Applying the Clumped Isotope Paleothermometer to Teeth from *T. rex* and *C. megalodon*

N. LÖFFLER[1, 3]*, M. E. BÖTTCHER[2], J. FIEBIG[1, 3], T. TÜTKEN[4], A. MULCH[1, 3]

[1] Biodiversity and Climate Research Center, Senckenberganlage 25, 60325 Frankfurt (Main), Germany (*correspondence: niklas.loeffler@senckenberg.de)
[2] Leibniz Institute for Baltic Sea Research, Seestraße 15, 18119 Warnemuende, Germany
[3] Institute of Geosciences, Goethe University, Altenhoeferallee 1, 60438 Frankfurt (Main), Germany
[4] Institute of Geosciences, Johannes Gutenberg University, Johann-Joachim-Becher-Weg 21, 55128 Mainz, Germany

Clumped isotope analysis of carbonates has been shown to be a powerful tool to reconstruct marine and terrestrial temperatures [1, 2]. Prelimary results suggested that this thermometer may also be applied to (bio)apatites to determine body temperatures of extinct vertebrates, although discrepant Δ_{47}-$1/T^2$ relationships were ascertained [3, 4]. Here, we present data that extend the existing (bio)apatite Δ_{47} record and ultimately lead to a refined Δ_{47} temperature calibration for (bio)apatite.

We confirm the temperature calibration of Wacker *et al*. [3] while enlarging their data set by a factor of four. Notably, we obtain consistent Δ_{47} values for enamel(oid) and dentine from identical specimens. Tooth dentine data are therefore integrated into the calibration, consequently broadening the spectrum of potential applications.

The refined calibration is applied to fossil tooth material from a *T. rex* and a *C. megalodon* shark. Enamel(oid) Δ_{47} data yield a body temperature of 34±4 °C for the *T. rex* and a habitat temperature of 16±6 °C for the *C. megalodon*. The oxygen isotopic composition of the seawater that the *C. megalodon* lived in is additionally derived from the apparent habitat temperature and $\delta^{18}O_{PO4}$ data. The resulting $\delta^{18}O_{H2O\ VSMOW}$ values range from -0.6 to -0.3 ‰, which is a reasonable range for Miocene to Pleistocene seawater.

[1] Ghosh *et al.* (2006a) *Geochim. Cosmochim. Acta* **70**, 1439-1456. [2] Eiler (2011) *Quaternary Sci. Rev.* **30**, 3575-3588. [3] Wacker *et al.* (2016) *Chem. Geol.* **443**, 97-110. [4] Eagle *et al.* (2010) *Proc. Natl. Acad. Sci. U.S.A*. **107**, 10377-10382.