



NORWEGIAN PETROLEUM DIRECTORATE

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Offentlig

4001 STAVANGER

Attn: Tore Sund

References yours

Ours

OD 84/05

/PV/IB

84 1344 /
Stavanger,
26 Jan 1984

Dear Mr Sund,

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Enclosed you will find a copy of an internal NPD note concerning the palynostratigraphy of the 6610/7-2 well on Trænabanken. These age determinations are based on cuttings samples only. Consequently, the results have to be considered as preliminary until further study of side wall cores has been accomplished.

The NPD is generally not providing any own data to companies unless for some special reason, in this case the poor understanding of Triassic stratigraphy. The information supplied in this note is meant to be a supplement to the usual consultant work, therefore, and emphasises the inter regional significance of the events recorded.

As far as it concerns the final well report we are of the opinion that these data can be included as NPD-data. These results can also be communicated to your license partners, but not to any consultant and/or other company, e.g., because of trading of the well.

Looking forward to further contacts with you.

Yours sincerely

Finn Roar Aamodt
Section Manager

Paul van Veen
Biostratigrapher

Enclosure: 1

APPEAL AGAINST DECISION (CF ADMINISTRATION ACT OF 10 FEBRUARY 1967, § 27, 3 PARAGRAPH AND CHAPTER VII)

The party or his representative may appeal a decision within 3 weeks following the receipt of the decision. The appeal shall: a) be presented to the Norwegian Petroleum Directorate, b) be signed by the appellant or his representative, c) state the decision appealed against, and if necessary give information to establish whether the right to appeal exists and whether the appeal period has been observed, d) state the modification desired in respect of the appealed decision, and present the grounds of the appeal. The Administration Act, § 18 cfr § 19 give the party right to see the documents of the case. The appeal does not have a postponing effect on the decision unless otherwise provided by the Norwegian Petroleum Directorate. Conditions for such postponement can be stipulated. The party or his representative has the right to request the execution of the decision in question postponed until the appeal has been considered, if an execution of the decision would cause damage to the party.

OLJEDIREKTORATET | AVDELING FOR RESSURSFORVALTNING | SEKSJON
FOR OPERASJONGEOLOGI | BIOSTRATIGRAFI GRUPPE

Fra: Paul van Veen

14-01-1984

*Revisjon 24/01-84
til Statoil*

AGE DETERMINATION OF THE LOWER JURASSIC AND TRIASSIC IN 6610/7-2

INTRODUCTION

Preliminary results are presented of the palynological investigation of 59 ditch cuttings samples from the Lower Jurassic and Triassic in well 6610/7-2. The study started at 1539 m and extended down to 3474 m. Drilling problems and the possibility of a side track at approximately 3300 m necessitate this short note.

Lithology: Lithological summaries are presently available for this well down to TD. A description of the succession down to approximately 2000 meter is provided by a recent ECM report. A brief description of the lithology below 2000 meter is given on a column presented by Statoil during a recent ECM (4/1-84). This column is attached to this note.

The kerogen in the Lower Jurassic and the Rhaetian is mainly of terrestrial origin. The original colour of the age indicating elements suggests that some of the Rhaetian material is more matured than similar levels in e.g., 6609/10-1, but probably not sufficiently to allow any generation of hydrocarbons.

In the Triassic the kerogen is generally dominated by opaque or black particles with a variable amount of often corroded structured wood particles. It must be considered as a very poor source rock (Type IV to III). This is probably due to strongly oxidizing soil conditions, especially during the Late Karnian. However, the Lower Norian interval is in part of lacustrine origin and might well be more prolific. A distinct change in kerogen occurs below 3000 meter: a relatively important portion of corroded and partially amorphous plant clasts is present (Type III). The organic content of the Triassic material is

thought to be low to moderate and only occasionally high. The kerogen appears to be marginally mature.

CORRELATION WITH HALTENBANKEN AND TROMS

At the present stage it is not possible to correlate in detail to 6507/12-2 on Haltenbanken until additional SWC samples from that well have been studied. A preliminary correlation to the wells in the Troms area is proposed, partly based on biostratigraphy as well as on comparison of lithostratigraphical trends.

