



Cretaceous low latitude sea-surface temperature seasonality: Implications from intra-shell variations of $\delta^{18}\text{O}$ in mollusk calcite

T. Steuber and M. Rauch

Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität, D-44801 Bochum, Germany

Estimates of Cretaceous sea-surface temperatures are generally derived from biological materials which do not provide data on sub-annual timescales. For most materials, the seasonal timing of formation is not known so that currently available data on Cretaceous seawater temperatures are believed to represent annual averages.

We have analysed shells of rudist bivalves for intra-shell variations in chemical (Mg, Sr, Fe, Mn) and isotopic ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) compositions. The large size, high skeletal growth rates, and compact shell structures of the studied specimens are important for the preservation of geochemical information with a high temporal resolution. The 35 shells analyzed are from Barremian - Maastrichtian localities of the Mediterranean Tethys and Middle East, which were at latitudes of 20-30° N during the Cretaceous. They show cyclic variations in $\delta^{18}\text{O}$ and Mg concentrations, and rather constant $\delta^{13}\text{C}$ values and Sr concentrations. The potential effect of seasonal salinity cycles on the $\delta^{18}\text{O}$ of mollusk calcite is discussed, and is not considered to significantly compromise palaeotemperature estimates. Annual shell accretion was up to 70 mm so that highly resolved records of intra-shell variations in isotopic and chemical compositions are obtained. In most specimens, the $\delta^{18}\text{O}$ values follow the expected sinusoidal pattern of seasonal temperature variations.

Maximum temperatures were as high as 35-36°C in the Barremian - Aptian and in the Cenomanian - Early Campanian. Seasonal minima were around 24°C in the Cenomanian - Early Campanian, but as low as 16°C in the Barremian - Aptian. The pronounced seasonal temperature range of up to 20°C for the Late Barremian - Aptian was observed in numerous shells at several localities. This suggests a large latitudinal

temperature gradient and vigorous atmospheric circulation during cooler episodes of the Cretaceous, while seasonality was much lower (c. 10°C) during peak greenhouse conditions of the Cenomanian -early Campanian.