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Carbonate composition and its impact on fluvial geochemistry in the NE Tibetan Plateau region

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Using co-variations of Sr/Ca and Mg/Ca, we examined the carbonate compositions of various bedrocks (silicate and carbonate rocks) and sediments (eolian and fluvial sediments, sand, and topsoil) found in the NE Tibetan Plateau (TP) region. A combined carbonate composition dataset based on our results and other reported data shows that bedrock carbonate composition on the NE TP displays a much broader range of Sr/Ca and Mg/Ca ratios than restricted source carbonate endmembers reported upon in previous studies. Bedrock carbonate compositions are characterized by disseminated carbonates with higher Sr/Ca and Mg/Ca ratios, and sedimentary carbonates (mostly marine) with lower Sr/Ca, but variable Mg/Ca, ratios. The mostly authigenic carbonates found in sediments show similar trends, with a gradient ∼0.97-1.00 in a plot of log (Sr/Ca) versus log (Mg/Ca), suggesting that 'calcite precipitation' processes – i.e. the sources of the dissolved cations in the water – control their chemistry. Based on observations and modeling, we conclude that the mixing of authigenic and bedrock carbonate endmembers, plus the incongruent dissolution of bedrock carbonates, accounts for the bulk carbonate composition of sediments (e.g. loess, sand and topsoil). A comparison of bedrock and sedimentary carbonate composition with reported fluvial water data in the NE TP suggests that weathering of carbonates in terrigenous sediments, rather than in bedrock, is mostly responsible for the changes in fluvial Sr, Mg and Ca compositions. The evolution of fluvial NE TP Sr, Mg and Ca compositions can be explained using a calcite fractional dissolution model. Secondary calcite precipitation largely accounts for the much higher Sr/Ca and Mg/Ca ratios found in fluvial water in this arid region. Our study suggests that interactions between carbonates and water occur widely during the exposure, transport and deposition of sediments, significantly modifying regional carbonate compositions and fluvial geochemistry.