The biogeochemical calcium cycle; isotopic insight into sedimentary authigenesis and seafloor weathering

ALEXANDRA V. TURCHYN[1]

[1]Department of Earth Sciences, University of Cambridge, Cambridge CB2 3EQ. avt25@cam.ac.uk

Chemical weathering and marine sedimentation dominate the global biogeochemical cycles for many key metals at Earth's surface and thus intimately link the cycles of these metals to the carbon cycle over geological time. The calcium cycle is one of the key metal cycles coupled to the carbon cycle because the dominant source of calcium to the ocean is terrestrial weathering and the dominant sink is through sedimentary carbonate deposition, similar to carbon. Unlike other biogeochemical metal cycles, tracking changes in the sources and sinks of calcium over geological time using calcium isotopes has been confounded by the 'one source, one sink' problem and the large calcium isotope fractionation associated with different carbonate minerals that may overprint calcium isotope variations resulting from changes in the biogeochemical cycle. Calcium isotopes have been shown to be an incredibly powerful tracer of processes within the calcium cycle, from weathering and precipitation in river, groundwater, and cave systems, to tracing sedimentary processes and carbonate diagenesis.

In this talk I will discuss the use of calcium isotopes to resolve key processes within the global calcium cycle; sedimentary authigenesis and seafloor basaltic weathering. I will discuss the use of calcium isotopes to track the precipitation of authigenic carbonate and carbonate cements within the sediment column. Authigenic carbonate is a minor sink for carbon and calcium in the modern ocean but this sedimentary phase could have been far more important in the geological past. Due to the calcium isotope fractionation on carbonate precipitation, these phases often can be recognized within the cements of the sediment column, and this offers a tantilizing possibility to identify this phase in the geological record. I will also discuss our record of the calcium isotope composition of carbonate veins in the oceanic crust and the calcium budget within hydrothermal systems. It has been suggested that carbonate vein formation, driven by the seafloor weathering of basalt, may respond to, and record, changes in the carbon cycle in a similar way to the terrestrial weathering feedback. The range of calcium isotopes in various hydrothermal phases allows the reconstruction of the flow of calcium through the seafloor weathering reactor and thus the potential quantification of this process in the calcium and carbon cycles.

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