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Cretaceous biostratigraphy and lithostratigraphy of the Glinzendorf Syncline based on well Gänserndorf UeT3 (Vienna Basin, Austria)

Mathias Harzhauser[1]*, Stjepan Ćorić[2], Matthias Kranner[1], Michael König[3], Ales Vrsic[3]

[1)] Geological-Paleontological Department, Natural History Museum Vienna, Burgring 7, 1010 Vienna, Austria; mathias.harzhauser@nhm-wien.ac.at; matthias.kranner@nhm-wien.ac.at

[2)] Geological Survey Austria, Neulinggasse 38, 1030 Vienna, Austria; stjepan.coric@geologie.ac.at

[3)] OMV E&P GmbH, Trabrennstraße 6-8, 1020 Vienna, Austria; michael.koenig@omv.com, ales.vrsic@omv.com

[*)] Corresponding author, Mathias Harzhauser

KEYWORDS

Glinzendorf Syncline, Cretaceous, Gosau Group, Gänserndorf Thrust, Glinzendorf Formation

Abstract

The 2200 m thick Cretaceous units of well Gänserndorf UeT3 have been biostratigraphically analyzed based on cuttings from 3210 m to 5140 m. The deposits from the Tirolic Glinzendorf Syncline (a part of the buried Northern Calcareous Alps) can be largely correlated with the Lower Gosau Subgroup of the Grünbach Syncline. An exception is the basal unit, which has no equivalent in the Grünbach Syncline. This lower unit is subdivided into a non-marine lower and a largely marine upper part. No age constraints are available for the lower part, whereas the upper part has a possible age range from middle Turonian to Coniacian. For this unit, which is documented for the first time from the Glinzendorf Syncline, we propose Glinzendorf Formation as new lithostratigraphic term.

The Glinzendorf Fm. is overlain by the Grünbach Fm., which is intercalated by a thick unit of conglomerates. These are interpreted as equivalents of the Dreistetten Conglomerate Mb. The calcareous nannofossils of these units suggest a latest Santonian to early Campanian age. Non-marine conditions prevailed during deposition of the Grünbach Fm., but marine incursions are indicated for parts of the Dreistetten Conglomerate Mb. The top of the Grünbach Fm. is formed by an about 50-m-thick unit of coal, rich in Characeae oogonia, which, together with the Dreistetten conglomerates serve as marker layer for correlation with the outcrops in the Grünbach Syncline. The Grünbach Fm. is overlain by marls and silty shales of the Piesting Fm. for which a late Campanian and Maastrichtian age is documented. Marine conditions predominated during this interval. The topmost unit in well Gänserndorf UeT3 is overthrusted on the Maastrichtian Piesting Fm. and represents Campanian sandstones and conglomerates of the Grünbach Fm. This Gänserndorf Thrust is detected and biostratigraphically constrained for the first time.

1. Introduction

The Glinzendorf Syncline is an about 70 km long and up to 8 km wide, SW-NE trending structure in the Vienna Basin, which was briefly described by Wessely (1984; 1992) and Hamilton et al. (1990). It is part of the Tirolic nappe system and reaches from Himberg in Austria in the SE to Jakubov, Gajary and Záhorská Ves in Slovakia in the NE (Wessely et al., 1993; Ralbovský and Ostrolucký, 1996) (Fig. 1). The structure is completely covered by Neogene deposits.

The Glinzendorf Syncline is part of a series of surface and subsurface outcrops of the Cretaceous to Paleogene Gosau Group, which range from the Gießhübl and Grünbach-Neue Welt outcrops along the southwestern margin of the Vienna Basin to the Brezová and Myjava region in Slovakia in the Western Carpathians (Plöchinger et al., 1961; Schlagintweit and Wagreich, 1992; Wagreich and Marschalko, 1995; Hofer et al., 2013) (Fig. 1). These occurrences are linked by subsurface outcrops, such as the Gießhübl and Glinzendorf synclines and the Prottes and Studienka Gosau (Wessely, 1992; 1993; 2006; Hofer et al., 2013 and literature therein). According to Wessely et al. (1993), the Glinzendorf Syncline might continue into the Grünbach Syncline in the SE, but this was doubted by Hofer et al. (2013).

Although the Glinzendorf Syncline is covered by about 3000 m of Neogene sediments, several wells have reached and drilled the Cretaceous units. Wessely (1984; 1993; 2006), Wessely et al. (1993) and Hofer et al. (2013) mention

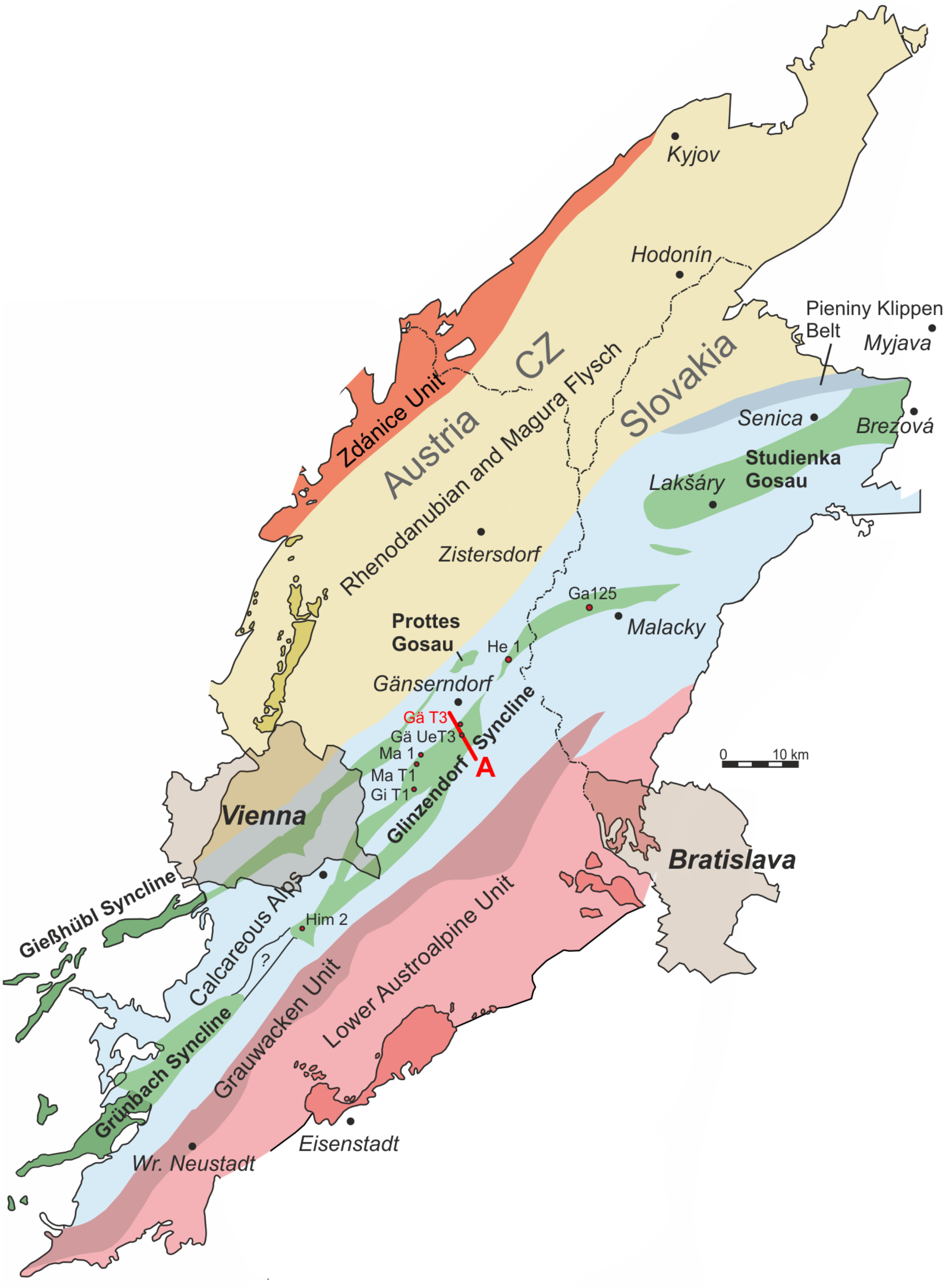

Figure 1: Geographic and geological setting of the investigation area in the Austrian part of the Vienna Basin. Surface and subsurface distribution of the Gosau Group after Wessely et al. (1993) and Hofer et al. (2013). Note that the connection between the Glinzendorf Syncline and the Grünbach Syncline is hypothetical but is supported by our data. Red line A corresponds to the seismic line in figure 6. Abbreviations: Ga 125: Gajary 125, Gä T3: Gänserndorf Tief 3, Gä UeT3: Gänserndorf Übertief 3, Gi T1: Glinzendorf 1, He 1: Heidenberg 1, Him 2: Himberg 2, Ma 1: Markgrafneusiedl 1, Ma T1: Markgrafneusiedl Tief 1.

