# Evidence of increasing surface-water oligotrophy during the Campanian-Maastrichtian boundary interval: calcareous nannofossil assemblages of DSDP Hole 390A (Blake Nose)

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Several stable isotope studies imply a general cooling trend throughout the Campanian-Maastrichtian period (*e.g.* Huber *et al.*, 2002; Miller *et al.*, 2005). Recently, this view has been modified with two short termed cooling events of early and middle Maastrichtian age, which interrupt the progressive cooling trend (*e.g.* Barrera & Savin, 1999; Thibault & Gardin, 2006). In order to better understand this climatic evolution, material from DSDP Site 390A has been studied for calcareous nannofossils. This site contains a chalky, 13.8m-thick uppermost Campanian-lower Maastrichtian interval (Benson *et al.*, 1978). Stable isotope studies on planktic foraminifera of DSDP Site 390 indicate three minor cooling events (events A, B, C) instead of one major event (Friedrich *et al.*, 2004). Subsequent studies on benthic foraminfera suggested an increasing oligotrophy throughout this interval (Friedrich & Hemleben, 2006).

We collected 60 samples from the Campanian-Maastrichtian boundary interval. For the study of calcareous nannofossil assemblages we used the settling technique (Geisen *et al.*, 1999). Abundances were determined by counting 372 to 469 specimens in each sample. Two traverses were investigated for rare species. Finally, we obtained biometrical data (coccolith length, width and central area) of 50 specimens of *Arkhangelskiella* in each sample.

The preservation of nannofossil specimens is generally good. A total number of 118 taxa has been encountered, the mean species richness is around 80 species per sample. The absolute abundance varies between 3.74 * $10^9$ and 11.52 * $10^9$ (mean 6.80 * $10^9$) specimens/g sediment. The assemblage is dominated by *Prediscosphaera* spp. (20.5%), *Watznaueria* spp. (20.3%), *Retecapsa* spp. (9.8%) and *Micula* spp. (5.1%). Other abundant taxa are *Cribrosphaerella ehrenbergii* (3.9%), *Ceratolithoides* spp. (3.5%) and *Discorhabdus ignotus* (3.3%). Around 133mbsf, several taxa (*D. ignotus*, *Zygodiscus exmouthiensis*, *Zeugrabdotus bicrescenticus*) decrease, while *Staurolithites flavus* increases (Fig. 1). The oligotrophic taxa *Watznaueria* spp. and *Micula* spp. increase slightly around this level (Fig. 1). On the