BIOSTRATIGRAPHICAL RESULTS

The results of this study can be summarized as below:

LOWER JURASSIC

1539 m	Pliensbachian to Late Sinemurian
1579 m	Hettangian (+ caved Sinemurian)

UPPER TRIASSIC - RHAETIAN

1629 m	Late Rhaetian (Assemblage A 1)
1668 m	Rhaetian (Assemblage A 2)
1707 m	
1746 m	Rhaetian (Assemblage B)
1785 - 1806	Rhaetian (Assemblage C)
HIATUS ?	Early Rhaetian to Late Norian (Assemblage D missing)

- NORIAN

1851 - 1911	Caved Rhaetian, probably indeterminate
1938 m	?? Middle Norian ??
1971 - 2061	Indeterminate (mostly caved Rhaetian)
2091 m	? Norian
2122 - 2208	Early Norian
2226 - 2334	Norian/Karnian transition

- KARNIAN

2364 - 2430	Late Karnian, (Late) Tuvalian I
2454 - 2664	Tuvalian II (marine)
2724 - 2784	(? Early) Tuvalian III
2814 - 2934	(Early) Tuvalian IV
2964 + 2994	Karnian, Tuvalian to Julian
3024 + 3054	Not determined, presumably Early Karnian, Julian
3084 - 3144	Early Karnian, Julian
3174 - 3264	Early Karnian, Cordevolian

MIDDLE TRIASSIC - LADINIAN

3294 - 3384	? Langobardian (Late Ladinian)
3414 - 3474	Langobardian (3474 - marine)

DESCRIPTION

PLIENSBACHIAN to LATE SINEMURIAN: 1539 M

Bisaccate pollen dominate the assemblage. Deltoidospora spp. are abundant, Chasmatosporites spp. and Quadraeculina annelaeformis are prominent constituents. Marine elements are absent. The composition of this assemblage suggests a Pliensbachian to Late Sinemurian age. Cerebropollenites spp. are notably absent, which may be evidence for an Early rather than a Late Pliensbachian age, corroborated by the prominence of Quadraeculina annelaeformis.

Environment of deposition: The dominance of brown structured and unstructured plant material, sometimes corroded or in aggregates, as well as of cuticle of plants, and the absence of marine indicators indicate a terrestrial environment. The flora is a mixture of swamp elements and trees, suggesting a fluvial to deltaic environment of deposition.

HETTANGIAN with CAVED SINEMURIAN: 1579 M

Bisaccate pollen still dominate the assemblage, but in this group Pinuspollenites minimus now is an important constituent, together with the pollen Chasmatosporites spp. and spores of the Deltoidospora type. Together with Trachysporites fuscus and Aratrisporites minimus this is indicative for a Hettangian age. Of note is the presence of Cadargosporites cf. reticulatus, known from the Lower Lias of Queensland, Australia, and of a possible algal spore ? Psophosphaera nimius (illustrated by Pocock, 1973, from the lowermost Jurassic from the Canadian Arctic) and of Spore type 3. The latter form appears to be restricted to Assemblage IIa from Haltenbanken (Late Sinemurian) and this suggests that this is present above and has caved down.

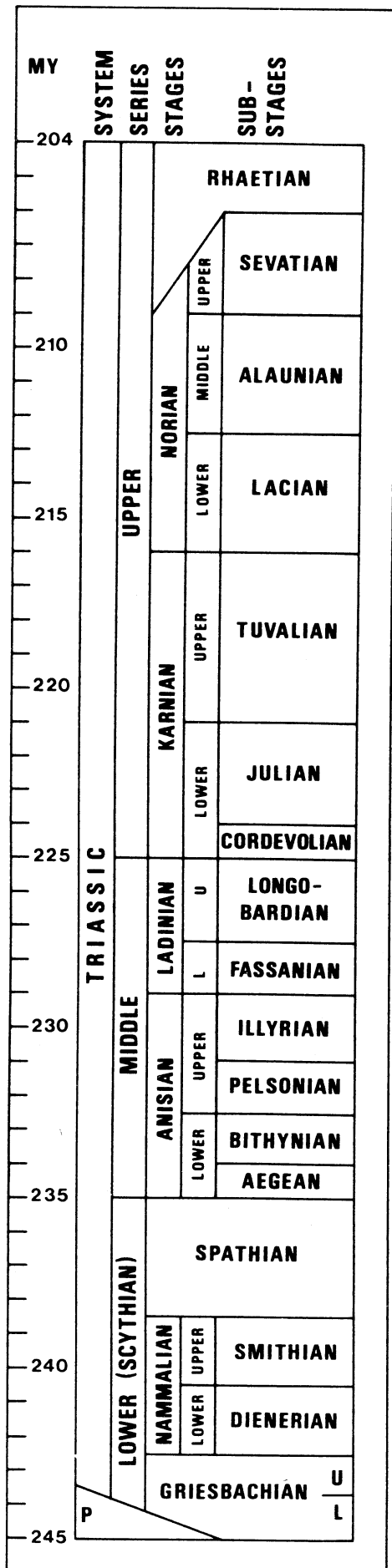
Environment of deposition: Similar as above.