Gänserndorf UeT3, T3, Heidenberg 1, Markgrafneusiedl 1, N1, T1, and Glinzendorf 1, T1 as important wells on Austrian territory (Fig. 1). In addition, several wells in the Himberg region in the southern Vienna Basin reached Gosau sediments (Wessely et al., 1993). The continuation of the Glinzendorf Syncline on Slovakian territory was analyzed by Mišík (1994) and Ralbovský and Ostrolucký (1996) based on the Ga 125 well at Gajary.

Several wells drilled the Glinzendorf Syncline but only little geological and biostratigraphic data has been published so far. Mišík (1994) provided lithological data for well Ga-125 and focused especially on the provenance of the conglomerates and identified a southern source in the Juvavicum. An undifferentiated Senonian age (= Coniacian to Campanian and possibly also Maastrichtian) was proposed by Mišík (1994) for Ga-125. Hofer et al. (2013) performed geochemical analyses on some samples from the wells Glinzendorf T3 and Markgrafneusiedl T1, to distinguish marine and limnic successions and Stern and Wagreich (2013) provided data on heavy mineral distribution from samples from wells Markgrafneusiedl T1 and Glinzendorf T1. Hofer et al. (2013) and Stern and Wagreich (2013) assumed a Santonian to Campanian or even Maastrichtian age for the analyzed deposits, based on unpublished sources. Pavlishina et al. (2004) indicated an early to middle Campanian age based on palynology from well Markgrafneusiedl T1. A Coniacian to Santonian age was stated by Wessely (1992) for the northernmost Austrian part of the Glinzendorf Syncline for grey marls of well Heidenberg 1 based on unpublished OMV reports. For the main part of Glinzendorf Syncline, Wessely (1992; 2006) proposed a Santonian to Maastrichtian age based on unpublished spores and pollen data. In addition, Wessely (1992) mentioned unpublished globotruncanid foraminifers and calcareous nannoplankton, which might support this correlation. For the upper units in Gänserndorf UeT3, Wessely (1992; 2006) mentioned Maastrichtian globotruncanid foraminifers, but did not provide identifications or illustrations. Interestingly, Mišík (1994) emphasized the absence of Globotruncanidae and Orbitoididae from the coeval deposits of the well Gajary 125 well in Slovakia. Similarly, we have not been able to detect Globotruncanidae in our samples from Gänserndorf UeT3.

Concluding, for none of the wells drilling the Glinzendorf Syncline, a reliably and comprehensible biostratigraphy has been published so far.

2. Material and methods

To clarify the stratigraphy of the Gänserndorf UeT3 well (48°18′18.4764″N, 16°43′41.4038″E, drilled 1985–1987), OMV provided cutting samples from 3210 m to 5140 m for biostratigraphic analysis. Each of the 97 analyzed samples was treated for few seconds in an ultrasonic bath. Afterwards smear slides were made drying few drops of suspension on the object glass and fixed using Canada balsam. All smear slides were investigated with a Leica microscope with 1000 magnification. UC-zones were applied for Cretaceous samples as defined by Burnett (1998). In total thirty-three samples were barren of calcareous nannofossils. Ranges of calcareous nannoplankton species follow https://www.mikrotax.org/Nannotax3/index.html and references therein. In addition, wire log data (SP, RES) have been provided by OMV. Data on the lithology was derived in 2020 from thin section analysis of cuttings by A.V. with a resolution of 10 m, including information of the occurrence of Characeae oogonia and larger foraminifers (Fig. 2). The list of nannofossil taxa detected in the investigates samples in provided in Table 1 (note that downfall is not listed).

2.1 Limitations

Using cuttings for calcareous nannoplankton biostratigraphy has several limitations. Down-core contamination frequently occurs and only in obvious cases (e.g., Miocene taxa in Cretaceous samples), this contamination can be reliably identified and excluded. In addition, reworking of stratigraphically older nannofossils from underlaying strata during deposition of younger strata is a process, which causes dilution of the autochthonous signal at varying amplitudes. Therefore, in the following we indicate the potential biostratigraphic range for each sample. Overlaps of these ranges are used to derive a most likely biostratigraphic zonation of the well but we emphasize that this method necessarily implies considerable uncertainties especially in detecting exact boundaries.

3. Results

3.1 Lithology

The Cretaceous deposits of the Glinzendorf Syncline rest uncomfortably on Jurassic units (Wessely, 1992; 2006 and own data OMV). The upper Jurassic Ruhpolding Fm. forms the basement of the Cretaceous strata in Gänserndorf UeT3 (OMV data). The Cretaceous of the Glinzendorf Syncline comprises an about 2000 m thick package, which can be separated from top to base into seven units based on lithologies and wire log patterns (Fig. 2). Note that all thicknesses are based only on drilling depth in Gänserndorf UeT3 and do not represent true thicknesses.

Unit 1 (3210–3550 m) is a 340-m-thick succession. Silty shales, sandstones and rare conglomerates predominate the lower part. Foraminifers (*Goupillaudina* sp.) have been recorded in this lower part from cuttings at 3510 m, 3520 m, 3540 m and 3550 m (Fig. 3). Marls and silty shales with two subordinate coal layers occur in the upper part of unit 1. Characeae oogonia appear at 3370 m. SP and RES logs show high frequency and high amplitude serrations forming two coarsening upwards sequences.

Unit 2 (3550–3970 m) is a 420 m thick succession of marls and shales with rare intercalations of sandstones. Its base is formed by a thin sandstone bed containing foraminifers (*Goupillaudina* sp.) (3930 m), another thin sandstone intercalation with *Goupillaudina* occurs at 3700 m. SP- and RES-logs are characterized by low amplitude shale line patterns interrupted by few peaks correlated with sandstone layers. Only the upper part displays some low amplitude serrations.

Unit 3 (3970–4020 m) forms a 50 m thick bed of coal and coaly limestones with numerous Characeae oogonia. This unit serves as marker horizon for OMV-cross-correlation with other wells in the Glinzendorf Syncline and is indicated by a shale-line wire log pattern.

Unit 4 (4020–4250 m) is an about 230 m thick sequence of conglomerates, which are rich in exotic volcanogenic components, such as quartz porphyry in a reddish matrix (see also Wessely, 1992; 2006). In wire logs, this unit is marked by very high, moderately serrated RES-values accompanied by very low, shale-line SP-values.

