Geophysical Research Abstracts
Vol. 21, EGU2019-18193, 2019
EGU General Assembly 2019

Clumped isotope thermometry on fossil corals from the Early Eocene Otway basin, Australia

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The Early Eocene is extensively studied due to its extremely warm climate and high atmospheric pCO_2 conditions (e.g. Bijl et al., 2009; Evans et al., 2018); and in spite of the differing paleogeography is often seen as potential analog for future climate projections. Existing studies show significantly warmer sea surface temperatures at high latitudes and in general a more flatter meridional temperature gradient than modern times (e.g. Evans et al., 2018). However, most of these high latitude temperature estimates are derived solely of the TEX_{86} proxy where complications with the different calibrations bring in a certain uncertainty. In this study we show with carbonate clumped isotope (Δ_{47}) thermometry an alternative proxy to add further temperature estimates and insights to Early Eocene high latitude climate reconstructions.

We collected fossil corals and gastropods from shallow marine beds of the Dilwyn formation that formed during the Early Eocene climatic optimum (~54.5 Ma) in the Otway basin, at a paleolatitude of ~60 ˚S. The application of Δ_{47} thermometry on fossil corals is challenging due to the high content of organics within the aragonitic skeleton, potential dis-equilibrium effects during skeleton formation, aragonite specific acid fractionation during isotope analysis and importantly, a potential diagenetic overprint on the primary aragonitic skeleton. In order to select well preserved corals we performed an extended screening of the material using a combination of multiple geochemical techniques (XRD, EBSD and μXRF), before analyzing the finely powdered fossils for their Δ_{47}.

Our Δ_{47} temperature estimates on the fossil corals show approximately 10 ˚C colder waters than nearby sea surface temperature records based on TEX_{86} (Bijl et al., 2013; Pross et al., 2012) whereas T estimates from a gastropod shell align well with the TEX_{86} data. We discuss the observed offset between the different reconstructions taking into account different formation depths and local circulation of a relatively cold intermediate water mass in the Otway basin, matching bottom water temperature estimates from the nearby, but deeper Pacific site U1172 based on oxygen isotope thermometry of benthic foraminifera (Bijl et al., 2013).

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