# A novel approach for determining the rate of organic carbon remineralization in bioturbated marine sediments at the global scale

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The spatial variability in benthic particulate organic carbon (POC) mineralization kinetics throughout the ocean is currently unknown. This creates considerable uncertainties when diagenetic models are used to couple benthic and pelagic biogeochemical cycles in global models. The aim of this study is to derive a predictive algorithm to calculate the depth-dependent rate of POC degradation in bioturbated surface marine sediments.

Our approach first uses measured fluxes of oxygen and nitrate across the sediment-water interface to calculate the total depth-integrated rate of POC degradation [1]. Next, a diagenetic reaction-transport model is used to simulate these fluxes to within a defined tolerance range by optimizing the parameters of a depth-dependent POC decay function. The model describes POC mineralization using oxygen, nitrite and nitrate as electron acceptors and also their transport into and out of the sediments by molecular diffusion, sediment burial and bioirrigation.

We applied this approach to published data from 151 stations around the globe to simulate the fluxes of oxygen and nitrate in the uppermost 50 cm of the sediment including the bioturbated layer. Where published data were available, the modelled and measured oxygen and nitrate concentration profiles were compared. Ongoing work attempts to search for spatial trends in the parameters of the optimized POC degradation model and relate these trends to master variables such as the rain rate of POC to the seafloor (RRPOC). Our over-arching goal is to use these results to better predict the benthic exchange fluxes between marine sediments and the overlying water column in global models. This is especially for the main ocean basins where field data is currently limited.

[1] Bohlen, L., Dale, A. W., & Wallmann, K. 2012 Simple transfer functions for calculating benthic fixed nitrogen losses and C:N:P regeneration ratios in global biogeochemical models. *Global Biogeochemical Cycles* 26, GB3029, doi:10.1029/2011GB004198.

# Soil organic matter and microbial activity in critical zones of tropical soils from Luquillo, Puerto Rico

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The Luquillo Critical Zone Observatory (LCZO) is located in northeastern Puerto Rico in the El Yunque National Forest (18.33 °N, 65.73 °W) and seeks to understand the evolution of landscapes over time due to varying critizal zone processes occuring in areas with similar climates, land use and geologic history. The critical zone is generally defined as the zone "where rock meets life" [1]. From this perspective, it is interesting to examine how microbial activity declines with depth into the critical zone as energy and substrate supplies decline and how this decline might be affected by various landscape properties.

The LCZO Soil Network consists of 216 quantitative soil pits, stratified across two parent materials (volcaniclastic and granodiorite), three forest types (Tabonuco, Palm and Colorado) and three hillslope positions (ridgetops, slopes, valleys). The current study used a subset of soils sampled to a depth of 140 cm and analyzed for organic C, total N and extractable organic P concentrations. Soil microbial biomass was determined using phospholipid fatty acid (PLFA) total lipid analysis [2] and enzyme activities were assayed according to German *et al*. [3].

All enzyme activities declined exponentially with depth, tracking exponential declines in total organic and microbial carbon. However, these trends differed when normalized by substrate or microbial C (i.e., specific activity). Soil parent material did not significantly affect microbial biomass or enzyme activity, though there were several significant depth × forest type interactions. Taken together, the results indicate that soil depth (as a surrogate for substrate availability) is the main driver of microbial activity in the critical zone of these tropical soils, rather than differences in landscape-scale variables.

[1] http://criticalzone.org/national/research/the-critical-zone-1national/. [2] White *et al.* (1979) *Oecologia*. **40**, 51-62. [3] German *et al.* (2011) *Soil Biol. Biochem.* **43**, 1387-1397.


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