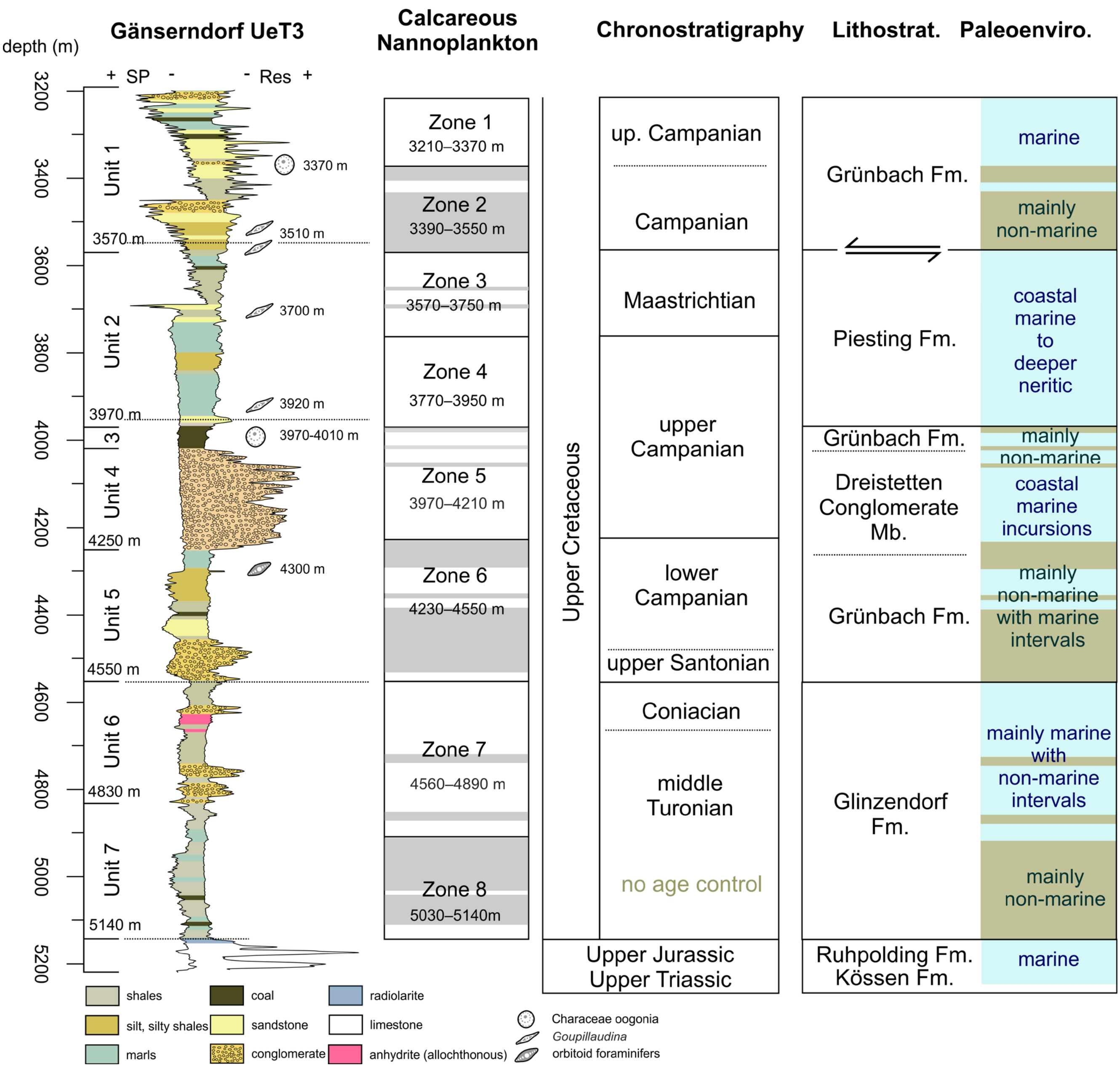

Figure 2: Wire logs (SP, RES) and lithologies of well Gänserndorf UeT3. Calcareous nannofossil assemblages define eight zones; grey intervals indicate barren samples. The 20-m-interval separating the zones represent uncertainty due to sampling distance. Chronostratigraphy and lithostratigraphy based on the age of the nannoplankton subunits and prevailing lithologies. Marine and non-marine phases are based on the presence or absence of marine calcareous nannofossils and the occurrence of Characeae and foraminifers.

Unit 5 (4250–4550 m) is an about 300 m thick fining upwards unit starting with basal conglomerates and sandstones passing into silty shales and shales with rare intercalations of coal. In wire logs, the succession is characterized by a funnel shaped to cylindrical SP-log with moderately high amplitudes and a RES-log of generally low variation interrupted by a marked positive excursion indicating basal conglomerates. Rare orbitoid foraminifers occur at 4300 m.

Unit 6 (4550–4830 m) consist of a 280-m-thick succession of grey to greenish grey and violet-brownish silty shales with conglomerates in its basal parts. Anhydrite is drilled between 4630 m and 4670 m. This anhydrite is interpreted as allochthonous intercalation and is overlain by conglomerates and silty shales. In wire logs, the lower unit is characterized by a funnel shaped to cylindrical SP-log with low amplitudes and a RES-log with serrated, positive excursions indicating coarse, conglomeratic units.

Unit 7 (4830–5140 m) consists of a 310-m-thick succession of marls with two intercalations of coal in its basal half. Wire logs are characterized by a cylindrical, low amplitude SP-log and a shale-line RES-log.

Below follow radiolarites, of the Upper Jurassic Ruhpolding Fm. (5140–5160 m) and limestones of the Upper Triassic Kössen Fm. (5160–5300 m) (unpublished OMV data), which have not been analyzed herein.

Taxon	3210	3230	3250	3270	3290	3310	3330	3350	3370	3390	3410	3430	3450	3470	3490	3510	3530	3550	3570	3590	3610	3630	3650	3670	3690	3710	3730	3750	3770	3790	3810	3830	3850	3870	3890	3910	3930	3950	3970	3990	4010	4030	4050	4070	4090	4110	4130	4150	4170
Acuturris scotus (Risatti, 1973) Wind & Wise in Wise & Wind, 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arkhangelskiella cymbiformis Vekshina, 1959	1	0	1	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Broinsonia parca subsp. *parca* (Stradner, 1963) Bukry, 1969	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculites obscurus (Deflandre, 1959) Prins & Sissingh in Sissingh, 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculites ovalis (Stradner, 1963) Prins & Sissingh in Sissingh, 1977	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0
Calculites percernis Jeremiah, 1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculites sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceratolithoides kamptneri Bramlette & Martini, 1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chiastozygus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cribrosphaerella ehrenbergii (Arkhangelsky, 1912) Deflandre in Piveteau, 1952	0	1	0	1	1	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclagelosphaera reinhardtii (Perch-Nielsen, 1968) Romein, 1977	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eiffellithus eximius (Stover, 1966) Perch-Nielsen, 1968	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Eiffellithus gorkae Reinhardt, 1965	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Eiffellithus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eiffellithus turriseiffelii (Deflandre in Deflandre & Fert, 1954) Reinhardt, 1965	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus arcuatus Forchheimer, 1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Lucianorhabdus cayeuxii Deflandre, 1959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus cf. *maleformis* Reinhardt, 1966	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Lucianorhabdus quadrifidus Forchheimer, 1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0
Markalius inversus (Deflandre in Deflandre and Fert, 1954) Bramlette and Martini, 1964	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microrhabdulus decoratus Deflandre, 1959	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula adumbrata Burnett, 1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula murus (Martini, 1961) Bukry, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Micula praemurus (Bukry, 1973) Stradner & Steinmetz, 1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Micula staurophora (Gardet, 1955) Stradner, 1963	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0
Micula swastica Stradner & Steinmetz, 1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Munarinus lesliae Risatti, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Nannoconus sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottavianus terrazetus Risatti, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Quadrum bengalensis Burnett, 1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Placozygus fibuliformis (Reinhardt, 1964) Hoffmann, 1970	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pontosphaera exilis (Bramlette & Sullivan, 1961) Romein, 1979	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prediscosphaera cretacea (Arkhangelsky, 1912) Gartner, 1968	1	1	0	0	1	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quadrum gartneri Prins & Perch-Nielsen in Manivit et al., 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reinhardtites levis Prins & Sissingh in Sissingh, 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa angustiforata Black, 1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa crenulata (Bramlette & Martini, 1964) Grün in Grün and Allemann, 1975	1	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa octofenestrata (Bralower in Bralower et al., 1989) Bown in Bown & Cooper, 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
Russellia bukryi Risatti, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Uniplanarius sissinghii (Perch-Nielsen, 1986) Farhan 1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Uniplanarius gothicus *(Deflandre, 1959) Hattner & Wise, in Wind & Wise 1983*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Watznaueria britannica (Stradner, 1963) Reinhardt, 1964	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watznaueria fossacincta (Black, 1971) Bown in Bown & Cooper, 1989	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watznaueria manivitiae Bukry, 1973	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zeugrhabdotus bicrescenticus (Stover, 1966) Burnett in Gale et al., 1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zeugrhabdotus blowii Lees, 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zeugrhabdotus diplogrammus (Deflandre & Fert, 1954) Burnett in Gale et al., 1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Taxon	4190	4210	4230	4250	4270	4290	4310	4330	4350	4370	4390	4410	4430	4450	4470	4490	4510	4530	4550	4570	4590	4630	4650	4660	4670	4690	4710	4730	4770	4790	4810	4830	4850	4870	4890	4910	4930	4950	4970	4990	5010	5030	5050	5070	5090	5110	5130	5140
Acuturris scotus (Risatti, 1973) Wind & Wise in Wise & Wind, 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arkhangelskiella cymbiformis Vekshina, 1959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Broinsonia parca subsp. *parca* (Stradner, 1963) Bukry, 1969	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculites obscurus (Deflandre, 1959) Prins & Sissingh in Sissingh, 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculites ovalis (Stradner, 1963) Prins & Sissingh in Sissingh, 1977	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculites percernis Jeremiah, 1996	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Calculites sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ceratolithoides kamptneri Bramlette & Martini, 1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chiastozygus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cribrosphaerella ehrenbergii (Arkhangelsky, 1912) Deflandre in Piveteau, 1952	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclagelosphaera reinhardtii (Perch-Nielsen, 1968) Romein, 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eiffellithus eximius (Stover, 1966) Perch-Nielsen, 1968	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Eiffellithus gorkae Reinhardt, 1965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eiffellithus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eiffellithus turriseiffelii (Deflandre in Deflandre & Fert, 1954) Reinhardt, 1965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus arcuatus Forchheimer, 1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus cayeuxii Deflandre, 1959	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus cf. *maleformis* Reinhardt, 1966	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus quadrifidus Forchheimer, 1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lucianorhabdus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Markalius inversus (Deflandre in Deflandre and Fert, 1954) Bramlette and Martini, 1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microrhabdulus decoratus Deflandre, 1959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula adumbrata Burnett, 1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula murus (Martini, 1961) Bukry, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula praemurus (Bukry, 1973) Stradner & Steinmetz, 1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula staurophora (Gardet, 1955) Stradner, 1963	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micula swastica Stradner & Steinmetz, 1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Munarinus lesliae Risatti, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nannoconus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ottavianus terrazetus Risatti, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quadrum bengalensis Burnett, 1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Placozygus fibuliformis (Reinhardt, 1964) Hoffmann, 1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pontosphaera exilis (Bramlette & Sullivan, 1961) Romein, 1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prediscosphaera cretacea (Arkhangelsky, 1912) Gartner, 1968	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quadrum gartneri Prins & Perch-Nielsen in Manivit et al., 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reinhardtites levis Prins & Sissingh in Sissingh, 1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa angustiforata Black, 1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa crenulata (Bramlette & Martini, 1964) Grün in Grün and Allemann, 1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa octofenestrata (Bralower in Bralower et al., 1989) Bown in Bown & Cooper, 1998	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Retecapsa sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Russellia bukryi Risatti, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uniplanarius sissinghii (Perch-Nielsen, 1986) Farhan 1987	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Uniplanarius gothicus *(Deflandre, 1959) Hattner & Wise, in Wind & Wise 1983*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watznaueria britannica (Stradner, 1963) Reinhardt, 1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watznaueria fossacincta (Black, 1971) Bown in Bown & Cooper, 1989	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watznaueria manivitiae Bukry, 1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zeugrhabdotus bicrescenticus (Stover, 1966) Burnett in Gale et al., 1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zeugrhabdotus blowii Lees, 2007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zeugrhabdotus diplogrammus (Deflandre & Fert, 1954) Burnett in Gale et al., 1996	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 1: Cretaceous calcareous nannofossil taxa detected in the investigated cuttings-samples.

