



# Calcareous benthonic foraminifera across the Cretaceous/Paleocene transition of Gebel Um El-Ghanayem, Kharga Oasis, Egypt



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## ABSTRACT

The studies of benthic calcareous foraminifera of the Maastrichtian–early Paleocene Dakhla Formation in Gebel Um El-Ghanayem (Western Desert, Egypt), improve reconstruction of depositional environments of these successions. In total, 68 taxa of benthic foraminifera were identified in the studied succession.

The late Maastrichtian assemblages (Zone CF3) are dominated by calcareous foraminifera with tapered tests, this tapered taxon *Loxostomum applinae*, *Lox. tegulatum* various dentalinid taxa, and *Buliminella cushmani* dominate in CF3 Biozone. We thus interpret these faunas as being dominated by infaunal morphogroups, suggesting a moderately eutrophic environment.

Danian assemblages are characterized by abundant epifaunal trochospiral species, such as *Cibicidoides abudurbensis*, *Cibicidoides farafraensis*, and *Gyroidinoides girardanus*. The infaunal morphogroups make up 25–47% of fauna in the Danian, in contrast to 62–76% in the Upper Maastrichtian. This dominance of the Danian benthic foraminiferal assemblages by epifaunal or mixed epifaunal/infaunal morphogroups suggests that the food supply to the benthos was less abundant than in the latest Cretaceous.

The Cretaceous/Paleocene boundary (K/Pg) is within the upper unit of the Lower Kharga Member and marked by a hiatus in at least the top of CF3 Zone of the Upper Maastrichtian to the Lower Paleocene (base Plc Zone).

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## 1. Introduction

The benthic foraminiferal faunal turnover across the K/Pg boundary has been described from many locations worldwide (Culver, 2003). The benthic foraminifera of the Upper Cretaceous through Lower Paleogene sections have been investigated intensively because one of the largest mass extinctions of the Phanerozoic occurred at the Cretaceous/Paleogene boundary (K/Pg). Most authors accept the catastrophic mass extinctions (Alvarez et al., 1980; Smit and Hertogen, 1980) on the Yucatan peninsula, and that the anomalous concentrations of iridium, shocked quartz and microspherules in K/Pg boundary sediments reflect that impact (e.g., Alvarez et al., 1980).

Meanwhile, some authors argue that the extinctions were not sudden but stepwise, starting in the Maastrichtian (e.g., Keller, 1989a,b, 2003), and linked at least in part to multiple impacts (Keller 2003). A scientific challenge is to assess the role of Deccan

volcanism in the Cretaceous–Tertiary boundary (KTB) mass extinction, where Keller et al. (2011) reported on the stratigraphy and biologic effects of Deccan volcanism in eleven deep wells from the Krishna–Godavari (K–G) Basin, Andhra Pradesh, India. The main eruptions ended at or near the Cretaceous Tertiary Boundary (KTB), an interval that spans planktonic foraminiferal zones CF1–CF2, and is correlative with the rapid global warming and subsequent cooling near the end of the Maastrichtian. Unfortunately a major K/Pg hiatus is present in Gebel Um El Ghanayem, the K/Pg contact was placed at the base of a 1-m-thick tan-colored calcareous siltstone and sandy limestone sequence that is widespread in the region and marks the base of the Abu Minqar Member.

In contrast to many other biotas, benthic foraminifera did not suffer significant extinction at the end of the Cretaceous (Culver, 2003). Their assemblages show temporal faunal restructuring, which has been related to the collapse of the pelagic food web, which delivers food to the benthos (e.g., Thomas, 1990a,b; Widmark and Malmgren, 1992; Coccioni et al., 1993; Kuhnt and Kaminski, 1993; Speijer and Van der Zwaan, 1996; d'Hondt et al., 1998; Alegret et al., 2001, 2002a,b, 2003; Culver, 2003). d'Hondt et al. (1998) argued that the decreased delivery of organic matter to the sea floor as the result of the extinction of pellet-producing

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zooplankton rather than decreased productivity might also have affected the benthos.

Benthic foraminifers are proxies for nutrient supply as well as for oxygenation at the sea floor, and constitute an important tool to reconstruct paleoenvironmental changes at the K/Pg boundary. Information from benthic foraminifers is particularly valuable in order to evaluate K/Pg extinction hypotheses that argue for widespread oceanic anoxia (e.g., Kaiho, 1999; Kaiho et al., 1999; Alegret and Thomas, 2005). Furthermore, benthic foraminifera can be used as a powerful tool to estimate depositional depths (e.g. Culver, 1993) as well as to infer seafloor paleoecology on the basis of their morphological similarity with recent benthic foraminifera (Olsson and Wise, 1987; Speijer and Van der Zwaan, 1996; Speijer et al., 1996; Kouwenhoven et al., 1997).

