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A synthesis of biotic and stratigraphic data from the Middle East on late Paleocene global change

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Lower Paleogene marine deposits cover extensive areas of Egypt and Israel, usually in a sub-horizontal or slightly tilted position. In combination with a near absence of vegetation, this setting provides unique opportunities to study upper Paleocene stratigraphy and events basin-wide and in great detail. We studied five upper Paleocene successions, focusing on planktic and benthic foraminifera, and stable isotopes. The sections are arranged on a generally NW-dipping slope of an epicontinental basin, which in its northern part was interrupted by – predominantly submarine – highs and lows of the Syrian Arc. Benthic foraminifera assemblages indicate overall deposition at c. 500 m at Ben Gurion and Wadi Nukhl, c. 200 m at Gebel Aweina and Gebel Qreiya, and c. 75 m at Gebel Duwi (Fig. 1).

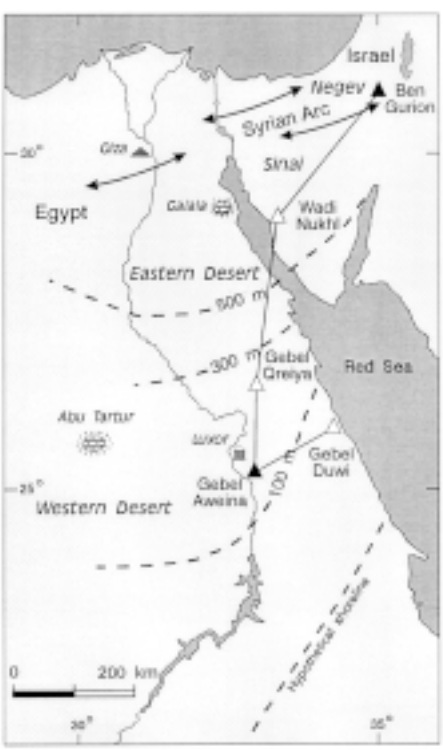

Fig. 1. Studied sections on late Paleocene bathymetric reconstruction. After Speijer et al. (2000).

Lithology. – Monotonous gray to brown marls prevail within the studied interval (Biozones P4–P6a). The short stratigraphic interval of global biotic and environmental change, however, is marked by a foraminifera-rich calcarenitic bed, overlying – in the more complete sections – a 20–50-cm thick fissile (Duwi) or TOC-rich laminated (Nukhl and Qreiya) marl bed. The Aweina and Ben Gurion sections do not show the latter bed, but instead a discontinuity (omission surface) at the base of the calcarenitic bed.

$\delta^{13}C$ isotopes. – The global negative carbon-isotope trend and the superimposed negative $\delta^{13}C$ excursion (CIE) have been recorded in whole-rock samples from all sections within Zone P5 (*sensu* Berggren et al. 1995). The CIE coincides with the anomalous beds and terminates above the calcarenitic bed. In Aweina and Ben Gurion, the base of the CIE coincides with the discontinuity, indicating that in these sections at least the lower part of the shift is truncated (Fig. 2). Whereas whole-rock isotopic records from this region are suitable for stratigraphic purposes, specimen-based paleoenvironmental studies are generally not reliable. Thin-shelled foraminifera (e.g., planktic or benthic like *Nuttallides truempyi*) from this region and time interval are morphologically well preserved, but mostly recrystallized and infilled with calcite, making them unsuitable for isotopic analysis. Reliable results can only be obtained from well-preserved, thick-shelled genera like *Frondicularia* and *Lenticulina*, from which the infillings can be removed (Schmitz et al. 1996).

Planktic foraminifera. – In all sections, the lowest common occurrence of *Globanomalina luxorensis* is found just above the base of the CIE. In addition, the fissile or laminated marl beds in the Nukhl, Qreiya, and Duwi sections contain a unique planktic assemblage (P/B ratios up to 99.9%), largely consisting of *Acarinina* (e.g. *A. sibaiyaensis*) and with a minor but distinct component of *Morozovella allisonensis*. To date, the latter species has only been recorded within the lower part of the CIE interval in ODP holes from the equatorial Pacific (Kelly et al. 1998) and western Atlantic (e.g. Cramer et al. in press), and thus has a very short stratigraphic range. These biostratigraphic data enable a threefold subdivision of Zone P5 (*Morozovella velascoensis* Zone; Fig. 2), with Subzone P5b being the total range zone of *M. allisonensis*. In Middle-East profiles where this subzone is missing (e.g. Aweina and Ben Gurion), Subzone P5a can be distinguished from Subzone P5c by the common presence of *G. luxorensis* in the latter. We consider this subzo-nation applicable in open marine low-to-middle latitude regions (Speijer et al. 1999).

Benthic foraminifera. – The benthic extinction event (BEE) marks the most important global turnover in deep-sea benthic foraminifera during the last 90 m.y. About 30–50% of all species became extinct within a few k.y. (Kennett & Stott 1991). At c. 500 m depth in the southern Tethys, the aerobic and oligotrophic *Gavelinella beccariiformis* deep-sea community abruptly collapsed with the onset of dysoxia/intermittent anoxia. Low-oxygen and possibly eutrophic conditions, triggered a c. 100–200 k.y. repopulation sequence, marked by downslope migration of oligotaxic neritic communities, dominated by opportunistic and tolerant taxa like *Anomalinoides aegyptiacus* (Fig. 3). Restoration was completed when a diverse, aerobic and oligotrophic *Nuttallides truempyi* deep-sea community became established. At neritic depths (75–200 m), similar faunal turnovers occurred in response to changing sea-floor conditions (dys- and anoxia) at BEE time. For some 10–100 k.y., *A. aegyptiacus-Valvulineria* sp. ("disaster") faunas populated extensive parts of the basin before becoming restricted to shallow water again (Speijer et al. 1996, 1997).

