Modelling the global riverine U fluxes to the oceans

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Mean U isotopic ratio of the ocean has remained roughly constant since about 600 kyrs (Henderson, 2001). This 1.14 value cannot be explained considering the present day value of the U riverine ratio (1.17, Chabaux et al., 2001). However, the mean riverine ratio was calculated on half of the total continental runoff. Is this partial mean value really representative of the mean value? If yes, might this value have changed over a glacial-interglacial cycle ?

We build up a numerical model calculating the flux of U transfer to the ocean through weathering. The spatial resolution of the model reaches 0.5°lat x0.5°long. Lithology is modified from Amiotte-Suchet et al. (2003). Weathering fluxes are estimated from simple parametric laws, calculating the flux of total dissolved solids from mean annual temperature and runoff. Soil PCO_2 is used to estimate carbonate dissolution rates, and is calculated from a simulation of the Caraib model. Uranium fluxes are estimated proportional to the TDS flux, weighted by its abundance in the source rock. CO_2 consumption through weathering is simultaneously computed. The $^{234}U/^{238}U$ ratio of the river is calculated according to a correlation existing between the measured $^{234}U/^{238}U$ and runoff, showing a decrease of this ratio with increasing runoff. The model is first validated over several large watersheds, including the Amazon, the Ganges-Brahmapoutra, the Mississippi, and the Congo rivers. Global runs are then performed, showing that the modelled mean global value is close to the measured partial mean of 1.17.

We explore then possible variations of the modelled ratio at the last glacial maximum. Temperature and runoff fields are taken from LGM simulations of the ECHAM GCM. Extension of ice sheets is assumed to cut off part of the weathering fluxes, producing possible fluctuations in the riverine U isotopic ratio, as well as changes in the regional runoff pattern.

Dissolved and adsorbed rare earth element (REE) transport by rivers in the Canadian Cordillera: Influence of weathering and erosion

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Labile REE (equals the sum of dissolved REE plus REE adsorbed to suspended particulate matter) were measured in three large river systems draining the western Canadian Cordillera into the Pacific Ocean (Fraser, Skeena and Nass). The results are used to interpret chemical and physical weathering processes within these watersheds.

Labile REE patterns are found to vary widely across the Cordillera, and reflect basin lithology, with chondrite normalised La/Yb ranging from 2.4 to 13.2. The labile REE composition of the Fraser River near the mouth represents a mixture of inputs from individual tributaries, indicative of the conservative nature of the labile REE. Furthermore, there is sufficient variability in labile REE patterns between watersheds to support the development of labile REE as a chemical weathering or hydrological tracer.

Kd (adsorbed / dissolved) values in June (high water stage, average $\approx$ 1000) are approximately 50 times lower than in October (low water stage, average $\approx$ 50000). This indicates a change in the composition of the suspended particulate matter, suggesting a shift in particulate source from recently eroded rock flour (alpine source) in June, to alluvial soils (valley source) in October, which have developed over the Holocene and have greater proportion of clay minerals and therefore higher adsorptive capacity.

The observed seasonal shift in particulate source and composition suggests that silicate weathering (and CO_2 drawdown) is occurring in the valley regions of these watersheds (relatively low physical erosion rates), not the alpine regions (high physical erosion rates). This means that silicate weathering in the Canadian Cordillera is not directly coupled to physical erosion.

Furthermore, approximately 80% of the annual particulate burden of these rivers is discharged during the high water stage. The REE distribution (adsorbed / dissolved) indicates this material is dominated by freshly eroded material being shed off the alpine regions of the catchments. This suggests that the sediment budget of these rivers is controlled by current uplift and erosion rather than re-working Pleistocene glacial sediments; in turn, this suggests that the erosional regime in the Canadian Cordillera may be approaching steady state.