Enhanced basalt weathering response to elevated global temperatures in the middle Eocene

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Silicate weathering is an important negative feedback on global climate and is thought to have helped prevent runaway greenhouse or icehouse conditions throughout Earth's history. Modern silicate weathering is known to operate under both climatic (temperature-limited) and tectonic (topography-limited) regimes [1], with the contrasting climatic sensitivities of these two mechanisms resulting in significant debate regarding the ability of the silicate weathering feedback to ensure climate stability through geological time.

In this study we test the importance of climate in driving silicate weathering feedback by characterising the weathering response to an ancient transient warming event that occurred ~40 million years ago, known as the Middle Eocene Climatic Optimum (MECO). By applying a high-precision radiogenic strontium isotope ($^{87}Sr/^{86}Sr$) isotope technique [2], we are able to resolve a previously undetectable shift in seawater $^{87}Sr/^{86}Sr$ ratios that occurred simultaneously with an inferred ~3.5˚C rise in global temperature. The short (~400 kyr) duration of the event, coupled with a strong correlation observed between $^{87}Sr/^{86}Sr$ and $\delta^{18}O$ values, precludes any tectonic influence on the changes in seawater $^{87}Sr/^{86}Sr$ at that time, and therefore provide compelling evidence for the operation of a temperature-controlled silicate weathering feedback process. Application of a reverse modelling approach to our data indicates that this response was most likely driven by a ~14% increase basalt weathering, which is consistent with the temperature sensitive weathering relationships observed in modern catchments [3] and suggests that enhanced basalt weathering may ultimately act as 'climate's policeman'.

[1] West *et al*. (2005). *EPSL*, **235**, 211-228.
[2] Mokadem *et al*. (2015). *EPSL*, **300**, 359-366.
[3] Li *et al*. (2016) *EPSL*, **443**, 59-69.