

Source versus weathering processes as controls on the Mackenzie river uranium isotope signature

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Uranium (U) isotope signatures recorded in sedimentary archives provide insight into the paleo redox state of the ocean. But the robust interpretation of these sedimentary U isotope records requires better constraints on the U isotope signature of rivers - the main source of U to the ocean [1]. Here, we investigate the elemental and isotope signatures of uranium in the dissolved and solid loads of a well-characterised river, the Mackenzie Basin (Canada).

The solid load $\delta^{238}\text{U}$ shows a positive relationship with U and vanadium contents, consistent with the variable contributions via erosion of silicate and black shale. The $\delta^{238}\text{U}$ of the dissolved and solid loads are correlated, which might suggest no U isotope fractionation during chemical weathering, and a purely lithological control on both the river dissolved and solid $\delta^{238}\text{U}$. Moreover, relationships between dissolved U and $\delta^{238}\text{U}$ and major elements such as calcium and sulfate, also support the idea of a lithological control. However, the $\delta^{238}\text{U}$ of end members inferred from mixing relationships are not consistent with binary mixing, suggesting U isotope fractionation during weathering. The abundance of U in the river dissolved load is always lower than that predicted by silicate rock weathering. This suggests that 1) the weathering of silicate can only explain the abundance of U in the river dissolved load and 2) secondary weathering processes scavenge a proportion of the U released by primary mineral breakdown. The broad negative relationship between $\delta^{238}\text{U}$ and the depletion of dissolved U is also consistent with the control of dissolved $\delta^{238}\text{U}$ by secondary weathering processes. The relationships observed between dissolved U, $\delta^{238}\text{U}$ and the large-scale environmental parameters (such as weathering intensity or runoff) support this hypothesis.

Overall, our interpretations of the variation in the river dissolved $\delta^{238}\text{U}$ challenge the common assumption that black shale and carbonate weathering control dissolved U. In addition, we suggest that the extent of secondary weathering processes can be imprinted on the U isotope signature of rivers, now and in the past.

Andersen, Morten B., et al. "Closing in on the marine $^{238}\text{U}/^{235}\text{U}$ budget." *Chemical Geology* 420 (2016): 11-22.