Ecological and Post-Depositional Changes across the Cretaceous-Palaeocene Succession Inferred from Molecular Fossils in Black Shales, Egypt

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Introduction

The upper Cretaceous-lower Palaeocene black shales of Egypt are part of a giant worldwide belt of organic-rich shales. In Egypt, these shales occur in an east-west trending belt extending from Quseir-Safaga district along the Red Sea to the Kharga-Dakhla landstretch passing through the Nile Valley. They are hosted mainly in the **Duwi** and **Dakhla** formations in ascending order.

The characterization of the studied Egyptian black shales, was conducted on core samples collected from two shallow bore holes in Western (OSN-1) and Eastern (OSR-1) Deserts of Egypt drilled by the Egyptian Mineral Resources Authority (former Egyptian Geological Survey; Fig. 1).

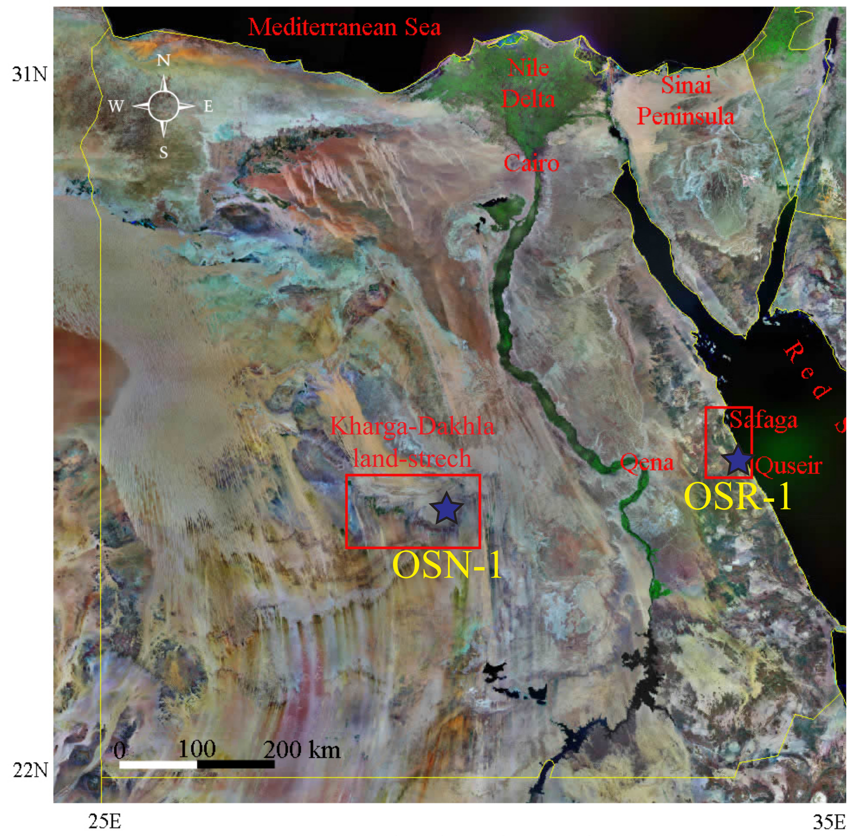

Fig.(1): Bore holes location (stars).

