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Spatiotemporal variation of lithium isotopes in the Yarlung Tsangpo River basin: Source and process

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The increase in marine Li isotope ratios (δ^7Li, ~9‰) since the Cenozoic is thought to be related to continental chemical weathering associated with tectonic uplift (e.g., Tibetan Plateau (TP)). The reasons for spatio-temporal variations of δ^7Li in the rivers flowing through the TP remain unclear, which may hinder us understanding the changes in δ^7Li value in marine. In this study, we collected various geological samples (e.g., river waters, suspended particulate materials, sediments, hot springs and silicate rocks) from the Yarlung Tsangpo River (YTR) basin which is the largest river system in TP. YTR is characterized by very high dissolved Li concentration ($[Li]_{dis}$) (mean 58.4 μg/L), high Li/Na ratios (mean 22) and low δ^7Li_{dis} values (mean +6.4‰). Monthly data showed that mainstream δ^7Li_{dis} increased significantly during monsoon (July and August), ranging between +8.3‰ and +11.5‰, while low values were general observed in non-monsoon and varied between +3.7‰ and +7.4‰. Geothermal water is suspected as the main source of high $[Li]_{dis}$ in the river waters due to extremely high $[Li]_{dis}$ (mg/L levels) in geothermal water and the abundance of geothermal systems distributed in southern TP. Although much of the dissolved Li in river water is derived from geothermal water, the δ^7Li_{dis} in river water obvious higher than that in geothermal water (-1.7‰ to +3.1‰). The binary mixture model results suggest that the dissolved Li from silicate weathering with high δ^7Li_{dis} cannot explain the elevated δ^7Li_{dis} in river water. Re-fractionation of Li isotope between dissolved Li and secondary minerals may be the main reason for the increased δ^7Li_{dis} in river water. Chemical weathering process provides more fresh secondary minerals to the river water and dissolved Li from geothermal water is transported through rivers with a long residence time together promote Li isotope fractionation. We speculate that tectonic uplift accompanying acceleration of chemical weathering, formation of more secondary minerals, input of geothermal water, and the birth of large rivers from mountains are collectively contributed to an increase in the riverine flux of dissolved Li with high δ^7Li_{dis} into the ocean, which may help to explain the increase of seawater δ^7Li since the Cenozoic.