$\delta^{44/40}$Ca of fossil bones and teeth – Ontogenetic versus diagenetic origin

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We present first Ca isotope ($\delta^{44/40}$Ca) data of Late Jurassic dinosaur bones and teeth (enamel and dentin) from different sympatric sauropods and theropods as well as from the embedding sediments.

$\delta^{44/40}$Ca values of tooth enamel range from –0.4 to +0.3‰ (relative to SRM 915a) while corresponding dentin values are enriched in ^{44}Ca by about 0.2 to 0.5‰. $\delta^{44/40}$Ca values of ambient sediments are between 0.1 and 0.4‰. No systematic differences of $\delta^{44/40}$Ca values of skeletal apatite do exist between herbivorous and carnivorous dinosaurs as would be expected due the trophic level difference [1].

There are two possible explanations for the difference in $\delta^{44/40}$Ca between dentin and enamel: (1) it reflects the original *in vivo* difference between enamel and dentin caused by different biomineralization processes during dental tissue formation which are preserved; (2) it is caused by chemical changes during fossilisation. Dentin is known to be more susceptible for diagenetic changes than enamel and thus the increase of dentin $\delta^{44/40}$Ca values relative to enamel could indicate a diagenetic alteration. However, as Ca is a major element in apatite (~40wt.%), such an alteration would imply a significant *post mortem* Ca exchange with the environment.

For one *Apatosaurus* bone the intra-bone variation of $\delta^{44/40}$Ca was analyzed. $\delta^{44/40}$Ca values decrease from 0.16 in the outer towards 0.01‰ in the inner bone cortex. The bone histology of the inner cortex indicates a complete remodelling. These observations are in agreement with Skulan & DePaolo [1] who suggested that remodeled bone should have lower $\delta^{44/40}$Ca values than primary bone. But alternatively, diagenetic alteration and Ca exchange with the ambient sediment may have shifted $\delta^{44/40}$Ca values in the outer bone part towards a higher value.

If the $\delta^{44/40}$Ca values of dinosaur bones and teeth reflect ontogenetic or diagenetic compositions is currently further investigated by analyzing skeletal tissues of modern reptiles and birds.

[1] Skulan & DePaolo (1999) *PNAS* **96**, 13709-13713.

^{231}Pa/^{230}Th in the Argentine Basin as a tracer of past southern-source water-mass flow

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Antiphasing of Greenland and Antarctic temperature records from ice cores has been explained by the bi-polar seesaw mechanism in which deep-water circulation occurs more vigorously in one hemisphere than the other, drawing heat from the tropics to the high latitudes of that hemisphere. ^{231}Pa/^{230}Th ratios in ocean sediments provide evidence for changing ocean circulation in the North Atlantic since the last glacial maximum[1]. Models predict an antiphase change in ocean circulation in the South Atlantic but this has yet to be directly observed. Recent data demonstrate the potential of ^{231}Pa/^{230}Th to assess past water mass flow from the Southern Ocean[2]. Here we present data from the Argentine Basin to assess the use of ^{231}Pa/^{230}Th to determine such flow and to directly test the role of the southern ocean in the bi-polar seesaw.

We sampled four cores from different water depths in the Argentine Basin representing southern source water masses AAIW, AABW and northern source NADW. A growing dataset of more than 30 ^{231}Pa/^{230}Th analyses are augmented with downcore opal and barite data. ^{231}Pa/^{230}Th data show that water masses AAIW, AABW and NADW have different values of ^{231}Pa/^{230}Th now and throughout the last 20ka. Values at any one time range by 0.03-0.10, a range similar to that seen in downcore records at a single site[1] indicating the importance of considering water-mass in interpreting ^{231}Pa/^{230}Th records. Sediment opal contents are low, with no correlation with ^{231}Pa/^{230}Th. ^{231}Pa/^{230}Th results show little evidence for millenial variability in AAIW or NADW circulation, with the largest temporal change in ^{231}Pa/^{230}Th occuring in the Holocene at intermediate depths – a time when ocean ciruclation is not expected to be particularly variable.

[1] McManus, J. *et al.* (2004) *Nature* **248**, 804-807. [2] Thomas, A. *et al.* (2006) *Earth Planet Sci. Lett.* **241**, 493-504.