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Decoupling primary productivity from silicate weathering – how ecosystems regulate nutrient uptake along a climate and vegetation gradient

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Water flow as well as the presence and growth rate of land plants are commonly thought to present drivers of rock weathering. While plants are indeed key players in weathering, the quantitative evaluation of biota on total abiotic and biotic weathering processes remains vague.

Here, we report on weathering rates and nutrient uptake along the “EarthShape” climate and vegetation gradient in the Chilean Coastal Cordillera. The hypothesis we evaluated is whether weathering rate and degree does increase from north to south along the EarthShape climate gradient and whether the increase in biomass growth rate along this gradient is accommodated by additional nutrient-supply induced through weathering. We quantified the bio-available fraction of nutritive elements in regolith and we measured $^{87}Sr/^{86}Sr$ isotope ratios in the different compartments of the Earth’s Critical Zone (bedrock, regolith, bio-available fraction in saprolite and soil, and vegetation) to identify the sources of mineral nutrients to plants. We were thus quantified gains and losses of nutritive elements in and out of these ecosystems and to quantify nutrient recycling.

We find that despite the increase in biomass growth the weathering rate is relatively uniform along the gradient. Instead of accelerating biogenic weathering ecosystems with high productivity rely on efficient recycling between plants and soil to sustain their nutrition. Thus, the organic nutrient pathway (between plants and litter on the foerst floor) intensifies, whereas the geogenic nutrient pathway (from minerals to plant) remains steady despite increasing precipitation and primary productivity. We further speculate that the presence of plants might compensate weathering downward by regulating the hydrological cycle, fostering secondary-mineral formation, and a microbial community specializing on nutrient-recycling rather than nutrient-acquisition through weathering.