UPPER TRIASSIC - RHAETIAN: 1629 - 1785 M

In the course of this study it became necessary to subdivide Assemblage A from the Haltenbanken area (Rhaetian) into two parts. Assemblage A1 is here defined by the low abundance of Limbosporites lundbladii and Riccisporites tuberculatus and the common presence of Polypodiisporites polymicroforatus, Rhaetipollis germanicus is present. Assemblage A2 is defined by the abundance of Limbosporites lundbladii, the presence of P. polymicroforatus and R. tuberculatus. Rhaetipollis germanicus is absent.

1629 m : Deltoidospora spp. dominate the assemblage. Bisaccate pollen are only of subordinate importance. The presence of Limbosporites lundbladii, Riccisporites tuberculatus and Rhaetipollis germanicus in this coal sample suggests a genuine Rhaetian age. The frequent presence of Polypodiisporites polymicroforatus (S) suggests a latest Rhaetian age for this assemblage. This level has also been recorded from some wells in the Haltenbanken area (6507/12-1, 12-2). Assemblage A1.

FIG. 3



Environment of deposition: The type of lithology (coal) as well as the composition of the assemblage indicate a swamp environment of deposition. The kerogen mainly consists of unstructured and structured plant clasts, partly corroded and aggregated. This latter feature suggests that the coal was formed as a very organic rich shale deposit rather than a true peat-coal.

1668 m : Deltoidospora spp. are still dominant, bisaccates are abundant. Limbosporites lundbladii and Riccisporites are present in equal portions (13%). Furthermore Lunatisporites noviaulensis and Araucariacites are present. Assemblage A2 (Rhaetian).

1707 m : Limbosporites lundbladii is dominant, whereas Riccisporites is only of subordinate importance. Ovalipollis pseudoalatus (P) and Vesicaspora fuscus appear. Of note is the presence of Semiretisporis wielowichiensis. Assemblage A2.

Environment of deposition: The palynodebris is characterized by structured and unstructured brown plant clasts, together with abundant cuticle rests. The material is poorly sorted. This suggests a fluvial environment of deposition.

1746 m : The composition of the assemblage is similar as above, but besides Vesicaspora fuscus and Ovalipollis pseudoalatus, Conbaculatisporites hopensis (S) and Protohaploxylinus microcorpus (P) appear. This indicates Assemblage B (Rhaetian) from Haltenbanken.

Environment of deposition: Similar as above.

1785 m : Riccisporites tuberculatus is abundant in this sample, which indicates Assemblage C. Apart from the aforementioned forms Vitreisporites bjuvensis is present.

1806 m : The assemblage is probably dominated by caved elements from the overlying Rhaetian Assemblage A2. Rare Heliosporites reissingerii as well as Corollina spp. have been observed here. Probably Assemblage C.

HIATUS: In this well, as in the previous one, Assemblage D - of Early Rhaetian to Late Norian age - is notably absent. The absence of Assemblage D therefore suggests a hiatus of latest Norian to earliest Rhaetian. Further study of side wall core material is necessary in this interval.

1851 m to 2061 m (except 1938): The assemblages are dominated by caved elements. In the palynodebris one can observe a higher proportion of opaque/black clasts and highly carbonized organic matter. This may be due to the effect of oxidation (near and within the redbeds).

1938 m : The very uncertain record of Antaulisporites sp. nov. (new species and genus now known from the Troms and Haltenbanken areas) gives a questionable Middle Norian age for this level.

