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Impact of climate on CO2 removal by mineral weathering

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Weathering of silicate rock on the continents removes CO_2 from the atmosphere and is thought to act as an important feedback on Earth's climate system over geological timescales. This natural process can also be accelerated to help mitigate climate change in the processes of carbon mineralization and enhanced rock weathering. The rate of weathering and CO_2 removal depends strongly on both the composition of the rock and climate variables such as water content, rainfall, and temperature, however, the impact of climate versus mineralogy is not readily separated due to differences in rock compositions between catchments. In the present study, we investigate weathering rates under water-limited conditions and isolate the impact of climate variables on weathering rate and CO_2 removal efficiency during weathering of identical basalt in different climates using outdoor, flow-through column experiments, and indoor experiments with different water contents. Column experiments are being conducted in the field in locations with different climates using aliquots of the same basalt, and laboratory experiments are being conducted with well-controlled rainfall, water availability, and temperature. For comparison of basalt weathering behaviour between a cool, wet, and a hot, dry climate, meter-scale columns were installed in Bern, Switzerland and Athens, Greece. A weather station installed next to the columns tracks rainfall, temperature, and relative humidity, and in situ sensors record temperature and water content within the columns. The concentration of major and trace elements and the Mg and Si isotope composition were measured in column outflow collected at regular intervals. Laboratory experiments demonstrate that sufficient humidity is required for reactions to proceed, and outdoor experiments demonstrate an impact of temperature and rainfall on weathering rate. Together, these experiments will provide insight into the impact of climate variables on mafic and ultramafic weathering fluxes and CO_2 removal rates during natural and enhanced weathering.