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Subsurface fabric-controlled oxidation flux of petrogenic organic carbon in metamorphic terranes

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Mountain building uplifts and exposes unweathered subsurface rocks to near-surface environments, where rock-bound organic matter is oxidized and ultimately contributes to CO_2 emissions. While metamorphic rocks constitute a large portion of active orogens, the degradability of their associated highly graphitic carbon remains poorly constrained. Here, we directly quantified subsurface CO_2 fluxes from boreholes drilled into black schist at the hilltop and the base of a hillslope within a small mountainous catchment in eastern Taiwan. The results demonstrate that the subsurface fluxes are highly dependent on formation fabrics and topographic positions. As the subsurface fabrics are highly heterogeneous and anisotropic, we used a one-dimensional reaction-diffusion model to constrain CO_2 production and transport within rock formations. Using field measurements to constrain the model, we estimate that potential oxidative weathering proceeds at rates between 2 and 9 tC km^{-2} yr^{-1}. The high area-normalized emissions, combined with the ample volume of subsurface metamorphic rocks in active orogens, underscore the high reactivity of graphitic carbon for microbial exploitation in the subsurface and the significance of this deep carbon pool in the geological carbon cycle.