Geophysical Research Abstracts, Vol. 9, 06172, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-06172

Analytical and numerical δ^{18}O high-resolution signals comparison in rhinoceros enamel: implications for rainwater paleo-seasonal reconstructions

C. Martin (1), I. Bentaleb (1), P. Tafforeau (2, 3)

(1) Université des Sciences et Techniques du Languedoc Montpellier II, Institut des Sciences de l'Evolution de Montpellier, UMR 5554, 34095 Montpellier, France. mart.cel@isem.univ-montp2.fr, bentaleb@isem.univ-montp2.fr

(2) Laboratoire de Géobiologie, Paléogéographie et Paléontologie Humaine, UMR CNRS 6046, Université de Poitiers, 40 Avenue du Recteur Pineau. 86022 Poitiers cedex, France.

(3) European Synchrotron Radiation Facility, 6 rue Horowitz BP 220, 38046 Grenoble Cedex, France. tafforea@pop.esrf.fr

Over the last decade, there has been a growing interest to reconstruct climatic variation records at a seasonal scale. One of the paleo-archives recently used to trace hydrologic cycle or paleoclimate parameters is mammalian tooth enamel stable isotopes. It is generally accepted that tooth enamel oxygen isotope ratios of large-sized water-dependant mammals reflect the δ^{18}O of drinking water ($\delta^{18}O_{dw}$ or $\delta^{18}O_{mw}$ for meteoric water; Longinelli, 1984; Luz et al., 1984). The $\delta^{18}O_{mw}$ seasonal variations at a given location (e.g. rivers and lakes) result from fluctuations in meteoric precipitation and residence time in reservoirs and evaporation. At low latitudes the $\delta^{18}O_{mw}$ being strongly correlated with the amount of precipitation (Dansgaard, 1964; Rozanski et al., 1993), enamel isotopic analyses can furnish information on the rainfall amount. Moreover, the incremental pattern of the enamel formation (Avery et al., 1961) allows us to obtain isotopic seasonal or sub-seasonal temporal record, carrying out sampling along the growth features of the enamel.

However, unlike the shells or speleothems calcium carbonate which is deposited as successively independent layers, the enamel formation is more complicated. First an enamel matrix slightly mineralised (10-20%), is laid down in increments delineated by long period lines (the Retzius striae), followed by the enamel maturation stage, which is characterized by the degradation of the organic matrix and an increase of the mineralization until 95% (Weinmann et al., 1942). The thin enamel layer near the enamel-dentine junction (EDJ) is heavily mineralised during the first stage. Some authors stipulate that the isotopic signal measured in enamel is an attenuated signal of the δ^{18}O rainwater signal due to these two stages enamel formation (e.g. Balasse, 2002; Passey and Cerling, 2002). The lack of knowledge about the temporal and spatial patterns of the tooth enamel maturation stage has, until now, been an obstacle to developing a standard sampling strategy for time-resolved studies.

A mathematical model (modified from Passey and Cerling, 2002) for rhinoceros specimens, is used to simulate the attenuation of a given input signal (δ^{18}O$_{mw}$) by enamel maturation, considering several patterns of maturation. Moreover, δ^{18}O signals were simulated considering several enamel sampling strategies to define the best one for paleoclimate studies. Numerical data were compared with analytical results obtained on Thai rhinoceros teeth.

The major challenge with this archive (proxy) is to develop an analytical method allowing enamel δ^{18}O analysis at a resolution better than 20μm (EDJ). The sampling strategy performed along successive striae of Retzius, is well adapted to the δ^{18}O seasonal rainwater variability reconstruction.

References: **Avery, J.K., Visser, R.L. and Knopp, D.E.**, 1961. The pattern of the mineralization of enamel. Journal of dental research, 40: 1004-1019.

Balasse, M., 2002. Reconstructing dietary and environmental history from enamel isotopic analysis: time resolution of intra-tooth sequential sampling. International Journal of Osteoarcheology, 12: 155-165.

Dansgaard, W., 1964. Stable isotopes in precipitation. Tellus, 16: 436-468.

Longinelli, A., 1984. Oxygen isotopes in mammal bone phosphate: a new tool for paleohydrological and paleoclimatological research? Geochimica et Cosmochimica Acta, 48: 385-390.

Luz, B., Kolodny, Y. and Horowitz, M., 1984. Fractionation of oxygen isotopes between mammalian bone-phosphate and environmental drinking water. Geochimica et Cosmochimica Acta, 48(8): 1689-1693.

Passey, B.H. and Cerling, T.E., 2002. Tooth enamel mineralization in ungulates: implications for recovering a primary isotopic time-series. Geochimica et Cosmochimica Acta, 66: 3225-3234.

Rozanski, K., Araguäs-Araguäs, L. and Gonfiantini, R., 1993. Isotopic patterns in modern global precipitation. In: P.K. Swart, K.C. Lohmann, J. McKenzie and S. Savin (Editors), Climate change in continental isotopic records: American Geophysical Union Geophysical Monograph 78, pp. 1-36.

Weinmann, J.P., Wessinger, G.D. and Reed, G., 1942. Correlation of chemical and histological investigation on developing enamel. Journal of dental research, 21: 171-182.