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Clumped isotope geochemistry of mid-Cretaceous (Barremian-Aptian) rudist shells: paleoclimatic and paleoenvironmental implications

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The Cretaceous period is generally considered to have been a time of climate warmth, but there is an ongoing dispute about the existence of Cretaceous cool episodes - including the short-termed installation of polar ice caps. The Late Barremian-Early Aptian represents a Cretaceous key interval in terms of paleoclimate and paleoceanography, as it provides evidence for (i) a cooler climate (Pucéat et al., 2003) and (ii) a considerable seasonality of sea surface temperatures (SSTs) at low latitudes (Steuber et al., 2005). The timing and significance of these cool episodes, however, are not well constrained. Recently published TEX_{86} data, in contrast to oxygen isotope paleotemperature estimates, now are in support of a climate scenario with equable hot (~30°C) tropical SSTs from the Early Cretaceous onwards.

The aim of this project is to reconstruct the evolution of Barremian-Aptian sea-surface temperatures (SSTs) in the tropical Tethyan realm by use of a combined geochemical approach including oxygen isotope analysis and carbonate clumped-isotope thermometry. Paleotemperature proxies are based on the isotope geochemistry of low-Mg calcite of pristine rudist bivalve shells (*Toucasia, Requienia*) collected from different carbonate platform settings, including the Provence platform in SE France and the Adriatic Carbonate platform in Croatia.

Carbonate clumped-isotope geochemistry deals with the state of ordering of rare isotopes in molecules, in particular with their tendency to form bonds with other rare isotopes (^{13}C-^{18}O) rather than with the most abundant ones. Carbonate clumped-isotope thermometry has been shown to allow for reconstructing (i) the temperature of carbonate mineral formation and calculating (ii) the isotopic composition of the water from which carbonate minerals were formed (by using the $\delta^{18}O$ of the analysed carbonate sample).

Our approach seeks to provide insights into possible biases in temperature estimates of different paleothermometers. Carbonate clumped isotope geochemistry (thermometry) is not only a robust new tool for reconstructing changes in temperature, but also enables paleoclimatic and paleoenvironmental implications, e.g. estimates about freshwater influx or evaporation intensity at ancient tropical shallow-water settings. In combination with high-resolution $\delta^{18}O$, clumped isotope analysis has the potential to differentiate between temperature and salinity changes and this may help to evaluate the significance of meridional temperature gradients. The assumed strong seasonality of low-latitudinal mid-Cretaceous temperatures, based on intra-shell $\delta^{18}O$ variations in sclerochronological sections of rudist bivalves (Steuber et al., 2005), is going to become verified or falsified during the current study.

References

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