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Effects of secondary carbonate precipitation and dissolution on Changjiang (Yangtze) river chemistry and estimates of silicate weathering rates

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Riverine solute chemistry has long been used to infer modern weathering fluxes and processes by assuming that river-dissolved loads are conservative mixtures of weathering products of different lithologies. Secondary carbonate precipitation and re-dissolution are important processes that can alter the original weathering fluxes. However, it remains less well understood how secondary carbonates affect the solute chemistry of large rivers and the estimates of silicate weathering rates. In this study, we systematically explored seasonal variations of river water chemistry in the lower Changjiang (Yangtze River) basin, seeking to better understand the time lag between chemical weathering and fluvial export of the dissolved weathering products. We report a new, biweekly-collected dataset of the elemental and isotopic compositions of the Changjiang river water. Variable Ca/Sr and Ca/Mg ratios but stable $^{87}Sr/^{86}Sr$ and $\delta^{26}Mg$ are observed, which can only be explained by the precipitation and dissolution of secondary carbonates. Across a range of possible Ca/Mg ratios of the primary weathering flux, we estimate that up to 30% of the dissolved Ca carried by Changjiang was controlled by secondary carbonate precipitation and re-dissolution. With inverse modeling, we show that secondary carbonate precipitation and re-dissolution have a minor influence on the calculated silicate weathering rates. In the sampling year, the CO_2 consumption rates by silicate weathering and carbonate weathering were $267\pm128 \times10^9$ and $703\pm84 \times10^9$ mol C/yr, respectively. These findings provide new insights into how secondary carbonates affect water chemistry in large river systems, highlighting the role of secondary carbonate precipitation and re-dissolution in modulating riverine dissolved fluxes in the Changjiang basin.