Benthic Biogeochemical Dynamics of Organic Carbon Mineralization and Oxygen Fluxes in Hadal Trench Ecosystems

Hadal trenches are among the most extreme environments on Earth. They are characterized by high pressure and unique microbial communities. The metabolic activity of surface sediments can be most effectively and integrally quantified by measuring benthic oxygen consumption. This study explores the biogeochemical processes associated with organic carbon mineralization and oxygen fluxes in different contrasting hadal trenches. We conducted extensive studies in various trench sediments, using in situ oxygen profilers and sediment cores to investigate rates of organic carbon decomposition, as well as the oxygen penetration and consumption at the seafloor. Our results indicate that hadal sediments exhibit a complex interplay between microbial activity and the organic matter quality and distribution. Organic carbon mineralization rates were found to vary substantially both between and within trenches. However, current investigations are based on a small number of in situ measurements, which typically target areas along the trench axis. Our data demonstrate extremely high regional variability between different hadal trench basins and habitats. This suggests the accumulation of reactive substrates is highly localized. This indicates a highly localized accumulation of reactive substrates. We discuss the plausibility and implications of these findings, emphasizing the importance of hadal trenches in the marine carbon cycle and the necessity of representative in situ measurements.

Keywords: Hadal trenches, organic carbon mineralization, benthic oxygen fluxes, biogeochemistry, microbial processes, deep-sea ecosystems.