Interrogating the Palaeocene Palaeoclimate Paradox

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The Palaeocene Epoch (66–56 Ma) presents a challenge to our current understanding of past climates and CO_2 forcing. Benthic foraminiferal oxygen isotopes suggest a greenhouse climate warmer than today, or even than the middle-late Eocene [1], while lithium isotopes may suggest high soil formation and silicate weathering rates [2]. Proxy estimates of atmospheric pCO_2 at this time are scant, however, and the few existing records mostly indicate low CO_2 levels more similar to those seen during the late Neogene [3]. Reconciling these sets of observations at face value would necessitate the existence of climatic controls that are presently under-expressed in palaeoclimate models, for example from clouds or other greenhouse gases. In addition, it is unclear how the long-term changes in the carbon cycle implied by Palaeocene marine $\delta^{13}C$ values were reflected in pCO_2 change.

Here we revisit these questions with new pCO_2 estimates from the boron isotope composition of foraminiferal shells. These measurements include the first boron isotope data generated at the GFZ Potsdam on as little as 3 ng B using 10^{13} Ω amplifiers. These new data, coupled with an updated understanding of how boron isotopes in fossil foraminifera can be affected by vital effects [4], provide important new constraints on climate forcing by CO_2 over this understudied interval.

[1] Zachos *et al.* (2001) *Nature* **451**, 279-283. [2] Vigier & Godderis (2015) *Clim. Past* **11**, 635-645. [3] Beerling & Royer (2011) *Nat. Geoscience* **4**, 418-420. [4] Henehan et al. (2016) EPSL **454**, 282-292.