The influence of weathering processes on riverine Mg and Li isotopes in rivers draining basaltic terrain

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Chemical weathering of continental Ca-Mg silicates is a long-term sink of atmospheric CO_2, and therefore exerts a major control on climate. However, tracing change in weathering processes through time is difficult because many traditional radiogenic isotope tracers yield ambiguous signals. The transfer of Mg from the continents to the oceans, and its subsequent removal from the oceans, plays a major role in the global carbon cycle, and has also been invoked as a dominant control on oceanic carbonate chemistry. However, the relative importance of these processes, as well as those which fractionate Mg isotopes during weathering, are not well understood. Distinguishing Mg isotope variations which arise from differences in lithology from those caused by weathering processes is difficult, because the range of δ^{26}Mg observed in different rock types is large. However, the study of mono-lithological terrains offers one way of circumventing the effects from different rock types.

This study presents Li and Mg isotope data for bedload, suspended and dissolved load of rivers from basaltic catchments in Iceland. In addition, primary basaltic mineral phases and soils have also been analysed to determine the possible effects of weathering of primary minerals and the formation of secondary phases.

Li isotope (δ^{7}Li), variations are generally thought to reflect the balance between dissolution of primary minerals and secondary mineral formation; the light isotope, ^{6}Li, is preferentially taken up by secondary minerals. The δ^{7}Li of the dissolved phase varies between +17 and +44‰, and generally decreases downstream.

δ^{26}Mg values of the river sediments range from -0.83 to +0.83‰ relative to DSM-3. Basaltic soils have variable δ^{26}Mg; those with a higher secondary mineral content are isotopially lighter. Co-variations of riverine δ^{26}Mg with suspended load δ^{26}Mg, as well as with pH and the fraction of Mg lost to clays appear to indicate that the isotope composition of the dissolved load is dominantly controlled by preferential uptake of ^{24}Mg into clays, leaving the residual dissolved load isotopically heavy.

These data suggest that Mg isotopes in basaltic rivers are dominantly controlled by secondary mineral formation, and thus the degree of chemical weathering.

Carbon isotope evidence (^{13}C and ^{14}C) for fossil methane-derived dissolved organic carbon from gas hydrate bearing cold seeps

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Vast reservoirs of gas hydrate in continental margin sediments have the potential to influence the properties of organic matter in both sediments and the overlying water column. Natural radiocarbon and stable carbon isotopes were utilized to determine if fossil methane-derived carbon associated with gas hydrate-bearing sediments was incorporated into the dissolved organic carbon (DOC) of both sediment pore waters and overlying near-bottom waters from northern Cascadia margin cold seeps. Pore water DOC from the sulfate-methane transition (SMT) had a δ^{13}C of -60‰ at a site with a microbial methane source and -45‰ at a site with a thermogenic methane source. In both cases, methane-derived carbon was the predominant carbon source (80-100%) for DOC associated with the SMT. Furthermore, ^{14}C- and ^{13}C-depleted bottom water DOC from the thermogenic gas hydrate site indicates that methane carbon constituted 30-50% of the bottom water DOC. Our results indicate that fossil-derived sources of carbon were a significant component of DOC in the cold seep systems we investigated, and suggest that fossil methane-derived DOC fluxes from cold seep sediments may contribute to the aged DOC pools of the deep open ocean.