Investigating carbon dioxide emissions from oxidative weathering of sedimentary organic matter

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In the long-term carbon cycle, the weathering of organic carbon contained in sedimentary rocks (petrogenic OC, OC_{petro}) is an important control on the concentrations of carbon dioxide (CO_2) and oxygen in the atmosphere. Assessing the environmental controls of this weathering process is crucial for understanding the global carbon cycle and the evolution of Earth's climate. However, our understanding is currently limited because CO_2 emissions from OC_{petro} oxidation are poorly constrained by field measurements.

Here, we present evidence for significant OC_{petro} oxidation in a tributary of the Waiapu River, a mountain catchment on the North Island of New Zealand, that is characterised by high erosion rates in sedimentary rocks. To do this, we have used a recently published method whereby CO_2 accumulation chambers are installed by drilling into bedrock which is undergoing weathering [1]. We also aim to assess the feasibility of short-term rock chamber installations (over 2 to 7 days) with respect to potential contamination associated with the chamber set-up.

Across six chambers installed in April 2018, we combined real-time measurement of CO_2 flux (by infrared gas analyser) with trapping of CO_2 on zeolite molecular sieves [1]. We measured the radiocarbon activity and stable carbon isotopic composition of the trapped CO_2, alongside complementary measurements of the local atmosphere and of the sedimentary rocks from the chambers. This allows the correction for inputs of CO_2 from the atmosphere and, importantly, to distinguish carbon sources between OC_{petro} oxidation and the production of CO_2 from carbonate dissolution by sulfuric acid. In the Waiapu catchment, we measure total CO_2 fluxes that are similar in magnitude to those from the highly erosive Draix-Bleone Critical Zone Observatory (Laval catchment, France) [1]. However in contrast, the CO_2 emissions are mostly sourced from OC_{petro}, with minor inputs from carbonate. In both locations, high erosion rates may enhance CO_2 emissions, but differences in lithology control the ratio of organic and inorganic C sources.

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