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Influence of atmospheric CO_2, temperature, and plants on basalt weathering

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Weathering of basalts exerts strong abiotic influence on carbon removal from the atmosphere while photosynthesis by plants is a biological process that influences carbon sequestration. These two processes can influence each other when plants are grown on basaltic substrate. They can also be potentially influenced by atmospheric CO_2 concentrations and temperature. It was hypothesized that elevated temperatures and CO_2 would increase both weathering and plant growth independently, but will also have synergistic effects, where increase in weathering will enhance plant growth, and strong plants would increase weathering.

We performed mesocosm experiments at Ecotron Ile-de-France where basalt with a loamy sand texture was exposed to rainfall at equilibrium with two different CO_2 concentrations in the air, 400 ppm and 800 ppm; and at two temperature ranges 21-26 and 25-30 °C. Four biological treatments included: a control without plants but with native microbial community; alfalfa, a N-fixing forb; mesquite, a N-fixing woody plant; and green sprangletop, a grass that does not form symbiotic relationships with N fixers. Over four months, mesocoms were watered regularly to support plant growth and exposed to four larger rainfall events to collect soil porewater and drainage solution. Concentrations of biogenic and lithogenic weathering products were measured in collected solution. Plant biomass was collected at the end of the experiment to determine dry weight, as well as uptake of lithogenic elements by the plants. Basalt was also analyzed for organic and inorganic carbon and total nitrogen before and after the experiment. It was observed that both temperature and CO_2 concentrations influenced plant growth. In particular, increase in temperature resulted in smaller below ground biomass in alfalfa, which had the highest biomass overall. Elevated CO_2 significantly increased release of Ca. Mg, and Na, while elevated temperatures increased Si, K and P. There was no significant effect of temperature or CO_2 on plant uptake of major elements, but elevated temperatures significantly increased trace metal uptake by the plants. This study indicates that both elevated levels of CO_2 and higher temperatures can significantly influence weathering processes.