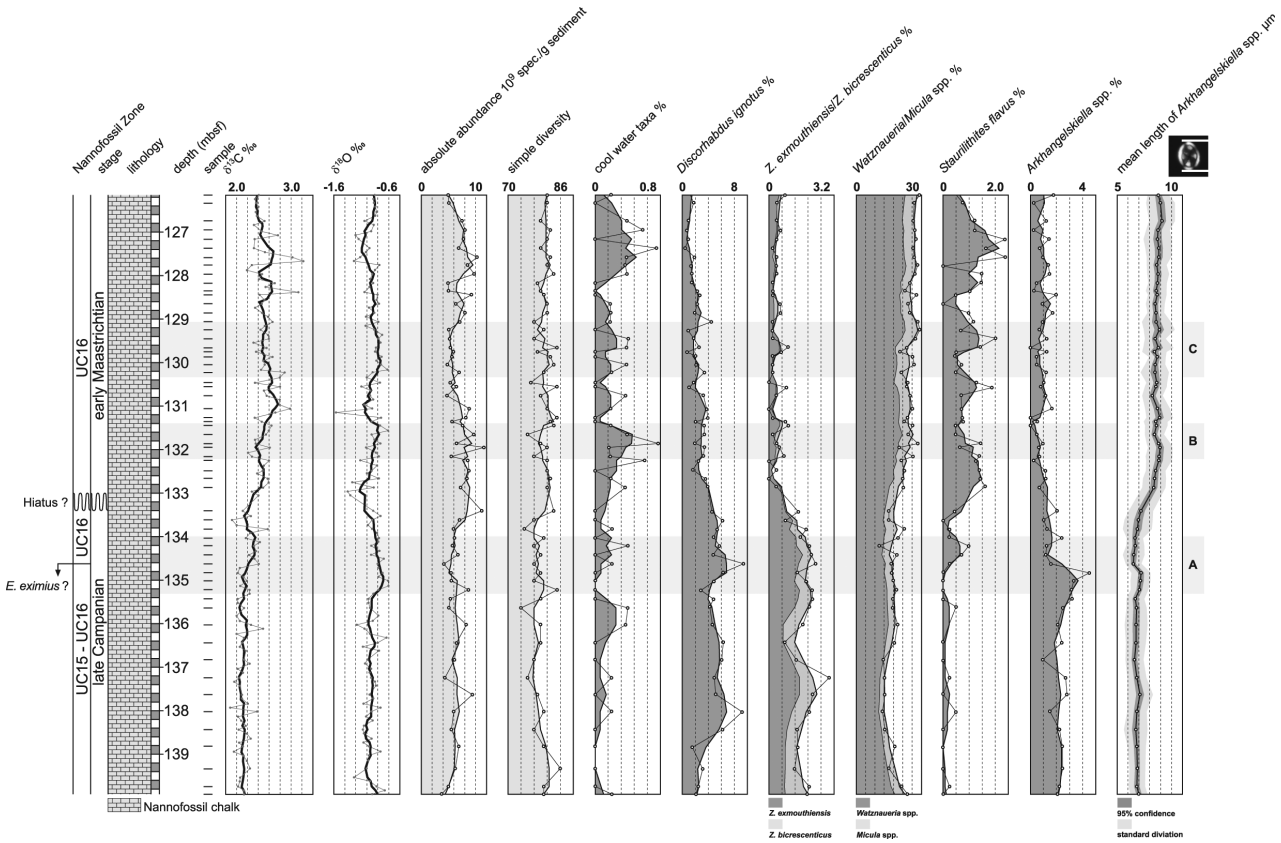


**Figure 1**: Fluctuations of absolute abundance, simple diversity (= species richness), relative abundances of several nannofossil taxa (*Arkhangelskiella* spp., cool-water taxa, *D. ignotus*, *Micula* spp., *S. flavus*, *Watznaueria* spp., *Z. exmouthensis*, *Z. bicrescenticus*) and the mean size of *Arkhangelskiella* during the Campanian-Maastrichtian boundary interval at Hole 390A. Cool-water taxa include *A. octoradiata*, *G. segmentatum* and *K. magnificus*. Stable isotopes are after Friedrich *et al.* (2004)

same level, the average length of *Arkhangelskiella* spp. coccoliths increases from 6.8 to 8.7$\mu$m (Fig. 1). Cool-water taxa (*Ahmuellerella octoradiata*, *Gartnerago segmentatum*, *Kamptnerius magnificus*) are present, but their relative abundance is always below 1%.

The oxygen isotope data of Friedrich *et al*. (2004) indicate three surface-water cooling events (A, B, C; Fig. 1). The rare cool-water taxa show an increase during cooling event B, but no significant increases during events A and B. On the other hand, the cool-water taxa show a similar increase around 127-128mbsf. Several taxa show a turnover at the level 133mbsf. While oligotrophic taxa, like *Watzanueria* spp. and *S. flavus* increase, the eutrophic zeugrhabdotids decrease (Fig. 1). This suggests a turnover to more oligotrophic surface-waters. The benthic foraminiferal studies of Friedrich & Hemleben (2007) support this interpretation. The different sizes of *Arkhangelskiella* seem to correspond to ecophenotypes. In the lower part of the succession, *Arkhangelskiella* is more abundant, but the specimens are predominantly small (mean 6.8$\mu$m). These small specimens are probably eutrophic ecophenotypes, having a r-selected life strategy. Above 133mbsf, the average size increases to 8.7$\mu$m, but the abundance declines. The large specimens may have been oligotrophic, K-selected ecophenotypes. Thus the decrease in nutrients would have caused an increase in average size. Girgis (1987) measured the length of *Arkhangelskiella* specimens throughout the Maastrichtian of a Tethyan outcrop (Egypt), and observed a continuous increase in mean length from 7.4$\mu$m (Upper Campanian) to 12.5$\mu$m (Upper Maastrichtian). The abrupt increase in size of *Arkhangelskiella* specimens from 6.8$\mu$m to 8.7$\mu$m in DSDP Hole 390A may hint towards a hiatus between the Upper Campanian below 133mbsf and the Lower Maastrichtian above 133mbsf.

The Campanian-Mastrichtian boundary interval is thought to be a time of massive global changes. In several localities, a prominent cooling event occurred. In other settings, a change in nutrient influx is recorded. Our results show a clear response of fossil coccolithophores, primary producers, to environmental changes at the Campanian-Maastrichtian transition.

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