A lithium isotope gradient on the Tibetan Plateau – source effect or weathering regime change?

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The continental crust is exposed to weathering which may act as a feedback on Earth's long-term climate. For determining how weathering has evolved in the past, as a function of climate and/or tectonic activity, models of the CO_2 cycle have used $^{87}Sr/^{86}Sr$, for example. However, this is challenging because it reflects both carbonate and silicate weathering. In contrast, lithium is a trace element that is hosted almost exclusively in silicate minerals. Particularly interesting are the stable isotopes of lithium because ^{6}Li and ^{7}Li fractionate when silicate minerals are weathered and secondary minerals (e.g. clays) are formed. Here, we examined surface waters and sediments from the Lake Bangong catchment located on the western Tibetan Plateau. We combine Li isotope ratios with major element data and compare the results with rivers and sediments of the southern and northeastern Tibetan plateau.

Two large inflows of the Lake Bangong have d7Li values of +6.1 and +8.9 (dissolved load). Similar low d7Li values for the headwaters of the Indus and Yarlung Tsangpo rivers provide evidence for a low d7Li regime all over the western and southern Tibetan Plateau, whereas d7Li values of rivers from the NE-Tibetan Plateau are systematically higher. Also lake and river sediments from the Lake Bangong catchment, Indus headwaters, and Yarlung Tsangpo display lower $d^{7}Li$ values than fluvial sediments from the NE Tibetan Plateau. The d7Li values of the studied sediments correlate with weathering intensity tracers such as the chemical index of alteration (CIA), K/(Na+K), or Na/Ti. This is consistent with weathering of igneous and low-d7Li sedimentary rocks, and mixing different proportions into modern sediments. However, several lines of evidence indicate that low d7Li values of sediments and river waters from the western and southern Tibetan Plateau result from modern weathering. Thus, the d7Li gradient across the Tibetan Plateau may mirror a change from kinetically limited to supply-limited weathering, at least formally. The latter is somewhat unexpected for weathering in a cold and dry climate, with its very low weathering rates, but might be feasible due to extremely low erosion rates on the Tibetan Plateau.