The Barents Sea Benthic Silica Cycle and its Sensitivity to Change: a Stable Isotopic and Reaction-Transport Model Study

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Biogeochemical cycling of silicon (Si) in the high latitudes has an important influence on the marine Si budget. The Barents Sea is divided approximately equally into Arctic and Atlantic water (ArW and AW respectively) domains. However, increases in the temperature and inflow of AW across the Barents Sea opening is driving an expansion of the AW realm. While the sensitivity of pelagic processes pertaining to primary production is receiving increasingly more attention, less is known of the effect on the benthic Si cycle. This knowledge gap could prove integral, as the flux of Si across the sediment-water interface (SWI) from Arctic shelf sediments could be up to 20% higher than that of riverine sources. This benthic flux is largely controlled by early diagenetic processes in sediment pore waters, including biogenic silica (bSi) dissolution and authigenic precipitation.

To improve our understanding of benthic Si dynamics in the Barents Sea and examine its sensitivity to future change, we analysed pore water and sediment samples from both the AW and ArW realms between 2017-2019 for dissolved silica (dSi) concentrations and stable silicon isotopic compositions. Moreover, to determine the composition and content of bSi, as well as Si sorbed onto metal oxides, we conducted a sequential digestion of surface sediment. Following this we coupled our analyses with reaction transport modelling to further improve our mechanistic understanding of the system and to quantitatively disentangle the relative importance of these diagenetic processes to pore water Si chemistry and benthic fluxes.

Our work suggests that both interannual and spatial variability of dSi are increased in the southern, AW region of the Barents Sea. Benthic flux estimates for the southern sites have been found to be more than double (~30 to 100 mmol m⁻² yr⁻¹) between cruise years, compared to a more consistent flux in the north (~80 mmol m⁻² yr⁻¹). Therefore, future Atlantification of the northern region may enhance the variability of dSi supply from the benthos to bottom waters, with potential consequences for diatom productivity in the region.