Quantifying seafloor dynamics of organic matter in the Barents Sea shelf sediments

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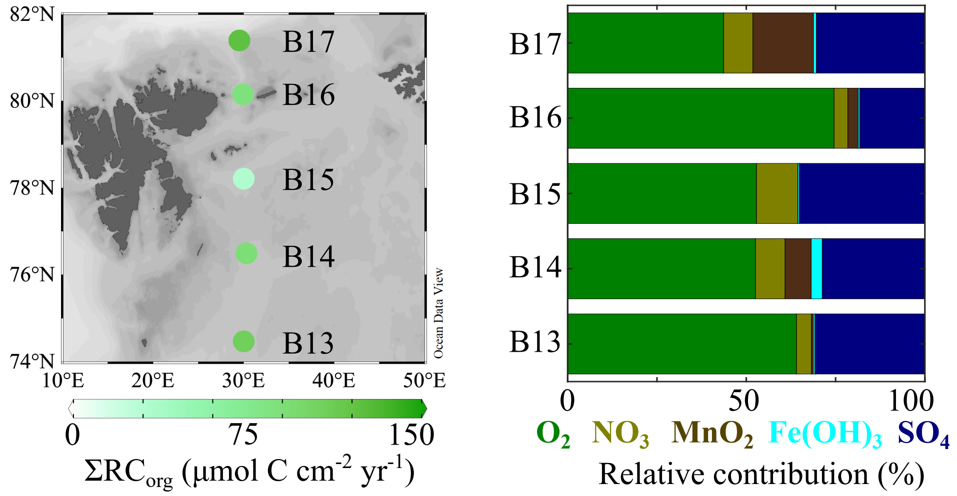
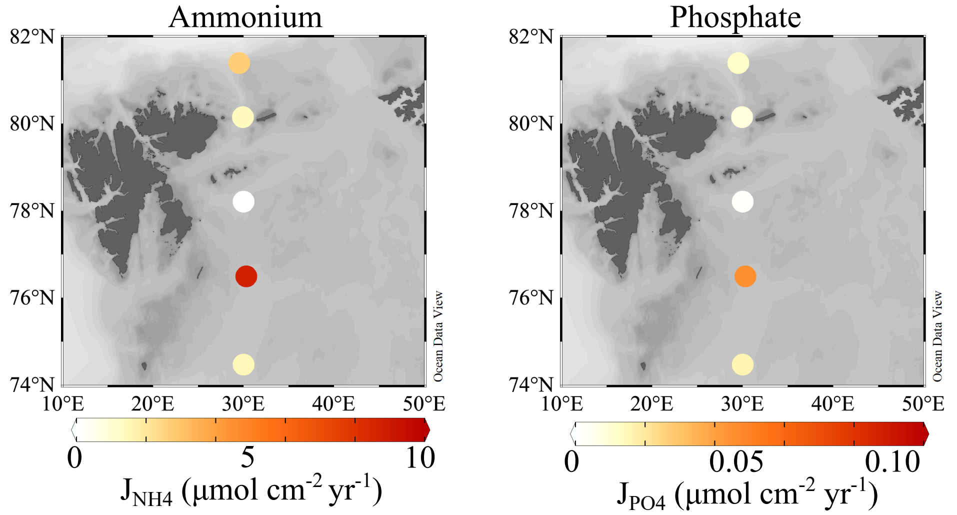
Organic matter transformation

Rates of heterotrophic degradation



Depth-integrated (0–100 cm) rates of **OM degradation** are driven by **reactivity** patterns along the shelf. The highest rates (high reactivity) are found in **Atlantic Water** and have no clear links with **sea-ice** cover. **Aerobic degradation** represents > 50% of total rates. **Sub-oxic pathways** have small and variable relative contributions. **Sulfate reduction** contributes to around one-third of overall rates.

