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Ca and Sr isotope in the upper reaches of the Yangtze River in the eastern Tibetan Plateau: Implication for source mixing, secondary mineral formation, and chemical weathering rates.

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Calcium is a critical element in the carbon cycle, due to carbon sequestration via carbonate formation. Here we examine Ca ($\delta^{44/40}$Ca) and Sr isotope (^{87}Sr/^{86}Sr) ratios during chemical weathering in rivers draining a diverse range of geologic and climatic environments in the upper reaches of the Yangtze River. The Ca isotopic composition of the riverine dissolved load suggests that the plateau and floodplain rivers have higher $\delta^{44/40}$Ca values than the mountainous rivers. Correlations between river dissolved $\delta^{44/40}$Ca and the carbonate saturation index and Sr/Ca ratios indicate that precipitation of secondary carbonates governs the Ca isotopic composition of the plateau and mountainous rivers and floodplain mainstreams. The different Ca isotope behaviour between the floodplain tributaries and other rivers suggests strong controls by topography and climate. Overall, in the floodplain, heavy precipitation lowers the pH of the soil solution, which inhibits the precipitation of secondary carbonate. Whereas, the flat terrain increases the time of the water-rock reaction, which results in the formation of large amounts of secondary clay minerals that preferentially incorporate lighter Ca isotopes. This study highlights the potential of stable Ca isotopes to identify secondary processes in conjunction with ^{87}Sr/^{86}Sr and δ^{7}Li values, and to trace both rates and intensity of silicate weathering in large river basins.