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Impact of prehistoric cooking practices on paleoenvironmental proxies in shell midden constituents

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Paleoenvironmental proxy records such as oxygen isotopes of calcareous skeletal structures like fish otoliths or mollusk shells provide highest-resolution information about environmental conditions experienced by the organism. Accumulations of such skeletal structures by ancient coastal populations in so called “shell midden” deposits provide us with sub-seasonally resolved paleoclimate records covering time spans up to several millennia. Given their high temporal resolution, these deposits are increasingly used for paleoclimate reconstructions and complement our understanding of ancient climate changes. However, gathered as comestibles, most of these skeletal remains were subject to prehistoric cooking methods prior to deposition. The associated alteration of the chemical proxy signatures as well as the subsequent error for paleoenvironmental reconstructions remained almost entirely neglected so far.

Here, we present clumped isotope, conventional oxygen and carbon isotopes as well as element:Ca ratios measured in modern bivalve shells after exposing them to different prehistoric cooking methods. Our data show that most cooking methods considerably alter commonly used paleoclimate proxy systems which can lead to substantial misinterpretations of ancient climate conditions. Since the magnitude of chemical alteration is not distinguishable from natural temperature variability in most coastal settings, the alteration of shell midden constituents by prehistoric cooking remains likely unnoticed in most cases. Thus, depending on the cooking method, pre-depositional heating might have introduced considerable errors into previous paleoclimate studies. However, our data also show that clumped isotope thermometry represents a suitable diagnostic tool to detect such pre-depositional cooking events and also allows differentiating between the most commonly applied prehistoric cooking methods.