3.2 Biostratigraphy

In total, 104 species-level taxa of calcareous nannoplankton have been detected in the samples. Of these, only 50 taxa are autochthonous. Of the remaining taxa, one might be reworked from Jurassic strata (*Triscutum*? sp.). The ubiquitous *Watznaueria barnesiae* might also be partly reworked from older strata in many samples (Figs 4, 5). All other species represent downfall comprising Paleogene and Neogene taxa. These Paleogene taxa have been reworked into Neogene deposits and are part of the downfall from the Neogene because no Paleogene strata rest on the Cretaceous of the Glinzendorf Syncline. Therefore, the assemblages of the samples down to 3690 m are extremely distorted by downfall from Neogene strata and the rich and diverse Miocene assemblages dilute the comparatively scarce autochthonous material. Without information from seismics, it would be difficult to decide whether the Cretaceous taxa are autochthonous or reworked. All samples below 3690 m are clearly of pre-Neogene age and lack the high amount of downfall. Rare occurrences of Miocene taxa in samples 3910 m, 4590 m, 4710 m and 4890 m are obviously results of downhole contaminations.

The nannoplankton assemblages of the Gänserndorf UeT3 well allow a separation eight zones:

Zone 1 (3210–3370 m) is covered by nine samples. All samples contain moderately to well preserved autochthonous assemblages, which however are

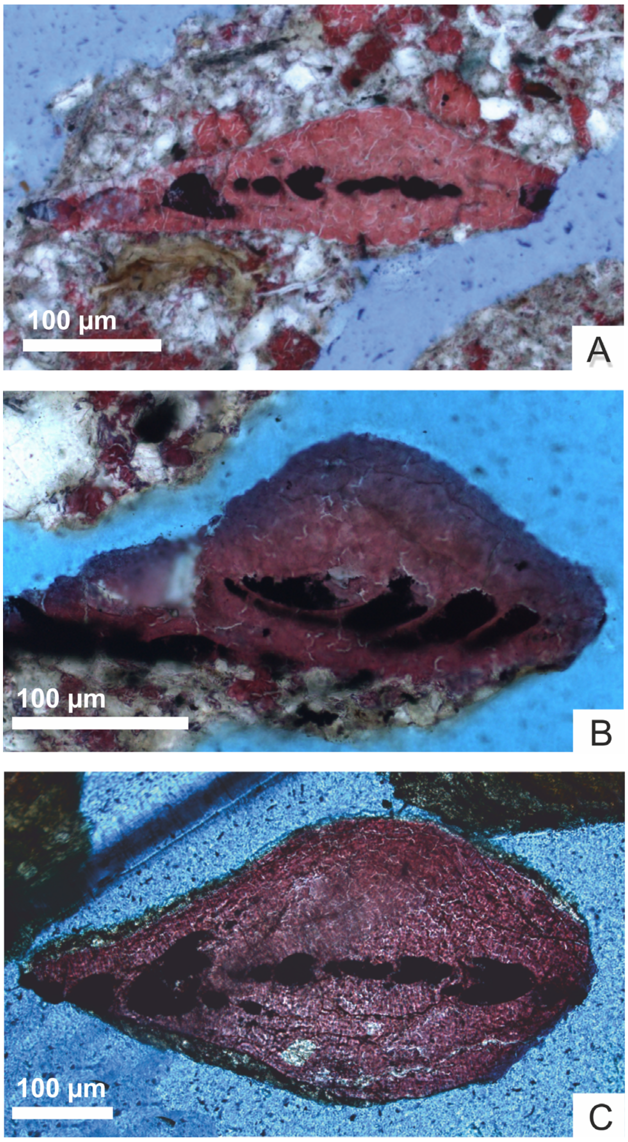

Figure 3: Specimens of the shallow water foraminifer *Goupillaudina* sp., **A**: 3540 m, **B**: 3520 m, **C**; 3520m.

strongly diluted by Neogene downfall. *Arkhangelskiella cymbiformis* and *Micula staurophora* are frequent in these samples (Figs 4, 5). Three samples (3250 m, 3290 m, 3370 m) contain *Broinsonia parca parca* (Fig. 4), which is indicative for the Calcareous nanoplankton Zones UC14–15d (Burnett, 1998) and suggests a Campanian age (Fig. 5). This age assignment is supported by the occurrence of *Eiffelithus eximinus* in sample 3330, which has its last occurrence in the Calcareous Nanoplankton Zone UC15e (Burnett, 1998). The constant occurrence of autochthonous nannoplankton points to prevailing marine conditions.

Zone 2 (3390–3550 m) is covered by eight samples, of which six are barren of nannofossils. Only samples 3410 m and 3430 m yield poor assemblages with the Campanian to Maastrichtian *Arkhangelskiella cymbiformis* and *Micula staurophora* (Burnett, 1998; Lees and Bown, 2005). The lack of autochthonous calcareous nannoplankton suggests prevailing non-marine conditions.

Zone 3 (3570–3750 m) is covered by ten samples of which only two are barren (3650 m, 3690 m). The calcareous nannoplankton assemblages comprise rare, moderately preserved specimens, suggesting restricted marine conditions. A Maastrichtian age is indicated by the presence of *Russellia bukryi* (UC17–UC20) in samples 3570 m and 3750 m (Fig. 4) and by the occurrence of *Micula murus* (UC20) in sample 3610 m (Burnett, 1998; Lees and Bown, 2005) (Fig. 5).

