Lithium isotopes in waters draining a large permafrost-dominated watershed: The Lena River

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The fractionation of lithium isotopes (δ^7Li) during weathering processes results in large variations in the δ^7Li of riverine input into the oceans, and have widely been used to understand silicate weathering processes. However, few studies have investigated large rivers draining permafrost-dominated regions, that are significant in the global riverine budget.

Here we have analysed [Li] and δ^7Li of river waters from the Lena River, Siberia, one of the largest global rivers draining into the Arctic Ocean. The Lena River and tributaries drain a range in lithologies, and the large watersheds are located in a region of continuous permafrost. This area is of particular interest due to potential changes in the geochemical behaviour of trace elements during permafrost thawing and organic carbon mobilisation, associated both with climate changes on Plio-Pleistocene glacial-interglacial timescales, as well as predicted future climate warming.

The riverine δ^7Li values range from +11.4 ‰ to +29.8 ‰, within the range of published global riverine values. Rivers draining the Central Siberian Plateu typically exhibit the highest [Li], but lowest δ^7Li values. The highest δ^7Li values are found in rivers draining the Verkhoyansk Mountain Range. This is in contrast to recent studies where areas of rapid uplift displayed low δ^7Li values, whereas floodplain areas had high δ^7Li due to increased secondary mineral formation.

We interpret the observed variations by distinguishing several counter-acting factors that are critical in understanding how lithium isotopes reflect weathering, including (i) lithological controls on secondary mineral formation, and (ii) changes in water-rock interaction time. Overall, the study shows how Li isotopes respond to weathering in a climatic system that is distinctly different from that of most weathering studies.