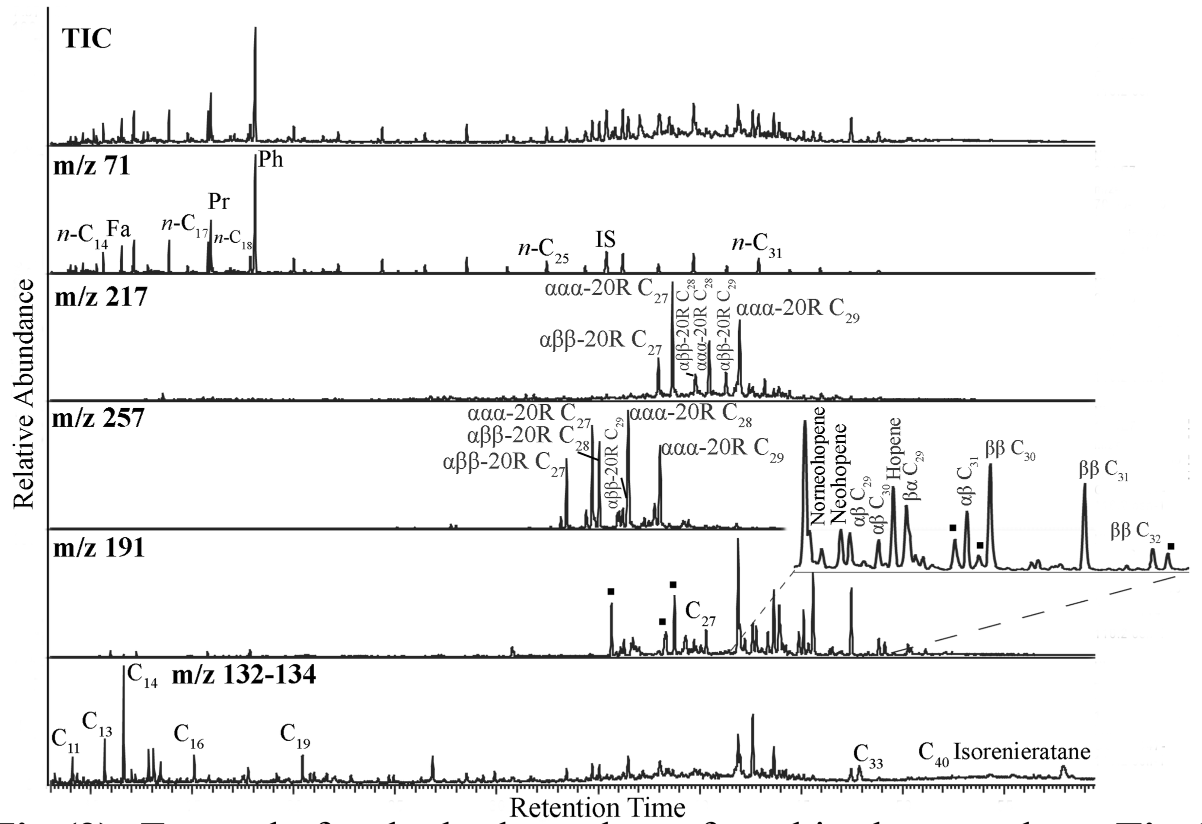

Fig.(2): Example for the hydrocarbons found in the samples.

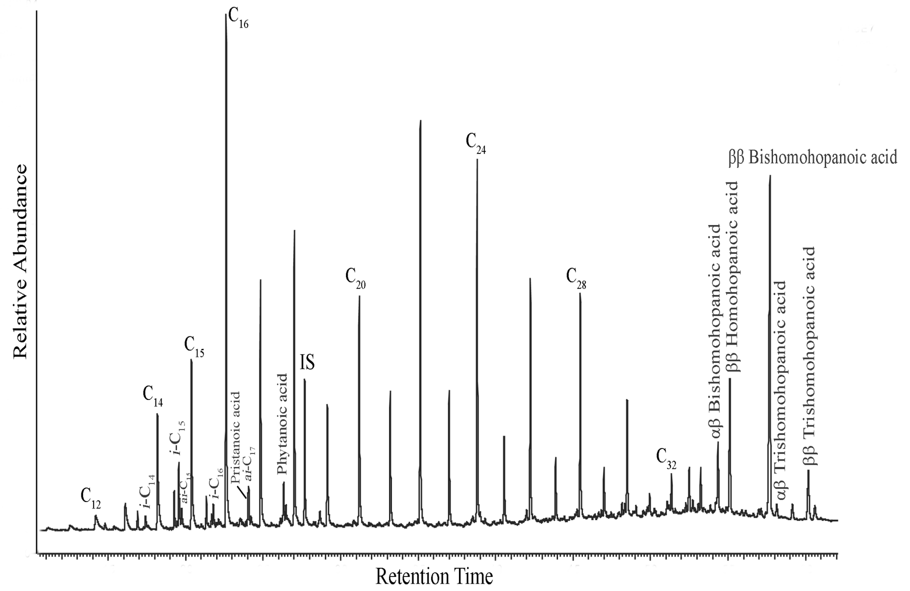

Fig.(3): Example for the fatty acidss found in the samples.

Results

About 100 samples from both locations were extracted for their lipid biomarker content using gas chromatography mass spectrometry (GC-MS) technique. The samples analysed were selected from different lithofacies in order to inspect the variation of the observed biomarkers during sea level fluctuations. Both the hydrocarbons and fatty acids fractions were examined in all samples (Figs. 2 and 3).

High quantities of desmethyl steranes (m/z 217) and rearranged steranes (diasterenes, m/z 257), were observed in the samples. Different isomers of hopanes (C_{27}, C_{29}-C_{31}, m/z 191) and hopanoic acids (C_{31}-C_{33}), as well as aryl isoprenoids (including isorenieratane, m/z 132-134), were further observed in the samples (Figs. 2 to 5). Higher contributions of the 17β, 21β (H) stereoisomers of hopanes and hopanoic acids over their 17α, 21β (H) counterparts, were observed. Negative carbon isotope excursions of -1 to -1.3‰ and -2‰ for OSN-1 and OSR-1, respectively, along with high organic carbon content (the interval in grey ; TOC data are not shown) are detected at the Duwi-Dakhla transition (Figs. 4 and 5).