Conclusions. – In all Middle-East sections studied – irrespective of paleobathymetry – the level of late Paleocene global

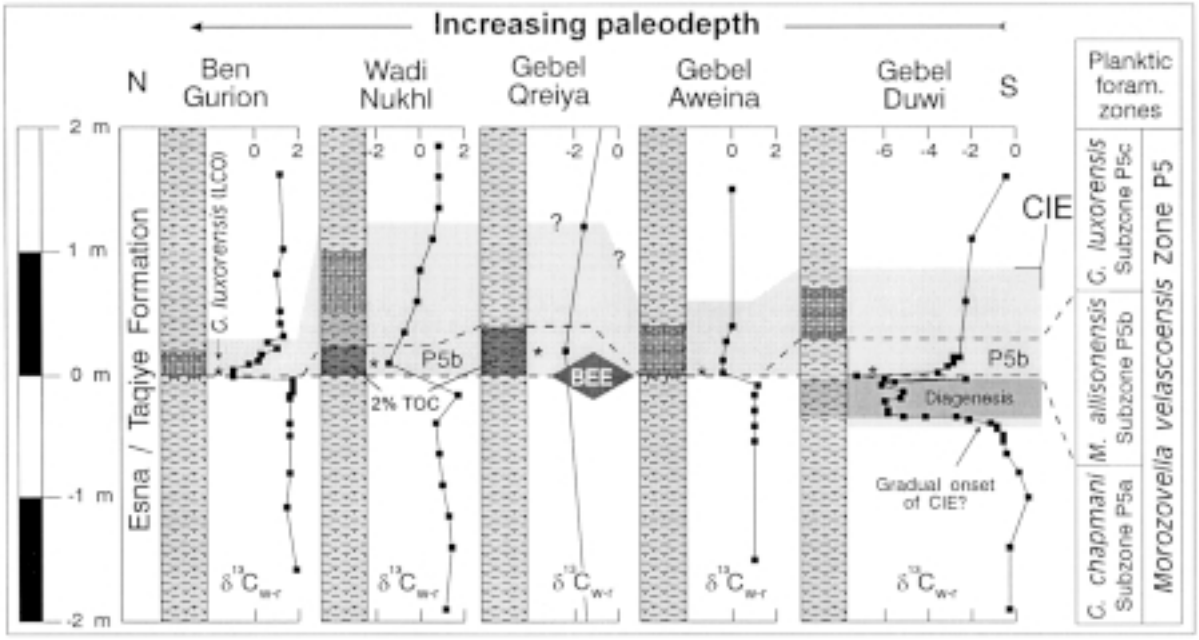

Fig. 2. Correlation of the profiles and subzonation of Zone P5. Area indicated by CIE marks the lateral and vertical extent of the negative $\delta^{13}C$ excursion. At Ben Gurion and Aweina a bioturbated omission surface truncates the CIE at its base. After Speijer et al. (2000)

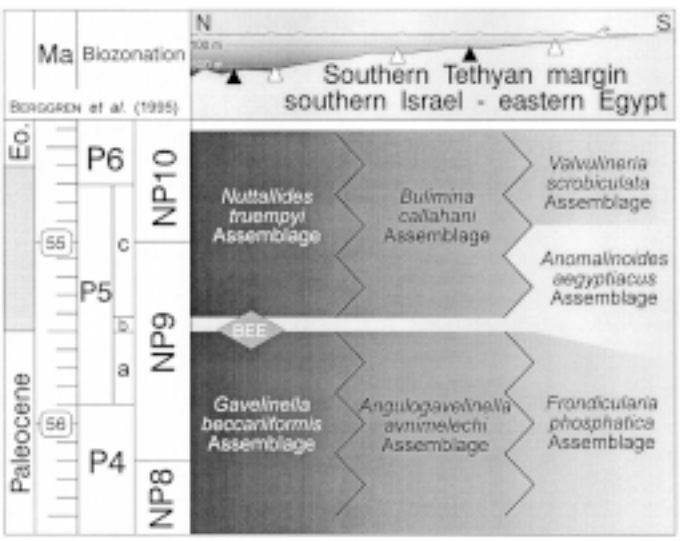

Fig. 3. Spatial and temporal distribution of the main benthic foraminiferal assemblages. Extinctions and turnover in the deeper sections appear abrupt, whereas gradual deterioration – probably related to shallowing – occurred towards the BEE in the shallow Duwi section. Triangles are localities in Fig. 1.

change can readily be monitored by distinct changes in the lithologic, biotic, and isotopic composition.

The Nukhl, Qreiya, and Duwi sections yield some of the finest records of this interval known worldwide. These sections show a laminated TOC-rich or fissile bed with unique benthic and planktic foraminifera assemblages within the critical interval

The short stratigraphic and wide geographic range of *M. allisonensis* enables a threefold subzonation of planktic foraminifera Zone P5 and worldwide correlation. Absence of this species in low-to-middle latitude successions indicates discontinuities which otherwise might easily be overlooked.

A well-expressed $\delta^{13}C$ excursion does not necessarily indicate a good coverage of the CIE: at Aweina and Ben Gurion, like in other sections worldwide, the lowermost part of the CIE is truncated.

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