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The circular nutrient economy of ecosystems and the consequences for rock weathering

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Because the massive machinery of the biosphere requires rock-derived nutrients, it is often assumed that the biosphere exerts a substantial influence on chemical weathering rates. We recently employed two means as test of this hypothesis and found that this may not be the case. 1) A combined plant growth and weathering model predicts that at erosion rates typical of the global land surface, more rapid mineral dissolution combined with enhanced formation of secondary minerals depletes the inventory of plant-available P, resulting in no benefit for plant growth [1]. We also found that even though the uptake rates of P and Ca into biomass may exceed the rates of dissolution in regolith by an order of magnitude, the increased chemical weathering export does not scale directly with plant growth. Rather, the excess in demand over supply of mineral nutrients is satisfied by recycling. 2) In field studies along sites that differ in erosion rate, erosion exerts the principle control over weathering. Even though these sites also differ in climate and biomass growth neither the degree of weathering nor the weathering rates increase systematically with precipitation or biomass growth along the gradient. A nutrient recycling factor can be quantified that increases inversely with erosion rate and shows that the increase in nutrient demand with increasing biomass growth is accommodated by faster nutrient recycling between plants and soil. [2, 3]. Collectively, our results suggest that biologically enhanced rock dissolution will only impact chemical weathering exports at high erosion rates uncharacteristic of most of the Earth's surface.

[1] Maher, K., and von Blanckenburg, F., 2023, The circular nutrient economy of terrestrial ecosystems and the consequences for rock weathering: Frontiers in Environmental Science, DOI: 10.3389/fenvs.2022.1066959

[2] Oeser, R.A., von Blanckenburg, F., 2020. Do degree and rate of silicate weathering depend on plant productivity? Biogeosciences DOI: 10.5194/bg-17-4883-2020

[3] von Blanckenburg, F., Schuessler, J.A., Bouchez, J., Frings, P.J., Uhlig, D., Oelze, M., Frick, D.A., Hewawasam, T., Dixon, J., Norton, K., 2021. Rock weathering and nutrient cycling along an erodosequence. American Journal of Science DOI: 10.2475/08.2021.01