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Fish tooth δ^{18}O revising Late Cretaceous meridional upper ocean water temperature gradients

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The warm Late Cretaceous period experienced a long-term climatic cooling, from mid (Late Albian-Turonian) to latest Cretaceous (Campanian-Maastrichtian) (e.g. Clarke and Jenkyns, 1999, Puceat *et al.*, 2003). Oxygen isotope measurements of planktonic foraminifera recovered from DSDP/ODP drilling sites showed that this cooling was superimposed to a decrease of the latitudinal sea surface temperature (SST) gradients (D'Hont and Arthur, 1996; Bice and Norris, 2002; Puceat *et al.*, 2003), thus suggesting a re-organisation in ocean-atmosphere dynamics rather than a direct response to a pCO_2 decrease.

We use here the oxygen isotope composition of fossil fish teeth, a paleo-upper ocean temperature proxy exceptionally resistant to diagenetic alteration, to provide new insight on the evolution of the low-to-mid-latitude thermal gradient during the Late Cretaceous. The new mid-Cretaceous low-to-mid-latitude thermal gradient agrees with that previously inferred from planktonic foraminifera δ^{18}O recovered from DSDP/ODP drilling sites, although the isotopic temperatures derived from δ^{18}O of fish teeth are uniformly higher by approximately 3-4°C. In contrast, our new latest Cretaceous thermal gradient is markedly steeper than previously published meridional SST gradients for this period. Fish tooth δ^{18}O data suggest that low-to-mid-latitude thermal gradients, of the mid-Cretaceous climatic optimum and of the cooler latest Cretaceous, are both quite similar to the modern one despite a cooling of 7 ˚C between the two periods.

Our results imply that no drastic changes in meridional heat transport are required to explain the Late Cretaceous climate. Based on climate models, such a cooling without any change in the low-to-mid-latitude thermal gradient points to an atmospheric CO_2 decrease as the primary driver of the climatic evolution recorded during the Late Cretaceous. Nevertheless, as demonstrated recently (Rowley, 2002), in the absence of large variations in the mid-oceanic ridge degassing rate, the mechanisms susceptible to generate the large pCO_2 decrease implied by our data remain yet to be elucidated.

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