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Monsoon seasonality inferred from mammal teeth stable isotope records

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Due to the massive Asian northern hemisphere continent and the unique orographic configuration of the Asian Highlands and the Tibetan Plateau, the Asian Summer Monsoon is the most vigorous and influential of all the monsoon circulations and is believed to be related to the inter-annual variability of the coupled ocean-atmosphere system. The survival of several million people (40% of the Earth's population) depends on this climatic system (water stocks, irrigation, and fertilization of the plains). Although modelling paleoclimatic fluctuations in monsoon variability has improved, records of past climate changes are crucial to observe the first occurrence or intensification of the monsoon wind system. Different time spans have been suggested from 30 Ma (Ramstein et al., 1997 and Fluteau and al., 1999)in the Indochina area to the end of the Miocene (8-6 Ma; Quade and Al, 1989 and Cerling and al., 1993) in the Himalayan area based on different hypotheses such as (i) Paratethys ocean shrinkage (Ramstein et al., 1997 and Fluteau and al., 1999), (ii) Himalayan and Tibetan plateau uplift (Kutzbach et al., 1989; Ruddiman and Kutzbach, 1989 and Prell and Kutzbach, 1992)and (iii) chemical weathering and atmospheric [CO_2] (Prell and Kutzbach, 1992 and Raymo and Ruddiman, 1992).

It is generally accepted that tooth enamel oxygen isotope ratios of large-sized mammals reflect the δ^{18}O of drinking water ($\delta^{18}O_{dw}$ or meteoric water: $\delta^{18}O_{mw}$), dictated by the precipitation/evaporation balance. High-resolution enamel sampling results provide a better insight into intra-seasonal δ^{18}O variation. The duration of tooth formation can be well estimated by counting daily incremental enamel deposits, hence micro sampling parallel to these growth lines is very tempting, in order to identify the length of dry and wet seasons.

We reconstruct the Asian rainwater seasonality for the period spanning the Oligocene to Miocene using high-resolution δ^{18}O records from mammal tooth enamel. Spatial variations of stable isotopes within a single tooth indicate seasonal changes in precipitation during the period of tooth growth. The first results of high-resolution variations in mammal tooth enamel show that the monsoon system prevailed $\sim$14 Myr ago and the amplitude and seasonality of the precipitation patterns in the middle Miocene were similar to those of today. The δ^{18}O values for Miocene enamel are about 4$\%_{\circ}$ lower than modern ones, which can be explained by higher amount of precipitation in the middle Miocene and/or lower temperature. These results will be compared to pollen data and BIOME 4 model, in order to test which of temperature and precipitation amount parameters is the main factor explaining such difference between past and present conditions. Finally, using the $\delta^{13}C_{enamel}$ we were able to reconstruct paleodietary of different species. We have shown the co-existence of C_3 and C_4 plants for the upper Miocene. These results are in agreement with previous studies showing the expansion of the C_4 towards 7-6My.

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