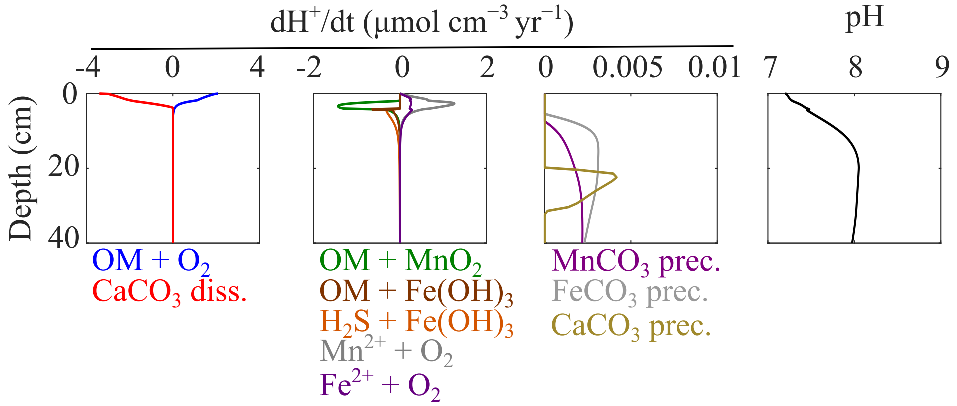
Benthic nutrient fluxes



Seafloor efflux of **ammonium** and **phosphate** closely follow OM reactivity patterns. The lowest fluxes are found in B15 where **low degradation rates of unreactive OM** are found in association with deeper **oxygen penetration** (≥ 3 cm). B14 displays the largest fluxes, where shallow **oxygen depletion** (< 0.5 cm) prevents ammonium oxidation and phosphate adsorption to iron mineral phases.

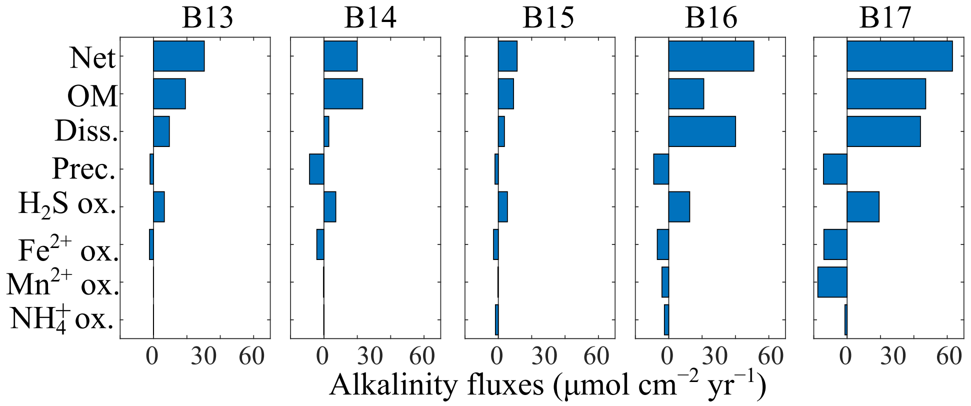
Seafloor carbonate chemistry and pH

Biogeochemical controls on pH dynamics

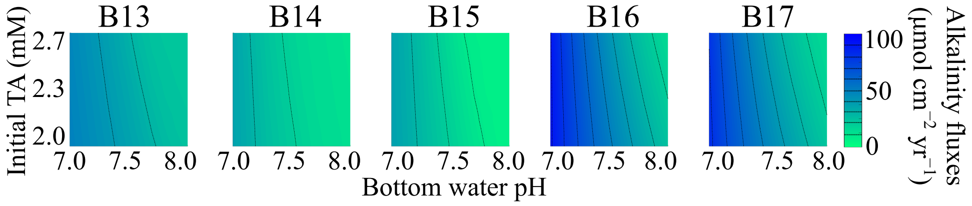


Aerobic processes in upper sediments (< 2 cm) **produce H$^+$** and a negative shift in pH. A reversal in pH occurs via **dissolution of CaCO$_3$** and **metal oxide pathways** through H$^+$ consumption. Thus, pH increases to ≈ 8.0 with depth. **Carbonate saturation state** also increases, enabling authigenic precipitation.

