Clumped isotopes in shell midden sclerochronology: Prehistoric cooking versus climate signatures?

Peter Müller¹*, Philip Staudigel², Sean T. Murray², Hildegard Westphal¹, Peter K. Swart²

1) Leibniz-Center for Tropical Marine Ecology, Fahrenheitstraße 6, 28359 Bremen, Germany
2) Rosenstiel School of Marine and Atmospheric Science, 4600 Rickenbacker Cswy, FL 33149, USA

Email: peter.mueller@leibniz-zmt.de

Incrementally banded calcareous components derived from prehistoric shell midden deposits like bivalve shells or fish otoliths provide high-resolution records of multiple paleoenvironmental proxies (e.g. δ¹⁸OCarbonate or element/Ca ratios). Thus, allowing the reconstruction of sub-seasonally resolved environmental conditions, such records became valuable tools to study ancient climate change. However, differing from other common marine paleoenvironmental proxy archives, shell middens were accumulated by the coastal populations, gathering local faunal resources for dietary purposes. Depending on the available technology and regional customs, the midden’s constituents could have been exposed to prehistoric cooking prior to deposition. The alteration of such proxy records by prehistoric cooking has poorly been studied so far and is neglected in most paleoenvironmental reconstruction using shell midden constituents.

Here we present experimentally determined clumped isotope, conventional oxygen and carbon isotope as well as element/Calcium data measured in bivalve shells of the hard clam Mercenaria campechiensis exposed to different prehistoric cooking methods. Our data clearly show that pre-depositional heating (i.e. cooking) of aragonitic shells can lead to a considerable alteration of most paleoenvironmental proxies including their clumped isotope signature, even without an apparent reordering of the initial aragonite into secondary calcite. Thus, common methods for assessing the preservation of aragonitic skeletal components (e.g. x-ray diffraction analysis) might fail to detect their potential alteration due to the exposure to pre-depositional cooking methods. However, our data show that clumped isotope thermometry represents a suitable tool for the detection of such pre-depositional heating events and the potential subsequent alteration of paleoenvironmental proxy records. In addition, clumped isotope thermometry also allows the differentiation between certain prehistoric cooking methods and thus appears to be a suitable approach for tracing changes in ancient cooking practices as a consequence of technological advancement throughout human history using shell midden deposits.