Zone 4 (3770–3950 m) is covered by 10 samples with rare and moderately preserved calcareous nannoplankton. A biostratigraphically important species is *Eiffelithus eximinus*, which has its last occurrence in the Calcareous Nanoplankton Zone UC15 (Burnett, 1998) and occurs in samples 3770 m, 3850 m, 3890 m, 3930 m and 3950 m. In addition, the occurrence of *Zeugrhabdotus blowii (LOD UC16)*, which does not pass the Campanian/Maastrichtian boundary, points to a Campanian age of the samples up to 3770 m (Burnett, 1998; Lees, 2007) (Fig. 5). The lower boundary is set by the occurrence of *Arkhangelskiella cymbiformis* (UC13–UC20) and *Reinhardites levis* (UC14d–UC18), resulting in a late Campanian age for this well-interval (Burnett, 1998). Marine conditions seem to have prevailed, although quality and quantity of the assemblages suggest that conditions were not ideal for calcareous nannoplankton.

Zone 5 (3970–4210) is covered by 13 samples, of which three were barren of nannofossils. Most of the other samples contained extremely rare and moderately to well preserved calcareous nannoplankton. Plant debris is frequent in all samples. The nannoplankton assemblages of this sequence gave a rather wide stratigraphic range. *Micula staurophora* and *Micula swastica* (Fig. 4) have a Coniacian to Maastrichtian range (samples 3990 m, 4090 m, 4130 m) (Burnett, 1998; Lees and Bown, 2005), which can be slightly narrowed down to the Santonian to Maastrichtian, based on the occurrence of *Lucianorhabdus cayeuxii* in sample 4190 m (Burnett, 1998). Only the presence of *Uniplanarius sissinghii* in sample 4070 m (Fig. 4), narrows the range even further down to Campanian to lower Maastrichtian (UC15–UC19) (Burnett, 1998) (Fig. 5). Therefore, we suppose a Campanian age as most likely solution. The low diversity and scarceness of nannofossils might be related to a very shallow, coastal marine depositional environment, which was unsuitable for calcareous nannoplankton. Overall, however, marine conditions seem to have been established during most of the deposition of this zone.

Zone 6 (4230–4550 m) is characterized by its poor nannoplankton content. Eleven out of 17 samples from this zone were barren of nannofossils and two yielded only rare *Watznaueria barnesiae*, which might have been reworked even from Jurassic strata. The potentially autochthonous assemblages of this interval from samples 4310 m, 4370 m and 4550 m are very poor and nannofossils are extremely rare. The presence of *Uniplanarius sissinghii in sample 4310 m suggests a* Campanian age (Burnett, 1998). The maximum age is set

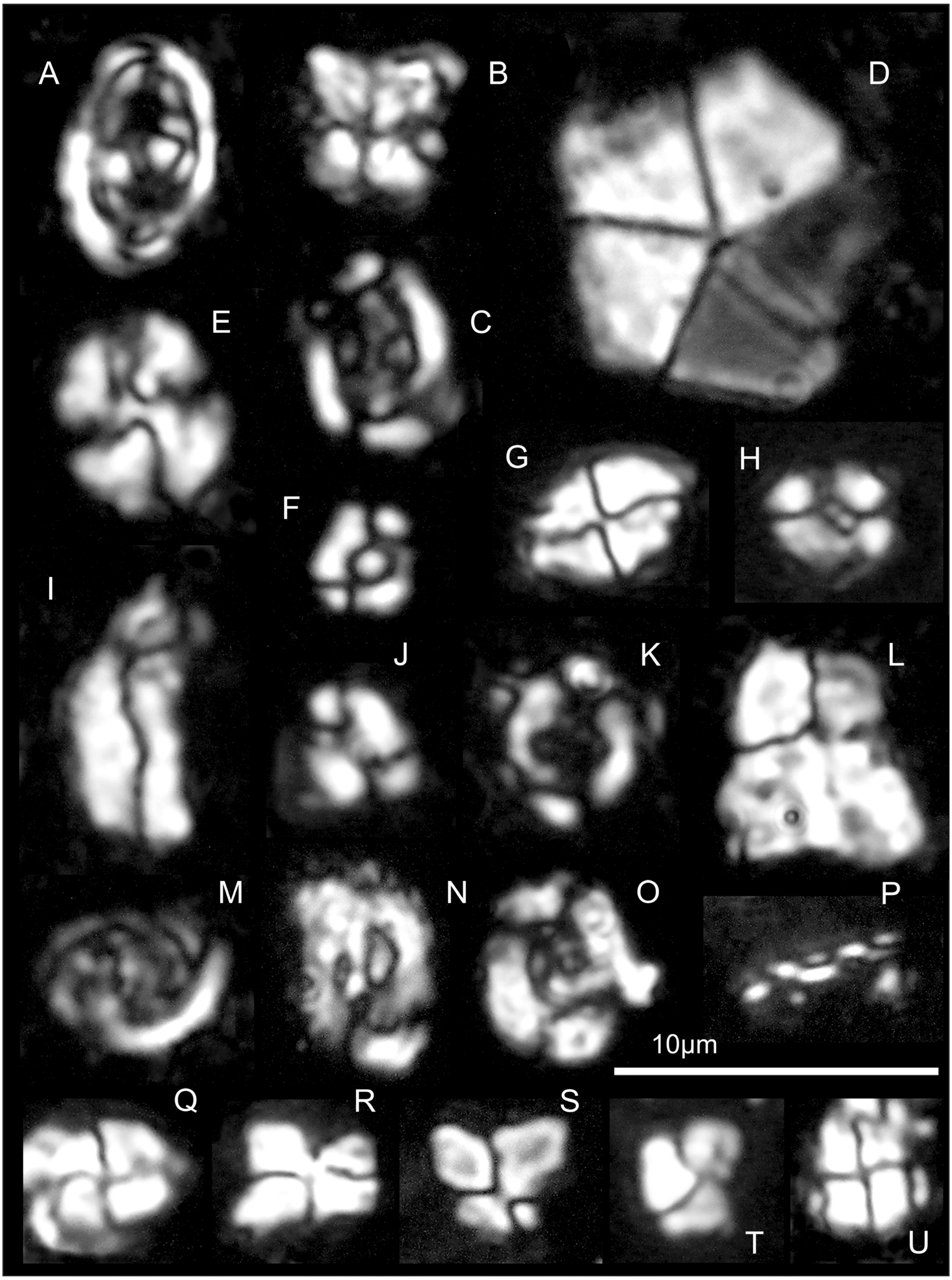

Figure 4: Calcareous nannoplankton from Gänserndorf UeT3: **A**: *Reinhardtites anthophorus* (Deflandre, 1959) Perch-Nielsen, 1968, Sample 3330m; **B***:* *Micula staurophora* (Gardet, 1955) Stradner, 1963, Sample 3330m; **C**: *Arkhangelskiella cymbiformis* Vekshina, 1959, Sample 3330m; **D**: *Braarudosphaera bigelowii* (Gran & Braarud 1935) Deflandre, 1947, Sample 3330m; **:**. *Watznaueria barnesiae* (Black *in* Black & Barnes, 1959) Perch-Nielsen, 1968, Sample 3750m; **F**: *Russellia bukryi* Risatti, 1973, Sample 3750m; **G**: *Calculites ovalis* (Stradner, 1963) Prins & Sissingh in Sissingh, 1977, Sample 3750m; **H**: *Munarinus lesliae* Risatti, 1973, Sample 3750m; **I**: *Lucianorhabdus arcuatus* Forchheimer, 1972, Sample 4030m; **J**: *Ottavianus terrazetus* Risatti, 1973, Sample 3750m; **K**: *Eiffellithus cf. eximius* (Stover, 1966) Perch-Nielsen, 1968, Sample 4030m; **L***:* *Quadrum bengalensis* Burnett, 1997, Sample 3750m; **M**: *Zeugrhabdotus sp.,* Sample 3750m; **N**: *Broinsonia parca* subsp. *parca* (Stradner, 1963) Bukry, 1969, Sample 3370m; **O**: *Broinsonia parca* subsp. *parca* (Stradner, 1963) Bukry, 1969, Sample 3290m; **P**: *Microrhabdulus decoratus* Deflandre, 1959, Sample 3270m; **Q**: *Micula praemurus* (Bukry, 1973) Stradner & Steinmetz, 1984, Sample 3670m; **R–S**: *Uniplanarius sissinghii* (Perch-Nielsen, 1986) Farhan 1987, Sample 4310m; **T**: *Micula swastica* Stradner & Steinmetz, 1984, Sample 3990m; **U**: *Uniplanarius gothicus* (Deflandre, 1959) Hattner & Wise, in Wind & Wise 1983, Sample 3930m.