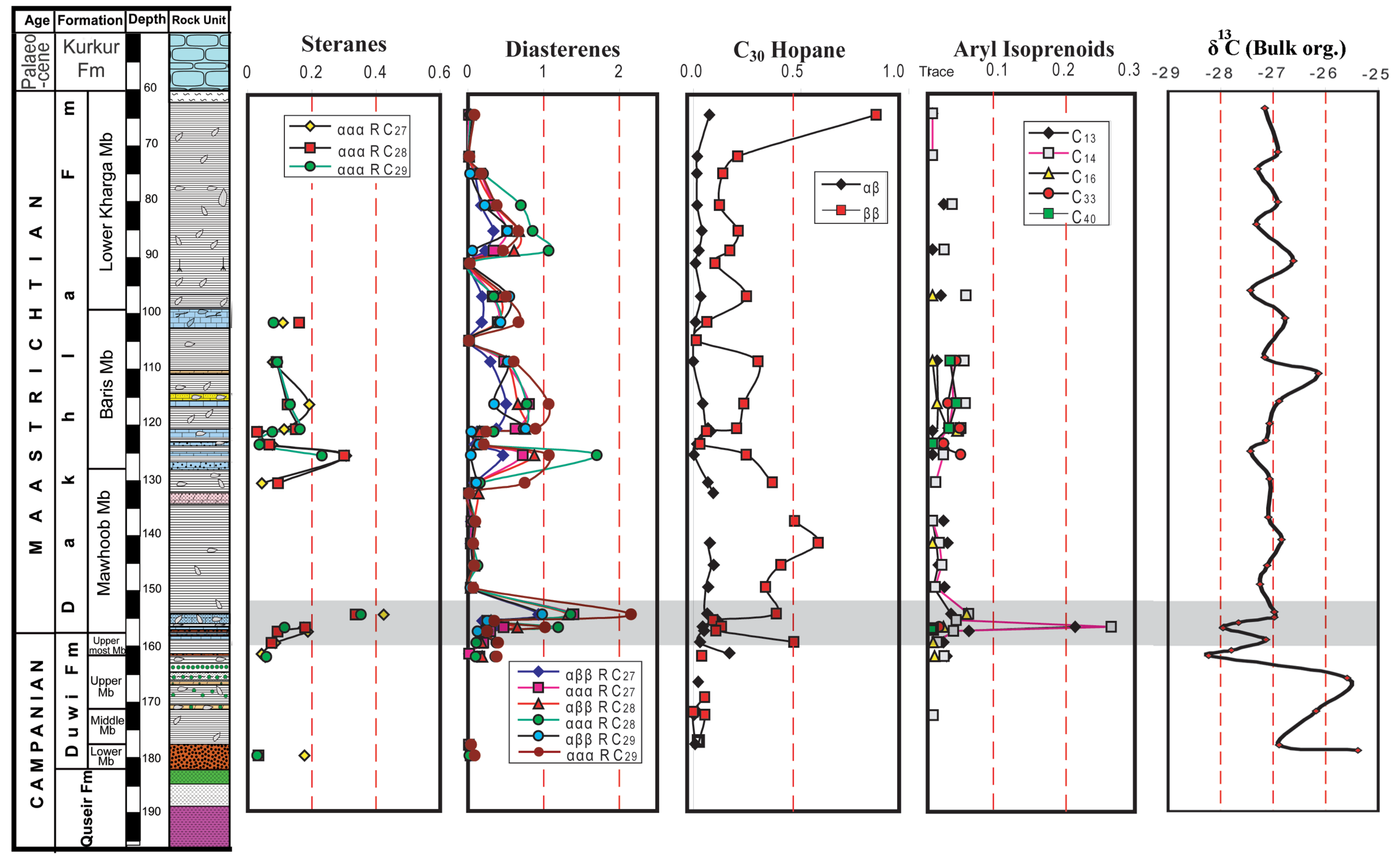

Fig.(4): Downcore distribution of the different molecular fossils and bulk organic carbon isotope (OSN-1).

