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Effect of elevated CO_2 and temperature on abiotic and biologically-driven basalt weathering and C sequestration

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Weathering of primary silicates is one of the mechanisms involved in carbon removal from the atmosphere, affecting the carbon cycle at geologic timescales with basalt significantly contributing to the global weathering CO_2 flux. Mineral weathering can be enhanced by microbiota and plants. Increase in both temperature and amount of CO_2 in the atmosphere can directly increase weathering and can also affect weathering through impact on biological systems. This would result in possible negative feedback on climate change. The goal of this research was to quantify direct and indirect effects of temperature and elevated CO_2 on basalt weathering and carbon sequestration. In order to achieve this goal we performed controlled-environment mesocosm experiments at Ecotron Ile-de-France (France). Granular basalt collected in Flagstaff (AZ, USA) was exposed to rainfall at equilibrium with two different CO_2 concentrations in the air, ambient (400 ppm) and elevated (800 ppm); and kept at two climate regimes, with ambient and elevated (+ 4° C) temperature. Four biological treatments were superimposed on this design: a plant-free control; N-fixing grass (Alfalfa, Medicago sativa), N-fixing tree (Velvet mesquite, Prosopis velutina); and grass that does not form symbiotic relationships with N fixers (Green Sprangletop, Leptochloa dubia). All used basalt had native microbial community. Mesocosms were equipped with solution and gas samplers. To monitor biogenic and lithogenic weathering product concentrations, soil solution samples were collected under vacuum after each rainfall event and analyzed to determine pH, electrical conductivity, major and trace elements concentrations, anions concentrations, and aqueous phase organic matter chemistry. Soil gases were monitored for CO_2 using porous Teflon gas samplers connected to the Vaisala probes. Plant biomass was collected at the end of the experiment to determine dry weight, as well as removal of N and lithogenic elements by the plants. Solid samples were collected to connect the measured weathered fluxes in solution with the mineralogical evolution. Obtained values for the solution composition, gas fluxes and solid phase changes will be used to determine dissolution rates, weathering incongruence and carbon sequestration using multicomponent reactive transport modeling.