Benthic alkalinity fluxes



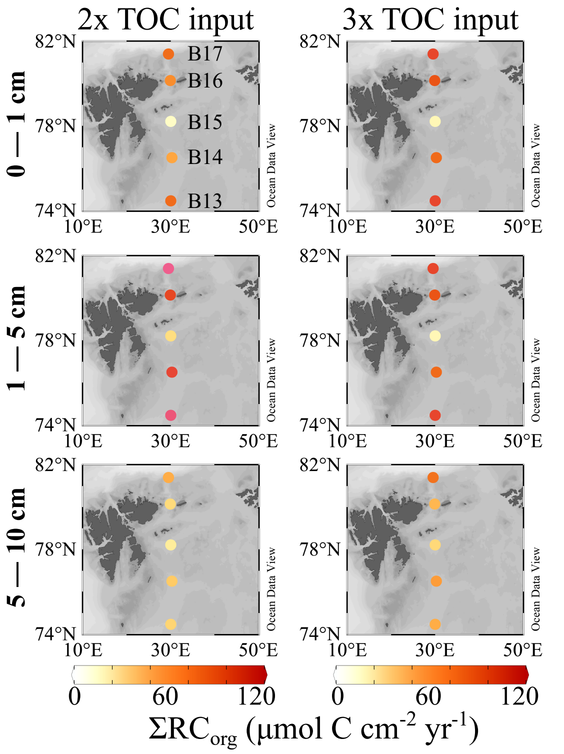
There is a **south-north** trend in alkalinity efflux. The greater fluxes in B16-B17 are fuelled by **OM degradation and CaCO$_3$ dissolution**. Fluxes in B13-B15 are lower due to lower **calcite contents**, which limits dissolution rates. **Authigenic precipitation and oxidation processes** are the main alkalinity sinks.



Bottom water **acidification** has a large role on shallow **dissolution of calcite**, which enhances seaflor alkalinity release.

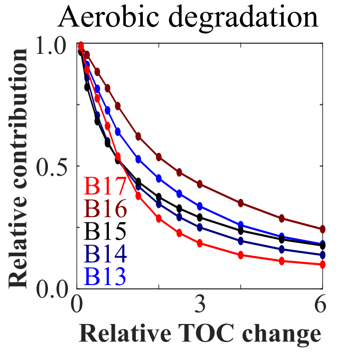
Changes in organic matter input fluxes

Degradation dynamics



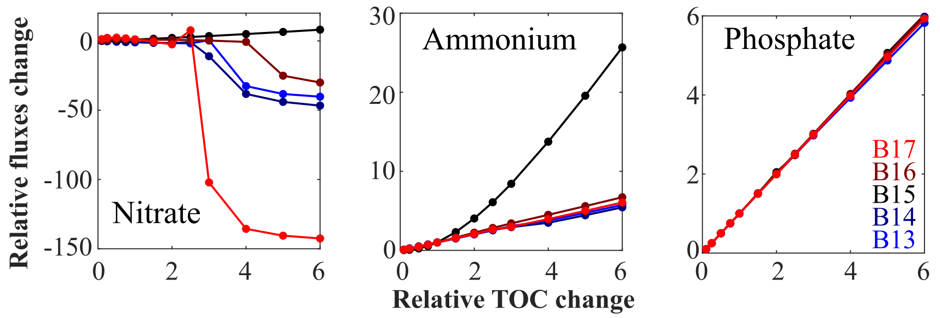
OM degradation **rates scale** with additional **OM** inputs to the seafloor (holding all other parameters unchanged).

Rates are highest at **0–5 cm**, where most **reactive OM** is found, and sediments are mixed and oxic–sub-oxic.



Enhanced OM fluxes to the seafloor lead to **faster oxygen consumption** and a shift from **oxic to anoxic** degradation pathways.

Nutrient dynamics



Ammonium and phosphate fluxes closely follow OM input. **Nitrate** shows a more dynamic behaviour. It changes from **release** to the bottom waters in low OM input to **uptake** in high OM degradation.

Impacts of bottom trawling

Fisheries expansion in Arctic shelves brings large uncertainties to **OM storage**. Disturbance of upper sediments (≈ 10 cm) may remove high reactivity OM and re-expose buried, unreactive OM, thus potentially diminishing OM burial. Nutrient fluxes are also vulnerable to **trawling**.

Freitas et al. (2020). Benthic-pelagic coupling in the Barents Sea: an integrated data-model framework. https://doi.org/10.1098/rsta.2019.0359

Freitas et al. (2021). Benthic organic matter transformation drives pH and carbonate chemistry in Arctic marine sediments. https://doi.org/10.1002/essoar.10507976.1

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