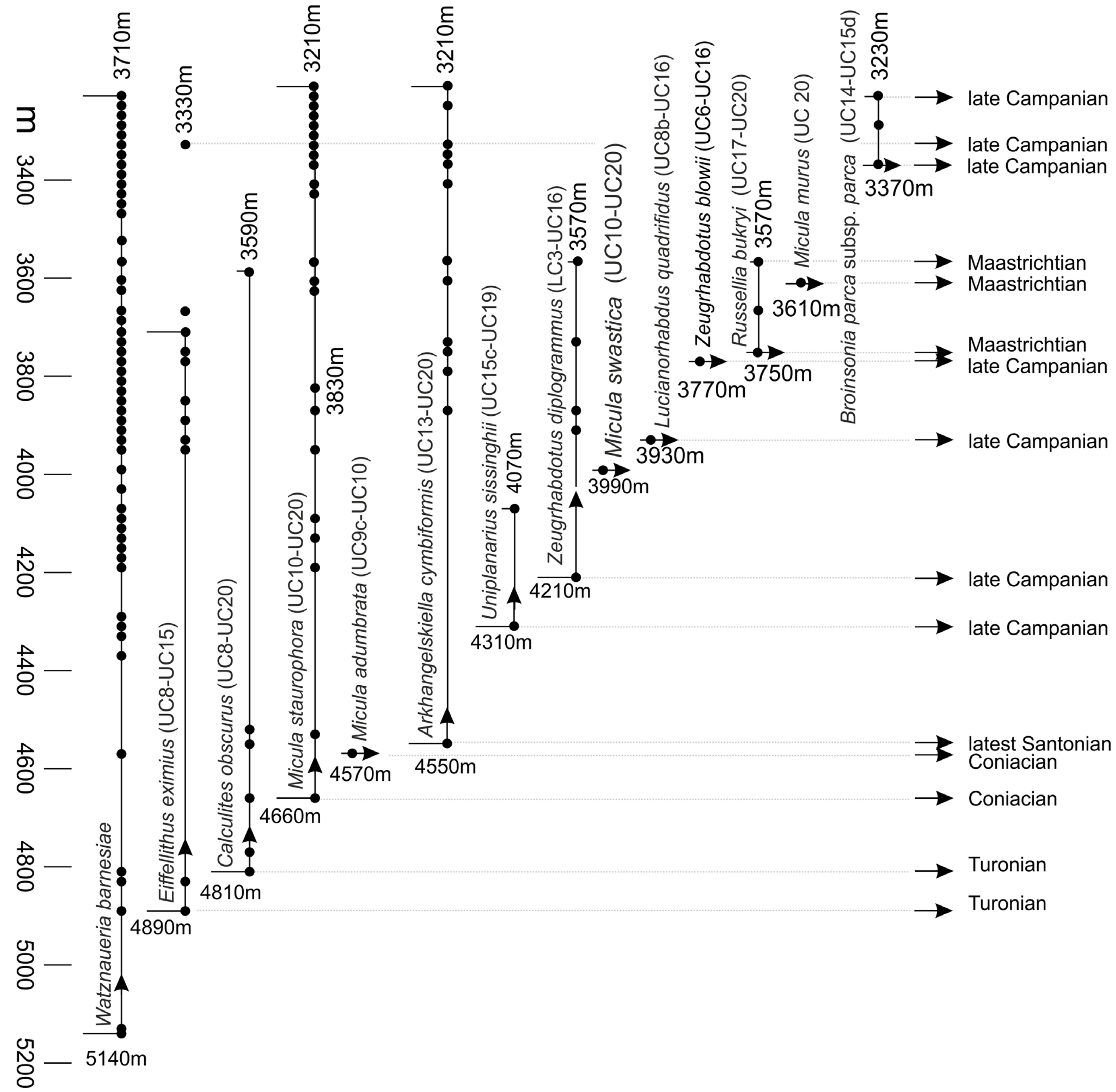

Figure 5: Occurrences of biostratigraphically important calcareous nannoplankton species in well Gänserndorf UeT3 and age interpretation.

to the latest Santonian to Campanian by the occurrence of *Arkhangelskiella cymbiformis* in sample 4550 m (Burnett, 1998) (Fig. 5). Overall, non-marine conditions seem to have prevailed.

Zone 7 (4570–4890 m) is covered by 16 samples of which six were barren of nannofossils. The assemblages of this interval contain rare, moderately preserved calcareous nannofossils. The occurrence of *Eiffellithus eximius (UC8–UC16) in sample 4890 m and of Calculites obscurus (UC8–UC20) in sample 4810 m indicate middle Turonian as maximum age (Burnett, 1998)*. The occurrence of *Micula adumbrata in sample 4570 m allows a correlation with the Coniacian zones* UC9–UC10 *(Burnett, 1998)* (Fig. 5). Based on these data, we correlate this interval with the middle Turonian and Coniacian. Coastal marine conditions, which were not ideal for calcareous nannoplankton seem to have prevailed, interrupted by repeated non-marine phases, reflected by barren samples.

Zone 8 (5030–5140 m) is covered only by three samples, which contain extremely rare and poorly preserved nannofossils. *Watznaueria barnesiae* in samples 5130 m and 5140 m has an enormous stratigraphic range from the Bathonian to the Maastrichtian (Mattioli and Erba, 1999; Lees and Bown, 2005) and might be reworked. The Jurassic ? *Triscutum* is recorded from sample 5030 m. Therefore, the scarce nannofossils of this unit seem to be entirely reworked and the depositional setting was probably non-marine.

Based on these data, Unit 1 is of Campanian age and Unit 2 is subdivided into a late Campanian and a Maastrichtian interval (Fig. 5). Units 3 and 4 are of late Campanian age and Unit 5 is correlated with the early Campanian but may span to the latest Santonian. Unit 6 contains middle Turonian and Coniacian parts. No biostratigraphic data are available for Unit 7.

4. Discussion

The Cretaceous units of the Glinzendorf Syncline represent eastern equivalents of contemporaneous deposits of Tirolic units of the Northern calcareous Alps such as the Grünbach Syncline and formed under largely similar depositional environments (Wessely, 2006; Hofer et al., 2013). Therefore, Wessely (2006) applied the lithostratigraphic scheme of the Grünbach Syncline, established by Summesberger et al. (2000; 2002) and Wagreich and Summesberger (2001), also for the Glinzendorf Syncline.

In the Grünbach Syncline, sedimentation commenced during the Santonian with the conglomerates of the Kreuzgraben Formation and the few-meter-thick, fully marine Maiersdorf Formation, comprising limestones rich in brachiopods and rudists along with sandstones. These are overlain by the Grünbach Formation, an about 150 thick succession of shales, sandstones and coals, which is famous for its reptile fauna (Bunzel, 1871) and for its diverse flora (Plöchinger et al., 1961; Herman and Kvaček, 2007; Summesberger et al., 2000; 2002; Hofer et al., 2011). The thick Dreistetten Conglomerate Member is intercalated within the Grünbach Fm. (Grundtner, 2011). The conglomerates are overlain by an about 60-m-thick unit of coal-bearing limestones, marls and sandstones with marine mollusc faunas alternating with limestones bearing Characeae oogonia (Schlagintweit and Wagreich, 1992). A latest Santonian to early Campanian age was proposed by Summesberger et al. (2000; 2002) for the Grünbach Fm. based on ammonites and inoceramid bivalves, nannofossils and $^{87}Sr/^{86}Sr$ data from the underlying Maiersdorf Fm. and the overlying Piesting Fm. The Grünbach Fm. formed under lacustrine and brackish conditions with rare marine incursions. Coastal swamps characterized the environment with alluvial fans at the basin margins (Summesberger et al., 2002; Hofer et al., 2011). The Dreistetten Conglomerate Member is interpreted as fan to fan delta complex within the Grünbach Fm. (Grundtner, 2011).

The Piesting Fm. overlies the Grünbach Fm. and represents a several hundred-meter-thick unit of grey marls, silt and sandstones with intercalations of orbitoid sandstones, which occur especially in the basal part (Schlagintweit and Wagreich, 1992; Summesberger et al., 2000; 2002; Wagreich and Summesberger, 2001). Based on its inoceramid and ammonite faunas, the Piesting Fm. is correlated with the late Campanian to Maastrichtian, which is supported by the calcareous nannoplankton assemblages (Summesberger et al., 2002). The Piesting Fm. formed under marine conditions. Inner neritic conditions, reflected by orbitoid sandstones, pass into middle to outer neritic water depths (Summesberger et al., 2002). The uppermost unit of the Grünbach Syncline is represented by turbiditic shales and sandstones of the Zweiersdorf Formation, which is of Danian to Thanetian age (Hradecká et al., 1999; Summesberger et al., 2002).

