New estimates of global rates of organic carbon mineralization and preservation in bioturbated marine sediments

K. STOLPOVSKY[1*], A. W. DALE[1], K. WALLMANN[1]

[1] GEOMAR Helmholtz Centre for Ocean Research Kiel, Wischhofstrasse 1–3, 24148 Kiel, Germany.
[*] kstolpovsky@geomar.de

The spatial variability in benthic particulate organic carbon (POC) mineralization kinetics, hence POC preservation efficiency, in marine sediments throughout the ocean is poorly defined. This creates considerable uncertainties when diagenetic models are used to estimate POC mineralization and preservation rates as well as the rates of corresponding redox transformations and solute exchange fluxes between sediments and seawater. In this communication, we present an empirical approach to predict POC mineralization in bioturbated marine sediments at the global scale.

We have derived a power law function that describes POC degradation with depth in the sediment. It requires only the rain rate of POC to the seafloor as the master variable. Using a diagenetic model, this function was found to be able to fit pairs of measured benthic O_2 and NO_3^- fluxes to within 50% at 132 out of 185 stations. It further provides realistic geochemical concentration-depth profiles, NO_3^- penetration depths and apparent first-order POC mineralization rate constants. The model performs less well on the continental margin shelf due to the high heterogeneity there. When applied to globally resolved maps of rain rate, the model predicts a global POC burial rate of 107 ± 52 Tg yr^{-1} of C with a mean carbon preservation efficiency of 6.1%. The model also predicts a global denitrification rate of 182 ± 88 Tg yr^{-1} of N. These are in excellent agreement with previous estimates.

The proposed function is conceptually simple and requires less parameterization than multi-G type models. It provides a basis for more accurately simulating benthic nutrient fluxes and POC preservation and mineralization in Earth system models.