The fate of rock organic carbon in the Critical Zone

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The rock organic carbon (OC_{petro}) reservoir is vast and contributes to the evolution of Earth's atmospheric O_2 and CO_2 concentrations over geological timescales[1]. There is an estimated 1100 Pg C stored as OC_{petro} in the upper 1 m of sedimentary rocks at the earth surface[2]. It has been shown that in rapidly eroding environments, chemical weathering of this OC_{petro} reservoir can rapidly release CO_2 to the atmosphere[3]. However, OC_{petro} oxidation rates are poorly constrained, especially in more moderate erosion settings, where pedogenic processes control OC_{petro} incorporation into the modern terrestrial environment. Here we assess the fate of OC_{petro} during weathering in soils, as a function of the rock OC content, its thermal history (metamorphic grade), mineral matrix composition and its potential links to microbial consumption.

To do this, we quantify the thermal reactivity and isotopic composition of organic matter using Ramped Pyrolysis Oxidation (RPO) coupled to radiocarbon measurements (RPO-^{14}C). Using soils that have developed on a range of sedimentary rocks (grey shales, black shales, schists), we examine the distribution of both ^{14}C and activation energies, E (kJ mol^{-1}). Systematic evolutions of these distributions reveal chemical alteration of the OC_{petro} along bedrock to surface soils profiles, allowing to explore the role of OC_{petro} chemical oxidation or incorporation into modern biomass. By visiting sites with well-developed soil profiles and low erosion rates, these new data will allow us to assess whether any unaltered OC_{petro} can persist in soils and illuminate how this material interacts with its surrounding environment.

[1] Berner, Lasaga & Garrels (1983), *Am. J. Sci.*, 641-683. [2] Copard, Amiotte-Suchet & Di-Giovanni (2007), *EPSL* **258**, 345-357. [3] Hemingway *et al.* (2018), *Science* **360**, 209-212.