4.1 Correlation of the Glinzendorf Syncline with the Grünbach Syncline

Wessely (2006) correlated the Cretaceous of the Glinzendorf Syncline with the formations of the Grünbach Syncline starting with the Santonian Maiersdorf Formation, followed by the Campanian Grünbach Fm., and the Maastrichtian Piesting Fm. Based on this scheme, the Cretaceous succession of Gänserndorf UeT3 would be completely correlated with the Grünbach Fm. We agree only partly with the schematic and conceptual correlation of Wessely (2006), because it does not resolve the appearance of Campanian strata (unit 1) on top of Maastrichtian ones (unit 2) and it does not explain the occurrence of Turonian/Coniacian strata in the basal fill of the syncline (units 6 and 7). Therefore, we propose the following lithostratigraphic subdivision and correlation (Fig. 2).

4.1.1 Glinzendorf Formation (Fig. 2)

4830–5140 m; units 6 and 7, nannoplankton zones 7 and 8.

The Turonian to Coniacian age of the lower part of the Cretaceous fill of the Glinzendorf Syncline excludes a correlation with the Santonian to Campanian Grünbach Fm. This unit has not been described so far from the Glinzendorf Syncline and no formation name is available for it. Therefore, we propose Glinzendorf Formation as new name.

Type area: Subsurface Glinzendorf Syncline, in the area of Glinzendorf and Gänserndorf. The transition into the southern and northern parts of the Glinzendorf Syncline will have to be evaluated based on biostratigraphic data from additional wells.

Type section: Well Gänserndorf Übertief 3 (48°18′18.4764″N, 16°43′41.4038″E), 4550–5140 m.

Derivation of name: After the village Glinzendorf in Lower Austria (48°14′48.83″N, 16°38′26.64″E), which is eponymous for the Glinzendorf Syncline.

Lithology: Shales with intercalations of coals and marls in its basal part and silty shales and conglomerates with an allochthonous intercalation of anhydrite in the upper part (see descriptions of units 6 and 7 in the results chapter).

Fossils: Only calcareous nannofossils have been detected so far.

Depositional environment: the coal bearing lower part (unit 7) seems to have formed under limnic conditions. Terrestrial conditions are reflected by repeated reddish and brownish coloring of the shales. Conglomerates at the base of the more marine influenced upper part may point to alluvial fans, which are soon replaced by coastal marine settings. Marine calcareous nannofossils occurred during this phase, but the composition of the assemblages suggests restricted marine conditions.

Chronostratigraphic age: Middle Turonian to Coniacian.

Biostratigraphy: *The occurrence of Micula adumbrata in sample 4570 m allows a correlation with the Coniacian zones* UC9–10 *(Burnett, 1998), whilst* the occurrence of *Eiffellithus eximius (UC8–UC16) and of Calculites obscurus (UC8–UC20) in samples 4810 m and 4890 m indicate middle Turonian as maximum age (Burnett, 1998).*

Thickness: 590 m (note that this refers to drilling depth; the real thickness is unknown).

Lithostratigraphically higher rank unit: Gosau Group.

Lithostratigraphic subdivision: The formation is subdivided into a shaley lower unit with rare intercalations of coals and an upper unit of silty shales and conglomerates. No formal subdivision is proposed herein.

Underlying units: Ruhpolding Formation, Upper Jurassic. The lower boundary of the Glinzendorf Fm. is indicated by the transition from shales to radiolarites of the Ruhpolding Fm. 5140 m. This boundary is most probably a tectonic contact. This is also suggested by the low thickness of the Ruhpolding Fm (20 m), which is underlain by limestones of the Kössen Fm.

Overlying units: Grünbach Formation. The upper boundary of the Glinzendorf Fm. is indicated by the conglomerate of the basal Grünbach Fm. at 4550 m. The predominance of shales characterizes the Glinzendorf Fm. and distinguishes it from the Grünbach Fm. in which conglomerates, silty sand (lower part) and marls (upper part) predominate (Fig. 2). The lower and the upper boundaries coincide with unconformities in seismics (Fig. 6).

Lateral units: The Glinzendorf Fm. is reminiscent of coeval Turonian formations of the Gosau Basin. Especially the about 250-m-thick Kreuzgraben Fm. and the <100 m thick, overlaying Streiteck Fm. are comparable with the upper part of the Glinzendorf Fm. and comprise conglomerates, sandstones and marls suggesting a transition from alluvial fans to inner neritic environments (Kollmann, 1982; Wagreich, 1986; 1988). Coastal marine to paralic conditions are also reflected by the few tens of meters thick Schönleiten and Noth formations in the Hieflau area, which comprise grey marls and sandstones with coal seams (Kollmann and Sachsenhofer, 1998). A direct genetic relation with the Glinzendorf Syncline is unlikely but similarities of the depositional environments are obvious. Especially the occurrence of bauxites in the Brandenberg and Weiswasser Gosau in western Austria, of assumed Turonian age (Wagreich and Faupl, 1994), point to humid and warm climatic conditions. Marine Coniacian sedimentation is represented in the Gosau and Gams basins by the Grabenbach Fm., which comprises grey marls of Coniacian to Santonian age (Hradecká, 2002; Grachev, 2009). The deposits reflect a major marine flooding of the Calcareous Alps (Wagreich, 2003; Lobitzer, 2016). The predominately pelitic lithology and open marine depositional environment of the Grabenbach Fm. does not point to a genetic relation with the Glinzendorf Fm. In the Gießhübl Syncline, Coniacian to Santonian deposits are represented by unnamed sandstones and sandy marls, which underlie the upper Santonian to Campanian marls of the Nierental Formation (Wagreich et al., 2011). On the Stratigraphic Table of Austria, this unit is referred to as Lower Gosau Subgroup (Piller et al., 2004) and is interpreted as shallow marine, coastal deposits (Piller et al., 2004; Wagreich et al., 2011).

Temporal equivalents of the Glinzendorf Formation are represented in the Brezová region in Slovakia (Wagreich and Marschalko, 1995) northeast of the Glinzendorf syncline. There, the Brezová Gosau Group starts with the Ostriež Formation comprising basal alluvial fans of the Valchov Conglomerate Member and sand of the shallow marine Baranec Sandstone Member. These units are dated as Coniacian based on the Santonian age of the overlying marls of the Štvernik Marl Member (Samuel et al., 1980; Wagreich and Marschalko, 1995). As this dating is rather vague, an at least partly Turonian age of these deposits cannot be excluded. Thus, the Ostriež Formation might represent a temporal equivalent of the Glinzendorf Fm.

Remark: The observed presence of anhydrite most probable relates to remnants of the Permo-Triassic evaporitic sequence (Strauss et al., 2020). Due to depositional and salt-tectonic processes during the extension and the subsequent contraction of the northern Meliata/Neo-Tethys passive margin,

the evaporitic sequence has been mobilized, and can occasionally be found in a stratigraphic context, which does not allow to trace its origin. Thus, although the presence of anhydrite is mentioned herein, it is not an autochthonous part of the Glinzendorf Fm.

4.1.2 Grünbach Formation (Fig. 2)

3970–4830 m; units 1, 3, 4 and 5, nannoplankton zones 1, 2, 5 and 6.