Environment of deposition : Terrestrial environment of deposition with strongly oxidative soil conditions.

NORIAN: 2091 - 2208 M

? NORIAN: 2091 M

This assemblage, which still contains caved rhaetian elements (Ricciisporites , Limbosporites), but shows some features suggesting an older age. Unlike the samples above, Ovalipollis pseudoalatus (P) occurs frequently. Furthermore, a typical species of Calamospora , which is also encountered below , occurs for the first time, as well as Corollina sp.1.

EARLY NORIAN: 2122 - 2208 M

The first occurrence downhole of Kyrtomispuris spp. (e.g., K. speciosus) indicates the presence of the Kyrtomispuris Assemblage Zone, which in the Troms area is taken as of Early Norian age. A Norian age is further corroborated by the presence of the spore Leschikisporis aduncus. Ovalipollis pseudoalatus as well as Deltoidospora spp. are prominent to abundant. Araucariacites type pollen are frequently encountered. Chasmatisporites apertus and Quadraeculina anellaeformis are still present, but may have been caved down from the Rhaetian.

If these latter elements are in place, they represent the oldest known occurrences.

The assemblage of 2171/4 is particularly rich and diverse. Several species of Kyrtomisporis are met: K. niger , K. laevigatus and K. speciosus . Of note in this sample are the presence of Lunatisporites and Uvaesporites spp. , Enzonasporites , Granuloperculatipollis rudis , the Cingulizonates sp. complex (also seen in 7120/12 in this zone), Corollina meyeriana and Protodiploxypinus ornatus . Of special interest is the presence of the fresh water algae Pediastrum, which is common, and of Botryococcus. Chomotriletes sp. is recorded from 2208 m.

NORIAN/KARNIAN TRANSITION: 2226 - 2334 M

The samples in this interval are virtually barren or contain a small amount of pollen and spores, predominantly Ovalipollis.

UPPER KARNIAN: 2364 - ?2994 M

(LATE) TUVALIAN I : 2364 - 2430 M

Assemblages in this interval are generally rich and diverse, dominated by Ovalipollis pseudoalatus and Brachysaccus spp. A late Karnian age is suggested by the first downhole occurrence of Triadispora spp., notably Triadispora verrucata. The latter species typically appears below the Kyrtomisporis assemblage in the Troms area as well as on Hopen Island (Van Veen, 1983; unpublished information, respectively). Furthermore it is taken as an upper Karnian marker in the North Sea area (Morbey and Dunay, 1978).

Protodiploxypinus spp. (P. ornatus , P. macroverrucosus) are common, as well as Kyrtomisporis spp. The circumpollis type pollen Corollina meyeriana and Granuloperculatipollis rudis are prominent to abundant. Porcellispora longdonensis is nearly always present. Ricciisporites cf umbonatus is only encountered in this assemblage. Species of the taeniate bisaccate pollen Striatoabieites occur for the first time in this assemblage, as well as Partitisporites spp. and Cycadaceaelagenella sp.1. The

Striatoabieites occur for the first time in this assemblage, as well as Partitisorites spp. and Cycadaceaelagenella sp.1. The sample of 2394 m is notable for its (optimum) of Uvaesporites spp. and the presence of some poorly described and known ?Microreticulatisporites.

Assemblages of this type have been described from Poland from the upper part of the Upper Gipskeuper and the lowermost part of the overlying Drawny Beds (Orlowska - Zwolinska, 1979; unpublished).

TUVALIAN II: 2454 - 2664 m (MARINE)

The uppermost occurrence of marine elements, in this case sparse dinoflagellates, is taken as top of this interval. In fact, the assemblage of 2454 is very similar to those seen above and in a later stage it might well be decided to assign it to the upper assemblage. Dinoflagellates are further recorded from 2664 m. The algae Crassosphaera cf. hexagonalis is recorded from nearly all the samples. The acritarch Veryhachium is present at 2454 and 2514 m.

The dinoflagellates in the 2454 sample (Heibergella cf. asymmetrica , ? Shublikodinium spp.) are of a type suggesting a relationship with those described from the Upper Karnian Shublik Formation of the North Slope of Alaska (Wiggins, 1973). The dinoflagellates in the 2664 sample show affinities to those described from the Upper Karnian and Norian of the Sverdrup Basin (Bujak and Fischer 1976).

