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River geochemical signatures in the Zambales Ophiolite Complex, Philippines: Implications for Southeast Asian uplift, weathering, and the long-term carbon cycle

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The textbook view of the geological carbon cycle identifies silicate weathering as a primary, but variable, negative feedback mechanism for modulating long-term atmospheric CO_2 levels, linking tectonics and paleogeography with the exogenic carbon cycle. For example, it has been hypothesized that the uplift of mafic and ultramafic lithologies in Southeast Asia induced gradual Neogene cooling. However, Sr and Os isotopic trends in marine sedimentary records provide contrasting evidence to this claim. Therefore, disentangling the contributions of multiple processes is necessary to accurately interpret geochemical records and clarify the role of tectonics and weathering in regulating global climate.

This work presents new modern geochemical constraints on silicate weathering in tropical Southeast Asia through a comprehensive characterization of rivers draining the Zambales Ophiolite Complex (ZOC). Estimated to be emplaced during the Neogene, the ZOC is among the best-studied ophiolite structures in the region and provides a representative site for silicate weathering in Southeast Asia. We analyzed water, soil, sediment, and rock samples collected across three field sampling cycles from over 20 rivers that drain the area (December 2022; August 2023 and 2024) and data from previous work [1].

Combined with published monitoring data, we present geochemical assessments of major ions (Ca^{2+}, Mg^{2+}, Na^{+}, Cl^{-}) and $^{87}Sr/^{86}Sr$ in both dissolved and bulk solid samples, along with mineralogical characterization of soils and river sediments. Expectedly, initial inversion analyses of dissolved parameters show higher-than-global average, area-normalized fluxes of weathering-derived dissolved load. We refine this finding by incorporating $^{87}Sr/^{86}Sr$ data into our inversion model and using mineralogical data to better inform our interpretations. This approach allows us to disentangle geochemical fingerprints of processes such as carbonate dissolution and serpentinization from silicate weathering contributions. Ultimately, our goal is to provide quantitative constraints on the dissolved ionic and isotopic fluxes from ophiolitic terrains in tropical Southeast Asia and evaluate their implications for global carbon cycle feedbacks.

[1] Schopka, H. H., Derry, L. A., & Arcilla, C. A. (2011). Chemical weathering, river geochemistry and atmospheric carbon fluxes from volcanic and ultramafic regions on Luzon Island, the Philippines. *Geochimica et Cosmochimica Acta*, *75*(4), 978–1002. https://doi.org/10.1016/j.gca.2010.11.014