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# A Palaeogene record of the ionic composition of seawater and its relationship to atmospheric $CO_2$

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Knowledge of the past major and minor ion composition of seawater is key to unravelling the role of large-scale geologic processes such as silicate weathering and fluid-rock interaction in driving long-term climate change. In addition, precise seawater chemistry reconstructions are a prerequisite of the application of carbonate mineral trace element thermometers in deep time. However, with the exception of reconstructions based on the analysis of fluid inclusions trapped in evaporitic sequences, a direct proxy for the past concentration of key elements in seawater is lacking. Recently [1], it was shown that the Na/Ca ratio of foraminiferal calcite can be used as a direct proxy for seawater [Ca], because Na has an extremely long residence time such that changes in calcite Na/Ca are principally driven by [Ca]. Here, we apply this relationship to a suite of exceptionally well-preserved fossil larger benthic foraminifera spanning the Eocene and early Oligocene. This record demonstrates that early Eocene seawater [Ca] was ~2× modern and decreased through the Palaeogene. By coupling these [Ca] reconstructions with existing data regarding the evolution of seawater elemental ratios (e.g. Mg/Ca, Sr/Ca), we furthermore reconstruct changes in seawater [Mg] and [Sr], demonstrating a modest increase in seawater [Mg] and a [Sr] decrease that almost exactly mirrors that of [Ca]. Finally, coupling our data with existing reconstructions of atmospheric $CO_2$ indicates a close correspondence in the timing of seawater chemistry and $CO_2$ changes, and we explore how this coincident variation might be explained.

[1] Hauzer, H. *et al*. [2018] *EPSL* **497**: 80.