The base of the Grünbach Fm. in the Glinzendorf Syncline correlates with the base of unit 5 at 4550 m (Fig. 2). Like in the Grünbach Syncline, this part of the Grünbach Fm. in the Glinzendorf syncline is of latest Santonian and early Campanian age and formed mainly under non-marine conditions with occasional marine floodings. A limnic development with few paralic marine incursions, reflected by rare coquinas with Acteonellidae gastropods, was also documented by Mišík (1994) for well Ga 125. The thick conglomerate beds of unit 4 represent equivalents of the Dreistetten Conglomerate Member and is expressed in seismics as prominent reflector (Fig. 6). The occurrence of calcareous nannofossils in several of the samples from the Dreistetten Conglomerate Mb., suggests repeated marine influence (Fig. 2). Conglomerates of up to 120 m thickness, containing exotic volcanogenic components, were also described from the Miesenbach outcrops by Gruber et al. (1992) and Schlagintweit and Wagreich (1992). The proposed Santonian age of these conglomerates, however, exclude

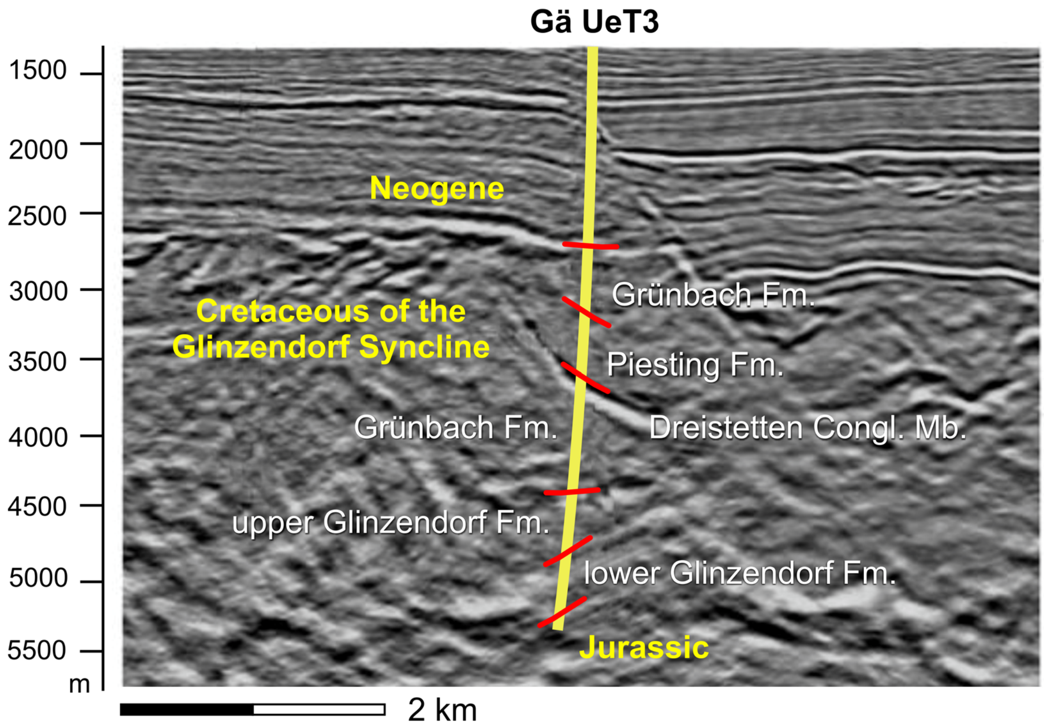

Figure 6: Seismic survey showing Cretaceous units of the Glinzendorf Syncline and lithostratigraphic subdivision based on well Gänserndorf UeT3. See red line in Figure 1 for position of the section. Note that seismic depth is given in True Vertical Depth, which is not fully identical with drilling depth.

a relation with the Campanian conglomerates of the Glinzendorf syncline.

The top of the Grünbach Fm. in the Glinzendorf Syncline is formed by coal and coaly limestones with Characeae oogonia of late Campanian age (unit 3). Limnic conditions prevailed during the formation of this part of the Grünbach Fm., which is corroborated by the geochemical data of Hofer et al. (2013). The coal bearing unit 3 of Gänserndorf UeT3 is identical in facies and thickness to the succession described by Gruber et al. (1992) and Schlagintweit and Wagreich (1992) from the Campanian successions of the Miesenbach outcrops, which are situated north of the Grünbach Syncline.

Unit 1 (3210–3570 m) is also of late Campanian age. Like unit 5, it is subdivided into a limnic basal part and a more marine influenced upper part and bears rare layers with Characeae oogonia and coal. Therefore, we interpret unit 1 also as Grünbach Fm. and as originally lateral equivalent of unit 5. In seismics, the boundary between unit 2 (Piesting Fm.) and unit 1 (Grünbach Fm.) is indicated by a slightly more prominent reflector and an unconformity. The shallow water foraminifer genus *Goupillaudina* has been recorded from basal parts of unit 1. This is in line with Plöchinger et al. (1961) and Oberhauser (1963), who recorded this genus from the Grünbach syncline, where these authors described it as typical for the coal bearing series of the Grünbach Fm.

4.1.3 Piesting Formation (Fig. 2)

3210–3870 m; unit 2, nannoplankton zones 3 and 4

The Piesting Fm. in the Glinzendorf Syncline commences with sandstones, bearing shallow water foraminifers, and passes quickly into marls and shales. This development is identical to the succession described from the Grünbach Syncline, where sandstones and orbitoid sandstones and conglomerates formed during the initial transgressive phase, passing upsection into more open marine "*Inoceramus*-marls" (Schlagintweit and Wagreich, 1992; Summesberger et al., 2002). The lower part of the Piesting Fm. in the Glinzendorf Syncline is of Campanian age, which is in line with data from the Grünbach Syncline. A shallowing occurred around the Campanian/Maastrichtian boundary indicated again by sandstone intercalations bearing the shallow water foraminifer *Goupillaudina* sp.. The top part of the Piesting Fm. in Gänserndorf UeT3 can be correlated with the Maastrichtian, which again is in line with data from the Grünbach Syncline. Maastrichtian globotruncanid foraminifers from Gänserndorf UeT3 derived from this unit (Wessely, 1992; 2006). This interval reflects the maximum of marine influx within the Cretaceous successions of the Glinzendorf Syncline (Fig. 2).

The presence of Danian to Thanetian deposits of the Zweiersdorf Fm. can be excluded for Gänserndorf UeT3 and is, to our knowledge, not documented so far from the Glinzendorf Syncline.

4.2 Gänserndorf Thrust

The occurrence of coarse siliciclastic Campanian strata of the Grünbach Formation on top of the pelitic Maastrichtian Piesting Fm. has not been described so far from Gosau deposits. It can be explained by a thrust, which transported lateral equivalents of unit 5 over Maastrichtian units or by an overturned and eroded syncline (Fig. 6). More data from seismic and wells will be needed to describe position and extension of this geological structure in detail.

5. Conclusions

For the first time a detailed biostratigraphic analysis of one well of the Cretaceous deposits of the Glinzendorf Syncline is presented based on calcareous nannofossil assemblages from cuttings from well Gänserndorf UeT3. These biostratigraphic data combined with lithological information, wire logs and seismic data allow a subdivision into lithostratigraphic units, which can partly be correlated with coeval successions of the Grünbach Syncline (Fig. 6).

The basal unit, for which the term Glinzendorf Fm. is introduced, rests on the Jurassic Ruhpolding Fm. and indicates a succession from limnic-paralic and terrestrial marls into coastal marine conglomerates and shales, which formed during the middle Turonian and Coniacian. Conglomerates and coal bearing silty shales of the Grünbach Fm. were deposited during the early and late Campanian. The poor quality of the nannofossil assemblages and the high number of barren samples suggests predominantly non-marine conditions, which agree with limnic conditions proposed by Wessely (2006) and Hofer et al. (2013) based on palynological and geochemical data. A 230-m-thick equivalent of the Dreistetten Conglomerate Mb., rich in rhyolitic clasts, and a 50-m-thick unit of coal and coaly limestones form the top of the Grünbach Fm. These units are of Campanian age. The comparatively frequent occurrence of nannofossils within the Dreistetten Conglomerate Mb., indicate surprisingly higher marine influx for this interval.

A marine transgression, leading to more open marine conditions, is indicated by a unit of marls from 3970–3570 m (Fig. 2). This unit can be reasonably correlated with the Campanian to Maastrichtian Piesting Fm. Sandstone layers with foraminifers (*Goupillaudina* sp.) formed around the Campanian/Maastrichtian boundary and might reflect a short shallowing.

Thus, a full correlation of the Upper Cretaceous deposits of the Glinzendorf Syncline with the Grünbach Syncline is documented for the Campanian to Maastrichtian formations. These data support the hypothesis of Wessely et al. (1993), that the Glinzendorf Syncline is a direct continuation of the Grünbach Syncline. The Turonian to Coniacian deposits of the of the Glinzendorf Fm., however, lack an equivalent on the Grünbach Syncline. The biostratigraphic data suggest a gap between the Glinzendorf Fm. and the Grünbach Fm. in the Gänserndorf UeT3 spanning the nannoplankton Zones UC11–UC12. Therefore, most of the Santonian is missing. The occurrence of Campanian siliciclastics on top of the marls and shales of the Piesting Fm. documents a post-Maastrichtian thrust, which is described for the first time from the Glinzendorf Syncline.

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