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Sulfuric acid disturbance in CO_2 effects of the Tibetan Plateau weathering: evidence from river geochemistry

WENJING LIU AND ZHIFANG XU

Institute of Geology and Geophysics, Chinese Academy of Sciences

Presenting Author: liuwenjing@mail.iggcas.ac.cn

Sulfuric acid (H_2SO_4) generated during oxidative weathering of pyrite (OWP) participates in chemical weathering, which has been argued as an important process counteracting the accelerated atmosphere CO_2 consumption by silicate weathering in Cenozoic. As the highest and largest plateau formed in Cenozoic, direct and quantitative evidence for H_2SO_4 involvement in weathering and its impact on carbon cycling are lacking in the Tibetan Plateau.

Systematic studies on water chemistry, carbon isotope ($\delta^{13}C_{DIC}$) and sulfur isotope ($\delta^{34}S_{SO4}$) were conducted in watersheds with different lithology and climate backgrounds on the Tibet Plateau. It has been found that: 1) OWP is the main source of riverine sulphate in the small catchments in eastern plateau (accounting for 69~77% of total); even in the northeastern watershed with a dry and cold climate where evaporative salts are widely distributed, its average contribution reached 38%, revealing the deep involvement of H_2SO_4 in the plateau weathering; 2) lithology and erosion rate together control the rate of H_2SO_4 generation and the rate of CO_2 releasing during its reacting with carbonate minerals. The H_2SO_4 generation rate of OWP in glacial watersheds is ~5 times higher than that in non-glacial watersheds; the CO_2 releasing rate in the sedimentary watersheds is ~3 times higher than that in the granite watershed, due to its high contents of sulfide and carbonate minerals, and weak erosion resistance; 3) 80% of the CO_2 flux consumed by silicate rock weathering is counteracted by the CO_2 released by H_2SO_4 dissolution of carbonate minerals in small watersheds in the eastern edge of the plateau. Previous river hydro-geochemistry studies without quantification of H_2SO_4 participation may have largely overestimated the chemical weathering carbon sink effect of the Tibetan plateau.