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Environmental controls on rock-derived carbon dioxide emissions

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Weathering of carbon contained in sedimentary rocks is an important control on the concentrations of carbon dioxide (CO_2) and oxygen in the atmosphere. Of particular significance are steep mountainous catchments with high rates of physical erosion that constantly introduce rock-derived carbon to the surface, and where oxygen in air and water can help drive oxidative weathering reactions [1]. Although crucial for understanding the geological carbon and oxygen cycles, measurements of CO_2 emissions from oxidative weathering are still scarce.

Here, we present CO_2 fluxes from three catchments in the Draix-Bléone Critical Zone Observatory, France, with records spanning up to 2.5 years of seasonal investigations, which are also compared with findings from a short field-campaign in the Waiapu River catchment, New Zealand [2]. The fluxes were measured with in situ accumulation chambers drilled horizontally into the exposed rock face of rapidly eroding terrains, following a recently published design [3]. To assess how much CO_2 is sourced from oxidation of sedimentary organic matter and from carbonate dissolution by sulfuric acid, we use radiocarbon and stable carbon isotope analyses of trapped CO_2.

Overall, the total fluxes were similar in size to those reported for soil respiration and all sites exhibited a fast response to weather conditions. Rainfall events caused a transient decline in CO_2 fluxes. In contrast, increases in temperature resulted in an exponential growth of CO_2 emissions, comparable to microbially driven soil processes. Furthermore, we find that differences in the size of CO_2 fluxes from rock organic carbon and from carbonates relate to differences in the chemical composition of the studied sedimentary rocks. Together, we show that magnitude and source of CO_2 emissions from oxidative weathering in rapidly eroding landscapes are lithologically controlled, whereas their variability over time is controlled by changes in precipitation and temperature, with a positive feedback to warming.

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[2] Roylands *et al.* (2019) *Goldschmidt Abstracts*, 2896.

[3] Soulet *et al.* (2018) *Biogeosciences* 15, 4087-4102.