Concerning pollen and spores, the assemblages are still dominated by Ovalipollis and Brachysaccus pollen; Alisporites spp. are prominent. Triadispora begin to be prominent, especially in the lower half of this interval, where Triadispora crassa and T. verrucata are common. The circumpollis type Partitisorites "granulatus" is also frequently met. An increasing amount of the bisaccate pollentype Protodiploxypinus is seen in the lowermost samples. Of the spores Deltoidospora spp. are frequent to abundant, whereas Kyrtomisporis are still characteristically present.

The Tuvalian I and II interval roughly corresponds to the interval 2600 to 2850 m in well 7120/12-1 in the Troms area.

(? EARLY) TUVALIAN III: 2724 - 2784 M

The absence of any indication of marine influence, the still increasing amount of Triadispora and the first occurrence of Staurosaccites quadrifidus are taken as characteristic for this assemblage. Ovalipollis pseudoalatus is now dominant (over 32%). Furthermore Protodiploxylinus spp. are abundant. Uvaesporites are again common to prominent.

Staurosaccites spp. indicate a relatively early Tuvalian age (Visscher and Brugman, 1980).

EARLY TUVALIAN IV: 2814 - 2934 M

The gradual changes taking place in the previous interval T III result in an assemblage dominated by Ovalipollis and Triadispora spp., in which Kyrtomispuris and Protodiploxylinus spp. are virtually absent and probably only occur as caved elements. The preservation of the material gets worse and the recovery is generally poor. Porcellispora longdonensis is still present.

The Tuvalian III and IV interval roughly corresponds to the interval 2850 to 3115 m in the Troms 7120/12-1 well.

KARNIAN - TUVALIAN TO JULIAN: 2964 - 2994 M

The top of this interval is taken at a sudden increase in the abundance of Aratrisporites spp., especially A. parvispinosus. Furthermore a number of new elements appear: Triadispora vilis, a double-walled variety of Araucariacites and questionable specimens of Kuglerina meieri and Aulisporites astigmosus. According to Visscher and Brugman (1980) and Brugman (1983) the highest appearance of Kuglerina meieri occurs near the base of the Tuvalian in the Alpine Triassic. Aulisporites astigmosus had its optimum during the Julian (e.g., Orłowska-Zwolinska, 1979). The concurrent appearance of the latter two species is thus taken to indicate an early Tuvalian to Julian age for this interval.

NOT DETERMINED, PRESUMABLY EARLY KARNIAN - JULIAN: 3024 + 3054

The lithology of these two samples is dominated by sand and this probably explains their poor productivity. Considering the regional framework and stratigraphical position these sands appear to be the lateral equivalent of the gas bearing sands in the Troms area as well as of the Schilfsandstein in Central Europe. The samples are presently being reprocessed in order to confirm this determination.

EARLY KARNIAN, JULIAN: 3084 - 3144 M

There is a complete change in type of organic matter and composition of the assemblage relative to the samples further above. Though often quite corroded or even amorphous, an important amount of structured woody plant material is present in these and underlying samples. The recovery from the samples is quite low, however. The assemblages are notably different from those above by the near absence of Triadispora spp. Ovalipollis pseudoalatus is dominant (over 32%) in the uppermost two samples compared to prominent (less than 16%) in the samples at 2964 and 2994 m. Aulisporites astigmosus is optimally occurring in the sample at 3114 m, together with Calamospora spp.

In sections and wells covering the same interval in Poland and Germany, similar but much better defined assemblages with abundant Aulisporites astigmosus have been recovered from the Schilfsandstein and its lithological correlatives (Reed Sandstone, Poland; Lunzer Sandstone, Austria). According to Visscher and Brugman, 1980 this interval is mainly of Julian age.

The interval from 2964 to 3144 m in this well is thought to correspond to the interval 3115 to 3275 m in 7120/12-1 and 2554 to 2703 m in 7120/12-2 .

