



## **Latitudinal gradients in Cretaceous seawater oxygen isotope composition and temperature: Evidence from clumped isotopes**

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In this study clumped isotope analyses of sub-Arctic, Boreal Cretaceous and sub-tropical (Valanginian-Hauterivian) fossil molluscs (belemnites) have been undertaken. These data provide new palaeotemperatures as well as a constraints on the oxygen isotope composition of seawater, which in turn underpins our understanding of the evolution of the Earth's climate. Our reconstruction of latitudinal temperature gradients reveals relatively modest high latitude marine temperatures and subtropical temperatures in excess of 30 °C. A congruence of both TEX86 and clumped isotope derived temperatures is noted and a reduced latitudinal temperature gradient observed. Our combined clumped isotope temperature and oxygen isotope data imply seawater isotope values that have a modern profile and much more positive than values typically assumed for Cretaceous seawater. The occurrence of less depleted high latitude seawater is a possible consequence of the reduced temperature gradient. Nevertheless, the seawater isotope average is a little more positive than modern seawater and suggests a hitherto unforeseen preferential uptake of heavy oxygen isotopes into the shell of the belemnites.