Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.31591

The Effect of Heating on Clumped Isotope Signatures in Three Heated Calcium Carbonate Archives from South Africa: *Turbo sarmaticus*, *Bivalvia* and Ostracoda

ELLIE J PRYOR[1,2], ANNA NELE MECKLER[1,2], MARGIT H SIMON[2,3], CHRISTOPHER MILLER[4], JAKUB SENEŠI[4], TESSA BOSCH[5], PETER FRENZEL[6], OLGA SCHMITZ[6], VICTORIA E TAYLOR[1], MATTEO DEMURTAS[1], LEONARDO PASQUALETTO[1] AND CARIN ANDERSSON[2,3]

[1]Department of Earth Sciences, University of Bergen
[2]SFF Centre for Early Sapiens Behaviour (SapienCE), University of Bergen
[3]Norwegian Research Centre (NORCE)
[4]University of Tübingen
[5]University of Utrecht
[6]University of Jena

Middle Stone Age deposits from archaeological sites found in South Africa contain abundant shellfish assemblages. These archaeological shell remains usually represent food waste, which may have been exposed to pre-depositional heat treatment, such as cooking. The shells also could have been purposefully or randomly left close to hearths. Since the geochemical signature of the shellfish can indicate the extent of heating [1], it can be used as a proxy to understand how these shellfish were cooked by early modern humans, i.e. roasted vs burnt, and provide insights into potential hearth locations in archaeological sites. Heat exposure is furthermore important to constrain when intending to use the primary geochemical signature of the shells as a paleoclimate indicator.

In this study, we test the impact of heating at different temperatures on carbonate clumped isotope (Δ_{47}) and oxygen isotope ($d^{18}O$) signatures in modern carbonate archives of the same species found in the archaeological sites to assess the potential of differentiating between roasting, burning and proximity to hearth locations. Analyses were performed on both heated and unheated modern South African shellfish species *Turbo sarmaticus* and *Bivalvia Mollusca,* typically found in the intertidal zone, and modern South African freshwater ostracods, *Gomphocythere obtusata*. Heating experiments were performed on all three carbonate archives at varying temperatures between 150 to 550°C. Our results demonstrate that the heated carbonates show signs of thermal reordering with progressively lower Δ_{47} values indicative of increasingly higher temperature exposure. Mineralogical studies additionally show that *T. sarmaticus* opercula vary structurally as the heating temperature increases. These geochemical and mineralogical techniques can be applied to archaeological specimens of all three fossil types, and our results suggest that they offer a promising and novel approach for identifying past heat exposure to differentiate between cooking methods, reconstruct hearth locations, and identify suitable specimens for paleoclimate reconstructions.

References

[1] Müller, P., Staudigel, P. T., Murray, S. T., Vernet, R., Barusseau, J. P., Westphal, H., & Swart, P. K. (2017). Prehistoric cooking versus accurate palaeotemperature records in shell midden constituents. *Scientific Reports*, *7*(1), 1–11. https://doi.org/10.1038/s41598-017-03715-8