

Intense sulfide oxidation in the western Himalaya compared to Indus floodplain: Constraints from sulfur isotopic study

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Sulfide oxidation counter-balances the CO₂ consumed by silicate weathering and hence, plays an important role in the long-term carbon cycle. This process is often found to be higher in mountainous region than in floodplains, mainly due to continuous exposure of fresher minerals through physical erosion. In this study, we evaluated the sulfide oxidation rate for the western Himalaya using sulfur isotopic composition of riverine sulfate for the Indus headwater basin in India. These data are compared with earlier reported $\delta^{34}\text{S}_{\text{SO}_4}$ data for the Indus floodplain [1] to constrain the locus of sulfide oxidation in this basin. The SO₄ concentrations in this basin vary between 36 and 425 μM (mean: 195 μM). The $\delta^{34}\text{S}_{\text{SO}_4}$ data vary from -11.5 to +5.5 ‰, with the lowest value is observed for a sample from the Dras sub-basin. Average $\delta^{34}\text{S}_{\text{SO}_4}$ value of the Indus mainstream (~ -4.5 ‰) in the upper reaches is ~5 ‰ depleted than that reported for the river mouth (~0.8 ‰; [1]) during summer season, and ~10 ‰ depleted than that reported as global average for rivers (~4.4 ‰; [2]). This depleted $\delta^{34}\text{S}_{\text{SO}_4}$ for the upper Indus points to intense oxidation of the pyrite minerals, which is characterized with relatively lower $\delta^{34}\text{S}_{\text{SO}_4}$ (~-12 ‰) compared to that for the gypsum (~-17 ‰; [2]). Our preliminary estimates show that about three-fourth of riverine sulfate in the Indus headwater basin (at Khalsi) are supplied by pyrite oxidation, which is higher than that computed for the Indus outflow. Further, the CO₂ release rate via sulfide oxidation is found comparable to the CO₂ consumption rate by silicate weathering for these glaciated regions of the western Himalaya. This observation, therefore, challenges the net effect of Himalayan erosion on global Cenozoic cooling.

References

- [1]: Karim and Veizer (2000) *Chemical Geology*, 170(1-4), 153-177.
[2]: Burke et al., (2018) *Earth Planet. Sci. Lett.*, 496, 168-177.