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Dual clumped isotope analysis of modern and Eocene mollusc shells

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The carbonate clumped isotope thermometer is advantageous over the oxygen isotope thermometer in that it does not require any knowledge about the isotopic composition of the fluid the carbonate precipitated from. However, recent studies have shown that many carbonates formed at Earth surface conditions do not attain thermodynamic equilibrium. As a consequence the corresponding clumped isotopic composition can also be affected by kinetics. Based on Δ_{47} analysis alone it is not possible to resolve the extent to which kinetics have compromised the clumped isotopic composition, possibly leading to serious errors in temperature reconstructions. Dual clumped isotope analysis of carbonates, i.e. high precision analysis of Δ_{48} along with Δ_{47} (Fiebig et al., 2019) has recently been demonstrated to be a way in which this problem can be overcome. This is because the method allows the nature and extent of kinetics involved in carbonate (bio)mineralisation to be identified and, moreover, to correct for any kinetic bias (Guo, 2020; Bajnai et al, 2020).

For this study we analysed Eocene mollusc shell (gastropods and bivalves) carbonates from the Barton clay formation as well as recent shells from South-East Scotland using the dual clumped isotope method. The formation temperature for the modern shell samples is presumed to be close to the mean annual sea surface temperature of 9.7°C at the site of sample collection. The formation temperature for the Eocene samples was determined in a different study using Δ_{47} in conjunction with Mg/Ca to be 23 °C (Evans et al., 2018). Most of the investigated samples plot indistinguishably from equilibrium in dual clumped isotope space and closely confirm the modern and Eocene temperatures.

Evans et al., 2018 *PNAS* 115, 1174-1179; Fiebig et al., 2019 Chemical Geology 522, 186-191; Bajnai et al., 2020 Nature Communications 11:4005; Guo, 2020 Geochimica et Cosmochimica Acta 286, 230-257