Geophysical Research Abstracts
Vol. 18, EGU2016-8276, 2016
EGU General Assembly 2016

Stable runoff and weathering fluxes into the oceans over Quaternary climate cycles

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Throughout the Quaternary, erosion and biogeochemical cycles at the Earth surface responded to large oscillations in temperature and precipitation. Such changes are recorded in sedimentary archives and radiogenic isotope mass balances. In contrast, climate models combined with empirical relationships between measures of climate and weatheringindicate minimal change in global weathering rates. Here we resolve the extent to which the supply of dissolved elements to oceans was altered by glacial-interglacial oscillations with a new weathering proxy. We estimate relative weathering fluxes from the ratio of cosmogenic beryllium-10, produced in the atmosphere, to the stable isotope beryllium-9, introduced into the oceans by the riverine silicate weathering flux [1]. Using sedimentary Be records,we show over multiple glacial-interglacial cycles, and over the last 2 Myr, shifts in global silicate weathering inputs are not detectable [2]. Combining climate model simulations of the Last Glacial Maximum with a new model for silicate weathering, we show how large regional variability in runoff between glacial and interglacial periods was insufficient to shift global weathering fluxes. The observed and modeled stability explains why removal of atmospheric CO_2 by silicate weathering has been balanced to within 2% of net CO_2 degassing over the last 600 kyr. Because over $>10^4$ yr time scales weathering and erosion are also coupled, our study provides additional evidence that global erosion rates did not shift along any long-term trend over the Quaternary [3].

[1] von Blanckenburg, F. and Bouchez, J. (2014). "River fluxes to the sea from the oceans ^{10}Be/^{9}Be ratio." Earth and Planetary Science Letters 387: 34-43.

[2] von Blanckenburg, F., Bouchez. J. Ibarra, D.E., Maher, K. (2015). "Stable runoff and weathering fluxes into the oceans over Quaternary climate cycles." Nature Geosciences 10.1038/ngeo2452.

[3] Willenbring, J. K. and von Blanckenburg, F. (2010). "Long-term stability of global erosion rates and weathering during late-Cenozoic cooling." Nature 465: 211-214.