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Tracing climatic conditions during the deposition of late Cretaceous-early Eocene phosphate beds in Morocco by geochemical compositions of biogenic apatite fossils

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Morocco's Western Atlantic coast was covered by shallow seas during the late Cretaceous-early Eocene when large amount of phosphate rich sediments were deposited. This time interval envelops a major part of the last greenhouse period and gives the opportunity to study the event's characteristics in shallow water settings.

These phosphate deposits are extremely rich in vertebrate fossils, while other types of fossils are rare or often poorly preserved. Hence the local stratigraphy is based on the most abundant marine vertebrate fossils, on the selachian fauna (sharks and rays). Our geochemical investigations were also carried out on these remains, though in some cases frequently found coprolites were involved as well. The main goal of our study was to test whether stable isotope compositions ($\delta^{18}O_{PO4}$, $\delta^{13}C$) of these fossils reflect any of the hyperthermal events and/or the related perturbations in the carbon cycle during the early Paleogene (Lourens et al. 2005) and whether these geochemical signals can be used to refine the local stratigraphy. Additionally, the samples were analyzed for trace element composition in order to better assess local taphonomy and burial conditions. The samples came from two major phosphate regions, the Ouled Abdoun and the Ganntour Basins and they were collected either directly on the field during excavations (Sidi Chennane) or were obtained from museum collections with known stratigraphical position (Sidi Daoui, Ben Guerrir).

The phosphate oxygen isotopic compositions of shark teeth display large range across the entire series (18.5–22.4 ‰) which can partly be related to the habitat of sharks. For instance the genus *Striatolamnia* often yielded the highest $\delta^{18}O$ values indicating possible deep water habitat. Despite the large variation in $\delta^{18}O$ values, a general isotope trend is apparent. In the Maastrichtian after a small negative shift, the $\delta^{18}O$ values increase till the Danian from where the trend decrease till the Ypresian. The latter negative shift can be linked to the globally recognized Early Eocene Climatic Optimum (Zachos et al., 2001).

In terms of carbon isotopic composition, shark teeth enameloid yielded often positive $\delta^{13}C$ values, while dentine are always negative and sometimes following clear trend along the series. Coprolites have similar values to dentine, however they display greater variation reflecting the burial milieu and the special environment of phosphatization with the intensive organic matter recycling. Bone-beds show even more variations that could be caused by reworked specimens and also possible enhanced oxidation of organic matter at these levels. Nevertheless, the Sidi Chennane section shows a negative $\delta^{13}C$ trend in the early Ypresian, which is compatible with global observations at the time. Moreover, the lowest $\delta^{13}C$ values are from the transitional layer between the Ypresian and Thanetian beds which might relate to the Paleocene-Eocene boundary event, though it must be further confirmed.

All the fossils display very similar rare earth element (REE) distribution that resembles typical seawater pattern with negative Ce-anomaly and heavy REE enrichment. However the large amount of analyses revealed a general drift in the magnitude of the Ce-anomaly from the older to younger beds that can be used in paleoenvironmental reconstruction.

References

Lourens et al. 2005. Nature, 435, 1083–1087.

Zachos et al. 2001. Science, 292, 686–693.