Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.10607

Preservation and/or escape: The fate of dissolved organic carbon in global marine sediments?

DR. PEYMAN BABAKHANI, PHD[1], ANDREW W. DALE[2], CLARE WOULDS[1], OLIVER W. MOORE[1], KE-QING XIAO[1], LISA CURTI[1], MINGYU ZHAO[1] AND CAROLINE L. PEACOCK[1]

[1]University of Leeds
[2]GEOMAR Helmholtz Centre for Ocean Research Kiel
Presenting Author: p.babakhani@leeds.ac.uk

The unknown fate of DOC in marine sediments has fuelled the enigma about the origin of old DOC in global ocean bottom waters, which might have played a marked role in atmospheric carbon dioxide concentrations thereby regulating the Earth's climate. Several mechanisms contributing to organic carbon (OC) cycling and preservation in marine sediments are widely debated but to date, they are not considered in mechanistic models. We develop a new modelling platform that combines a novel mechanistically-resolved reactive-transport model with artificial intelligence and Monte Carlo techniques, that takes into account all common biogeochemical processes, such as burial, bio-turbation/-irrigation, etc., but we newly add processes that are proposed to be important for OC cycling, including hydrolysis, kinetic and equilibrium sorption and geopolymerisation on a global scale. We find that sorption and geopolymerisation play a relatively comparable role in dissolved OC cycling with formerly recognised biogeochemical processes like bio-turbation/-irrigation. We show that minerals act as a shuttle, taking up DOC in the active, bioturbated sediment layer and releasing it in deeper layers, while at the depth of 1 m globally, ~20% of total OC is associated with minerals. Our mechanistic model further demonstrates that geopolymerisation triggers further sorption of dissolved OC to minerals. Geopolymerised organic substances (GPS) contribute ~10% of total OC turn-over rate at a depth of 1 m, while also increasingly contributing to the production of unreactive dissolved OC with increasing sediment depth, revealing the crucial role of geopolymerisation in OC preservation. We also show that effluxes of geopolymerised OC and unreactive dissolved OC from global marine sediments together can account for ~10% of semi-refractory and fossil dissolved OC in ocean bottom waters.