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Paleo-environmental reconstruction in the East African Rift: how to interpret stable isotope ratios of Early Pleistocene carbonate fossils from the Turkana Basin?

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Oxygen and carbon isotope ratios of fossil mollucs and ostracods are widely used to reconstruct climatic and environmental change. Aquatic molluscan bivalves are considered to be powerful proxy archives, recording environmental change at seasonal resolution in their shell chemistry. Thus, sclerochronologically-sampled fossil molluscs potentially give insight in past climate change at seasonal resolution.
In the tropical climate of the East African Rift System (EARS), oxygen isotope data of carbonate fossils are usually interpreted in terms of temperature and E/P balance (rainfall/lake level) variation. Resulting paleoclimatic reconstructions potentially serve to construct the paleoclimatic backdrop of evolutionary patterns observed in the hominin record of EARS basins.

Here we present sclerochronological isotope records of well-preserved Early Pleistocene (~1.9Ma) shells from the Turkana Basin (N. Kenya), from one of the long-periodic wet phases documented in the EARS. Considerable seasonal stable isotope variation occurs within individual specimens, which is often of the same order of magnitude as isotope variation between specimens of different age. There is no direct relationship between molluscan stable isotope ratios and the precisely documented Milankovitch-forced climate cyclicity in the sedimentary sequence studied. In contrast, isotopic comparison with modern shells from the Turkana Basin reveals that molluscan stable isotope variation primarily reflects the aquatic environment in which the shells live. Particularly spatial transitions between riverine facies and lacustrine facies affect the stable isotope composition of calcareous organisms. δ18O - δ13C cross plots appear to be of good use to identify such facies shift in the isotope records, allowing us to better deconvolve the effect of climate and facies change in molluscan isotope records. Our data further demonstrate that carbonate δ18O data are a poor proxy for lake level variation in the more evaporative (alkaline) lake stages of the Turkana Basin.

In summary, our data show that molluscan stable isotope ratios serve as an excellent indicator of the Quaternary sedimentary facies distribution in EARS basins, but are much less suitable as an EARS climate proxy. Climate reconstruction in the Turkana Basin on Milankovitch time scales clearly requires proxies with less high-amplitude variation in the sub-centennial band. A good example of such a proxy was recently developed based on the application of strontium isotope analysis of lacustrine fossils (see Joordens et al., this session).