Global Weathering Responses To Glaciation: A Multiproxy Approach

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The motivation for a "case study" approach

Glaciation and associated changes in global climate can affect patterns and rates of chemical weathering. Changes in weathering can, in turn, influence climate through carbon cycle feedbacks. However, the time scale, magnitude and even direction of these feedbacks are not known. Moreover, there is no *a priori* reason the weathering response to glaciation should remain invariant through time. Using Os isotopes as a proxy for globally integrated input to the ocean, we have investigated several Cenozoic examples of glaciation including the first major Oligocene glaciation (Oi1), the middle Miocene climate transition (MMCT), and an early Pleistocene ("41 kyr world") time slice. In general proxy records (e.g. $\delta^{18}O$ and $\delta^{13}C$ in benthic foraminifera, paired Mg/Ca and $\delta^{18}Os$ in planktonic foraminifera) from the same cores are available.

A variety of weathering responses

Previous investigations of the most recent glacial episodes showed that the marine $^{187}Os/^{188}Os$ record displays ≈ 4% decrease coincident with peak glacial conditions [1]. Our early Pleistocene results show that $^{187}Os/^{188}Os$ varies less than 2% over multiple G-I cycles. The Oi1 Os isotope record shows unambiguous evidence of a major perturbation of Os input to the ocean leads glaciation by 1.5 M.Y [2]. While this is permissive evidence that changes in weathering patterns might play a role in the Oi1 event, independent supporting data are lacking. The records of the MMCT from ODP 1171C indicate declining SST and expansion of the East Antarctic ice sheet (EAIS) [3] occurred while the marine Os cycle remained close to steady state. Immediately following EAIS expansion a transient 6% increase in $^{187}Os/^{188}Os$ occurred. This event lasted ≈ 200 kyr and led the CM6 carbon event. This sequence of events is consistent with an interpretation that enhanced weathering and nutrient supply resulting from EAIS expansion contributed to increased productivity and carbon burial following the MMCT.

References

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[3] Shevenell et al. (2004) *Science* **305,** 1766-1770.