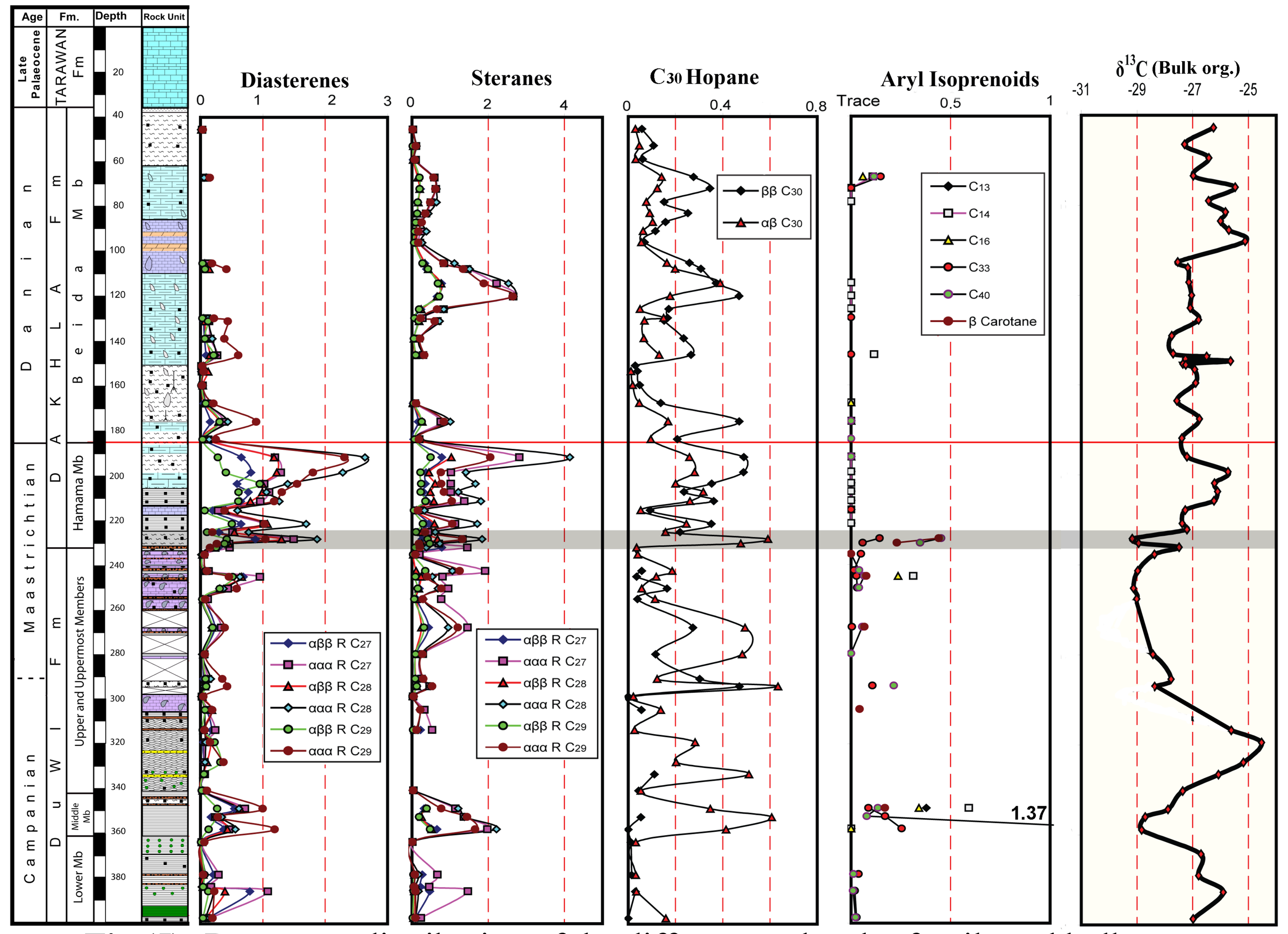

Fig.(5): Downcore distribution of the different molecular fossils and bulk organic carbon isotope (OSR-1).

Conclusions

1- The observed high quantities of steroids suggest that marine algae and chlorophyll *c*-containing phytoplanktons were the main primary producers (Knoll et al., 2007).

2- The sharp decline of all steroids at the Cretaceous-Palaeocene boundary in OSR-1 section agrees well with Sepúlveda et al., (2009). This indicates that the eukaryotic algae were affected by extinction of phytoplanktonic communities and the diminished productivity at the boundary, whereas bacteria and cyanobacteria were not affected in the same manner.

3- The presence of different isomers of hopanes and hopanoic acids, in addition to aryl isoprenoids reveals the contributions from bacteria (Rohmer et al., 1984; Knoll et al., 2007) and green sulfur bacteria (e.g. *Chlorobiaceae*; Summons and Powell, 1987; Grice et al., 1997; Brocks et al., 2005; and Knoll et al., 2007), respectively.

4- The observed variable abundance of biomarkers corresponds to changes in planktonic assemblages and are associated with sea level change and "episodic" Photic Zone Anoxia (PZA) in particular, which is indicated by the occurrence of aryl isoprenoids (Summons and Powell, 1987) in some strata.

5- The dominance of 17β (H), 21β (H) hopanes and hopanoic acids over 17α (H), 21β (H) homologues indicates the immaturity of the preserved organic material. However, the preponderance of diasterenes over the regular steranes in section OSN-1 indicates enhanced clay catalysis rather than increased thermal maturity.

6- The causes of the carbon isotope excursions along with the highest TOC% are not yet understood.

References

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