Sulfur isotopes in rivers: insights into global pyrite oxidation and the modern sulfur cycle

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The sulfur cycle plays an important role in global climate via weathering reactions and its link to the cycling of carbon and oxygen. However many aspects of the modern sulfur budget are not well constrained. We present new $\delta^{34}S$ measurements on aqueous sulfate from more than 160 river water samples from different geographical and climatic regions. These data were generated by MC-ICP-MS and represent more than 46% of the world's freshwater flux to the ocean. We use these data to revise the modern riverine sulfur isotope budget. Combined with major anion and cation concentrations, the sulfur isotope data allow us to tease apart the relative contributions of different processes to the modern riverine sulfur budget, resulting in new estimates of the flux of riverine sulfate due to the oxidative weathering of pyrites and the weathering of sedimentary sulfates. These data suggest that the global oxidative weathering of pyrite has previously been underestimated, and place important constraints on the modern sulfur cycle and sulfur isotope balance. Furthermore, the large range (-13 to 21‰) of sulfur isotope ratios in modern rivers indicates that secular changes in the lithologies exposed to weathering through time could play a major role in driving past variations in $\delta^{34}S$ of seawater.