Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.16534

Pelagic and sedimentary microbes conspire to alter nutrient availability and stoichiometry in the low-oxygen Benguela upwelling system

PETER KRAAL[1], KRISTIN ANNA UNGERHOFER[2], GERT-JAN REICHART[2], ZOË R. VAN KEMENADE[3] AND DARCI RUSH[3]

[1]NIOZ-Royal Netherlands Institute for Sea Research
[2]Royal Netherlands Institute for Sea Research (NIOZ)
[3]NIOZ Royal Netherlands Institute for Sea Research

Presenting Author: peter.kraal@nioz.nl

Ocean deoxygenation is accelerating, for a large part due to anthropogenic eutrophication and global warming. This leads to severe oxygen depletion in eutrophic coastal systems and global loss of oxygen from the ocean. Humans are initiating another period of widespread ocean deoxygenation, which in Earth's geological past occurred under greenhouse conditions and is associated with major perturbation of marine nutrient cycles. To understand the response of marine systems to oxygen loss, we turn to modern systems that are experiencing various degrees of oxygen depletion such as the Benguela upwelling system (BUS) in the Southeast Atlantic. The BUS experiences upwelling of nutrient-rich deep waters that fuels primary productivity and thereby boosts microbial oxygen demand beyond its supply. Here, we aim to elucidate coupled pelagic and benthic diagenetic processes that regulate (re)cycling of the key nutrients nitrogen (N) and phosphorus (P) as a function of (changing) environmental conditions.

During a research expedition in 2019, we collected water-column and sediment samples across different depositional environments, from the periodically anoxic shelf (100 m water depth) to the oxygenated slope (1500 m water depth). Analysis of dissolved nutrients, N-cycling biomarkers and sediment geochemistry reveals how microbial processes fuel pelagic N loss and benthic P supply on the anoxic shelf, resulting in BUS waters with extremely low N:P ratios. The finding that benthic P release contributes to the apparent N deficit in BUS waters forces reinterpretation of this parameter as an indicator of the intensity of anaerobic N loss. Furthermore, the variability in N and P cycling on the shelf highlights how local conditions control nutrient dynamics, requiring caution when extrapolating local results to arrive at global nutrient budgets.

Overall, our dataset across a redox transect in the BUS illustrates how pelagic and benthic microbes together profoundly alter marine nutrient availability and stoichiometry and ecological niches under excess nutrient input and low oxygen. This sheds further light on global feedbacks between ocean deoxygenation and biogeochemical cycles in the past, present and future.