Clumped isotope analyses of large benthic foraminifera

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The oxygen isotope and Mg/Ca ratio of foraminifera tests relate systematically to temperature, and have been widely and successfully applied within the recent geological past. However, both proxies are dependent on the respective ratio in seawater, which significantly complicates the interpretation of such datasets. Foraminifera have been successfully utilised for clumped isotope analysis [Grauel et al., 2013; Tripathi et al., 2010], yet the small mass of most species precludes their widespread use, especially given the simultaneous requirement for exceptionally-preserved material. We present clumped isotope data for a group of large benthic foraminifera species, which are always associated with photosymbionts in the modern ocean and are thus restricted to the upper 100 m of the water column in shelf and reef environments. This group of benthic foraminifera are well suited for clumped isotope analysis as their large size means that fewer than 10 individuals are required for a typical measurement. Previous work has shown that these organisms have promising utility for ocean temperature and seawater chemistry reconstruction during the Eocene [Evans et al., 2013], a geological epoch spanning 56 to 34 million years before present which was characterized by atmospheric CO\textsubscript{2} concentrations several times greater than modern. During this time, these large foraminifera were globally distributed within the low-mid latitude oceans, and abundant to the extent that they are the main component of some shallow water carbonates.

Our data show that live-collected large benthic foraminifera of the genus \textit{Operculina} precipitate calcite with a clumped isotope signature in tight agreement with the inorganic calcite data of Zaarur et al. [2013]. This allows us to derive near-surface ocean palaeotemperatures by applying this calibration to fossil specimens. We present data from 10 globally-distributed (sub)tropical sites, with an aim to more accurately constrain the magnitude and latitudinal extent of Eocene warmth. Preliminary results indicate that the western Pacific was substantially warmer (~6°C) during the Eocene, whilst the mid latitudes (southern UK) was characterised by mean annual sea surface temperatures more than twice present-day.