EARLY KARNIAN, CORDEVOLIAN: 3174 - 3264 M

The top of this interval is taken at a characteristic optimum of Triadispora verrucata, concurrent with a jump in the abundance of Triadispora spp. Pollen of this group again dominate the assemblages. Unlike the interval above Ovalipollis is only frequently met (less than 8%, generally). Spores of the Deltoidospora type are common to frequent. Furthermore a notable increase in the abundance of monolete spores is recorded in this interval (Punctatosporites walkomii, Leschikisporis aduncus). The monosulcate pollen Cycadaceaelagenella sp.1 is decreasing from frequent to present downwards, whereas Kuglerina meieri and specimens of the taeniate bisaccate pollen Striatoabieites are now regularly met. The top of this interval also records the highest appearance in this well of Tetrasaccus sp., bisaccate pollen belonging to the Illinites chitonoides complex and Thomsonisporites toralis. A possible specimen of Doubingerispora filamentosa is recorded in the 3204 sample.

An optimum of Triadispora verrucata is characteristically recorded in Poland at the top of the Lower Gipskeuper (Orlowska - Zwolinska, 1979; unpublished), above the highest occurrence of the late Ladinian key species Echinitosporites illiacoides. As the latter pollen is recorded below (3294 m) this interval and its assemblages are inferred to be of Cordevolian age (Bouman, 1981).

This interval is corresponding to the interval 3275 to 3373 in 7120/12-1 and 2703 to 2799.5 in 7120/12-2.

MIDDLE TRIASSIC

LATE LADINIAN, LONGOBARDIAN I : 3294 - 3384 M

The top of this interval is taken at the incoming of the taeniate bisaccate pollen Infernopollenites rieberi and the trilete bisaccate pollen Angustisulcites spp. The important latest Ladinian markers Echinicosporites illiacoides and Eucommiidites microgranulatus are only very rarely recorded.

Triadispora spp. are still dominant to abundant, whereas Ovalipollis pseudoalatus remains a frequent guest. Most of the new and/or common forms of the overlying interval continue. There appears to be a decrease in the number of spores.

Infernopollenites rieberi has been reported from the Upper Ladinian of Tessin, Switzerland (Scheuring, 1979), whereas Echinitosporites illiacoides and Eucommiidites microgranulatus are important markers for the Longobardian stage (Van der Eem, 1983; Brugman, 1983). E. illiacoides first occurs in the lower part of the Lower Gipskeuper in Poland, but has a characteristic optimum - together with E. microgranulatus - in the underlying Grenzdolomite (Orlowska - Zwolinska, 1979; unpublished). This optimum has not been recorded in this interval in this well. This might be due to a hiatus, but can also be attributed to differences in environment or even the state of preservation, which is very poor in this interval. Pending a further examination of side wall core material it is assumed that we have a complete, but diverging development of the palynostratigraphy at this level.

LONGOBARDIAN II: 3414 - 3474 M (lowest sample studied)

An important change in the composition of the assemblages is recorded at the top of this interval: Taeniate bisaccate pollen of the type of Striatoabieites (S. balmei, S. multistriatus) are jumping to abundant at 3414, but remain common below. Cycadaceaelagenella sp.1 steadily increases to abundant in the lowest sample, concurrent with an increase of Kraeuselisporites spp. In contrast, a steady decrease is recorded for Ovalipollis pseudoalatus and Triadispora spp. Triadispora verrucata is notably absent in two of the samples and might well be caved in the 3450 sample.

Characteristic appears the increase in zonate spores, as already mentioned above (Kraeuselisporites spp.) and especially the first appearance of a new species of Semiretisporis (informally called S. "vigranii"). This latter species has also been recognized in the Troms area, where it has its optimum in the Upper Ladinian. Furthermore in the lowest sample Heliosaccus dimorphus is recorded, which further adds to corroborate a

Longobardian age. This Longobardian II interval can be compared palynologically to the Lower Keuper of Poland, e.g., by the presence of Heliosaccus dimorphus.

The acritarchs Baltisphaeridium and Veryhachium spp. have also been encountered in the lowest sample, indicating marine influence during deposition .

The sand recorded at the base of the presently drilled section (3498 m) probably correlates to the sands penetrated at approximately 3500 meter in 7120/12-1 and at ca. 2935 meter in 7120/12-2. These sands were dated as late Anisian (early Middle Triassic) in the latter wells (Van Veen, 1983).

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