The faunal and lithological variations across the K/Pg boundary in Egypt have been dealt with by many workers (e.g. Abdel Razik, 1972; Anan and Hewaidy, 1986; Hewaidy and Cherif, 1987; Hewaidy, 1990; Speijer and Van der Zwaan, 1994; Aubry et al., 1999; Bolle et al., 2000; Tantawy et al., 2000; Hewaidy and Strougo, 2001; Aubry et al., 2002; Berggren and Ouda, 2003; Knox et al., 2003; Ismail, 2012). In addition, numerous studies of benthic foraminifera have been carried out, especially on the palaeoecological interpretation of the terminal Maastrichtian, Cretaceous/Tertiary boundary (e.g., Speijer and Van der Zwaan, 1996; Alegret et al., 2001; Culver, 2003). However, no attention has been given to the benthic foraminiferal morphogroups quantitative study across the K/Pg boundary. Therefore, this paper present detailed information on the calcareous benthic morphogroups characteristic that have prevailed during the sedimentary deposition across the K/Pg boundary to evaluate the changes in the benthic foraminiferal ecosystem at Gebel Um El-Ghanayem section, Western Desert, Egypt (Fig. 1).

2. Material and methods

Forty samples were collected from the northern side of Gebel Um El-Ghanayem, at decimeter intervals, with closer sampling across the top Maastrichtian and basal Danian strata. Samples were disaggregated in water with diluted H<sub>2</sub>O<sub>2</sub>, washed through a 63 µm sieve, and dried at 50 °C. Species richness measurement and quantitative studies were based on representative splits (using a modified Otto microsplitter) of approximately 300 specimens larger than 63 µm except for relatively poor samples from which only 50 specimens were picked. All the representative specimens were mounted on microslides for permanent record and identification. These microslides as well as the SEM-imaged (Supplementary Plates 1 and 2) specimens are part of the private collection of the senior author; fresh samples and residues are stored at the Department of Geology, Faculty of Science, Menoufia University.

In order to obtain general paleoenvironmental conditions and potential taphonomic alterations, the P/B ratios were calculated {expressed as 100 × P/(P + B)}, benthic foraminiferal numbers expressed as the number of benthic specimens per gram dry sediments (Murray, 1991), while dominance was calculated as percentage of the frequent taxon (Walton, 1964) and the proportion of non-calcareous agglutinated taxa.

The comparison of fossil and recent communities of benthic foraminifera, in addition to morphotype analysis (e.g., Corliss, 1985; Corliss and Chen, 1988; Jones and Charnock, 1985), allows us to infer probable microhabitat preferences and environmental parameters such as the nutrient supply to the sea-floor, its seasonality, and sea water oxygenation (e.g., Bernhard, 1986; Jorissen et al., 1995; Fontanier et al., 2002). One should be careful with the interpretation of these comparisons because the ecology of present foraminifera is complex and not fully understood

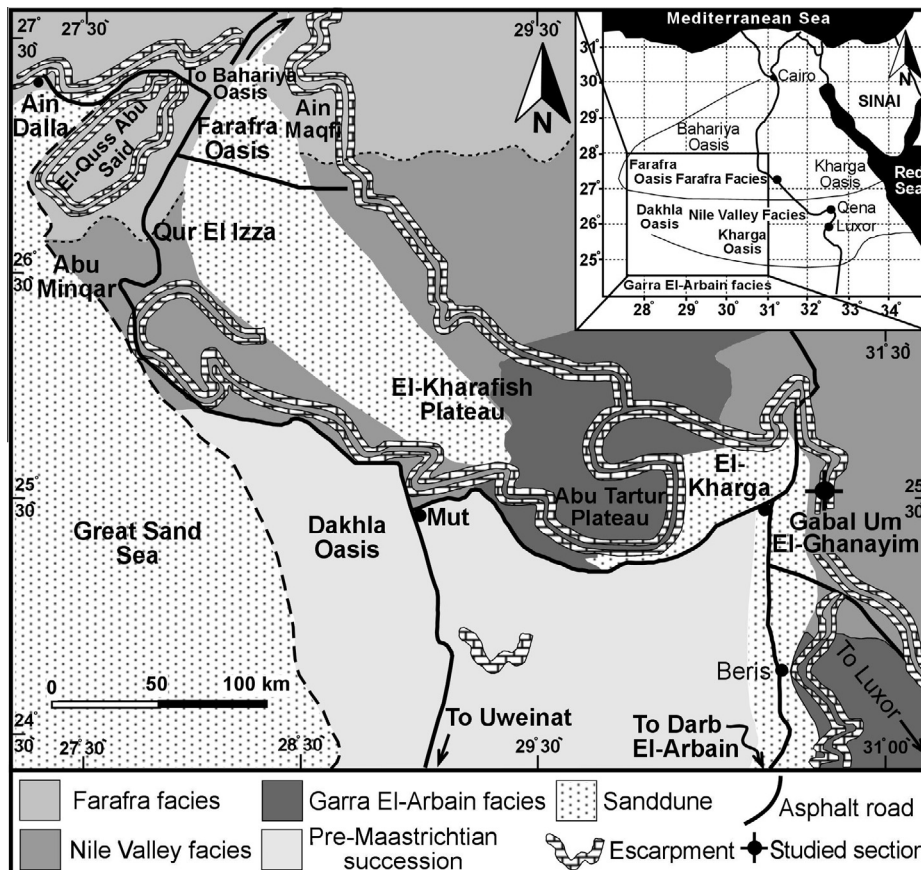


Fig. 1. Locality map.

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