Variations in chemical weathering and CO_2 flux along a subtropical catchment in an active orogen

YI-JIE WANG[1] , RICK CHEN [1] , JUI-FEN TSAI[2] , LI-HUNG LIN[2] , PEI-LING WANG [1]

[1] *Institute of Oceanography, National Taiwan University, Taipei, Taiwan* (jackyw6645@gmail.com)

[2] *Department of Geosciences, National Taiwan University, Taipei, Taiwan*

Chemical weathering play a vital role in the global carbon cycle over geological time scales. The central themes focus on the pathways of acid production, rock availability for dissolution, and correlations between rates and climatic or tectonic factors. Most previous efforts are diverted to measuring great exports of solutes and sediments from large rivers systems. As small rivers in active orogens across Asia and Oceania could deliver solutes and sediments at a rate surpassing large rivers on the per area basis, the exact flux and reaction pathway of chemical weathering in these catchments remain poorly quantified.

This study aims to investigate the spatial and temporal variations in patterns of chemical weathering along the Beinan-Sinwulyu river in southeastern Taiwan where uplifting rates range up to 3 cm/yr and fluxes of sediment export are among the largest in Taiwan. Analyses of river water collected from different tributaries between 2016 and 2018 yielded Ca^{2+},SO_4^{2-} and dissolved inorganic carbon as the major constitutes. In particular, SO_4^{2-} concentrations are two to sixteen times higher than the world average value at ~300 μM. With the lack of gypsum, correction of rain contribution and SO_4^{2-}/Cl^- ratios unlike seawater, the measured sulfate is primarily attributed to being produced from pyrite oxidation. Using a new computational approach to evaluate these solute data, we demonstrate that carbonate weathering mostly driven by sulfuric acid accounts for >70 % of solutes at all sites. The catchment-wide flux derived from carbonate weathering ranged between 10 to 64 million mole km^{-2} yr^{-1}, a level four-five orders of magnitude greater than the average of major large rivers at ~250 mole km^{-2} yr^{-1}. The computation also indicates that the CO_2 efflux was correlated with the flux of pyrite-derived carbonate weathering with the net emission occurring in upstream, mountainous regions in all seasons and the net consumption in the downstream plain to estuarine regions in dry seasons. Overall, these results demonstrate a strong modulation of the oxidation of pyrite inherited with metamorphic rocks in chemical weathering and CO_2 emission in a rapidly uplifting catchment.