Geochemistry of fossil bones and teeth – Reconstruction of past environments

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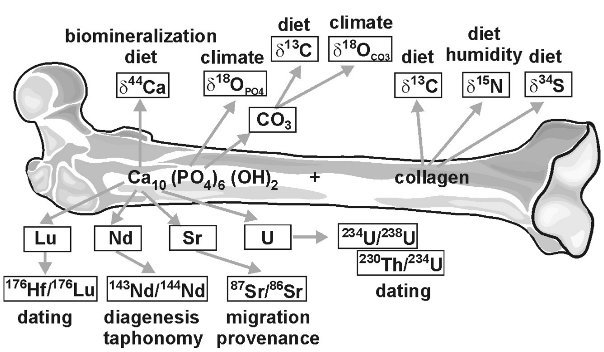
Skeletal tissues such as bones and teeth are often the only remains of vertebrates that are preserved in the fossil record. They represent important archives for the reconstruction of life-history and environment because the skeletal apatite integrates chemical signals over the period of tissue formation. The isotopic composition of the food and/or drinking water ingested by the animal depends on the environmental conditions (e.g., climate, vegetation, geology). This might be incorporated into the biogenic apatite either unchanged or with fractionations during metabolism and tissue formation (vital effects).

In palaeoecology, archaeology, and palaeontology the isotopic composition of fossil bones and teeth are increasingly used for the reconstruction of diet, niche partitioning, climate, provenance, migration, metabolism and biomineralization processes (Figure 1).



However, diagenesis and recrystallisation of the microcrystalline biogenic apatite might severely bias original *in vivo* compositions. On the other hand chemical and mineralogical changes during diagenesis yield information about the thaphonomy. Especially *postmortem*-uptake of rare earth elements or uranium into the biogenic apatite enable to characterize the diagenetic milieu, detect fossil reworking or radiometrically (U/Th, Lu/Hf) date early diagenesis.

If diagenesis is carefully considered, the isotope compositions of fossil bones and teeth can yield important quantitative information about the palaeobiology and palaeoecology of fossil vertebrates and their palaeoenvironment. Results of different case studies will be discussed to demonstrate the broad application potential of isotope analysis on phosphatic vertebrate skeletal tissues.

Bone oxygen isotope profiles (SIMS, Micromill) − Implications for archosaur growth and biomineralization

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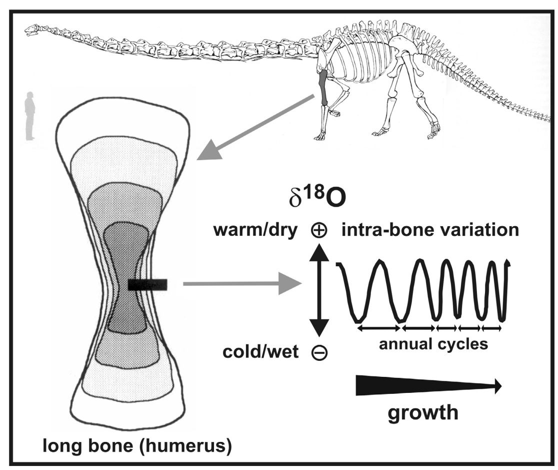
Accretionary, non-remodelled bone tissue can provide a multi-year proxy record of ingested meteoric water and/or body temperature. Seasonal oxygen isotope cyclicity may be used as annual time marker of osteogenesis and thus for skeletochronology of extant and extinct vertebrates such as dinosaurs (Figure 1).



Long bones of extant crocodiles (*Alligator mississippiensis*) and ostriches (*Struthio camelus*) of known individual age as well as of different sauropod dinosaurs were serially sampled to measure high-resolution oxygen isotope time series. Analyses of bone growth increments were performed with two different techniques and spatial resolutions: (1) *in situ* oxygen isotope measurements on polished, gold-coated bone thin sections of the same specimens with a CAMECA IMS 1270 ionprobe SIMS (20 to 30 µm resolution), (2) sampling with a Merchantek Micromill (100 µm resolution) from polished bone cross-sections and analysis of their oxygen isotope composition ($\delta^{18}O_{CO3}$) after chemical pre-treatment.

Oxygen isotope results of both techniques will be compared. Implications for skeletochronology, growth rate, and biomineralization processes of archosaurs (crocodiles, birds, and dinosaurs) will be discussed.