

Boron-based insights into late Cretaceous climate and carbon cycle: Updates from the PETRARCH project

MICHAEL J. HENEHAN, SOPHIE WESTACOTT, BERNÁT
HESZLER, EMMELINE GRAY AND ELLIE CHAMBERS

University of Bristol

Presenting Author: Michael.Henehan@bristol.ac.uk

While our understanding of Cenozoic CO₂ has greatly improved over the past 10 years thanks in part to advances in the boron isotope-pH proxy [see e.g. 1,2], the Cretaceous period remains an uncharted frontier for boron-based CO₂ reconstructions. While there are challenges associated with the extension of our records into the Mesozoic, the Cretaceous poses major questions that would greatly benefit from the attention of boron isotope geochemists. In particular, the late Cretaceous saw the warmest greenhouse temperatures of the past 100 Myr. Understanding what CO₂ levels are needed to drive these extreme temperatures, and how CO₂ is cycled in hothouse worlds, are pressing priorities in the face of current anthropogenic climate change [e.g. 3]. Not only this, but this time period witnessed intervals of prolonged, sometimes global marine anoxia in the form of the Cretaceous Ocean Anoxic Events (OAEs), and the role for CO₂ in predisposing the Earth system to anoxia, or tipping Earth into an OAE, is still not well understood. Here I present progress from the PETRARCH project (www.petrarch-project.science), which aims to address these open questions. This includes efforts to extend the boron isotope-pH proxy to radiolarian silica, through laboratory culturing and open-ocean sampling, to allow us to apply boron isotope approaches to time intervals and sediments where planktic foraminifera are not preserved. In combination with our multi-species planktic foraminiferal boron isotope records, this work allows us to place better quantitative constraints on climate forcing from CO₂ through the late Cretaceous. Synthesising these geochemical insights with Earth system modelling, we aim to shed new light on the role of elevated CO₂ in driving marine anoxia.

[1] Rae et al. (2021), *Ann. Rev. Earth Planet. Sci.* 49, 609-641.

[2] Hönisch et al. (2023), *Science* 382(6675), eadi5177.

[3] Tierney et al. (2020), *Science* 370(6517), aay3701.