Introduction

The Arctic is experiencing rapid warming, at about two to four times the global average, mainly due to feedback mechanisms like sea ice and snow albedo loss, intensified poleward heat and moisture transport, along with shifts in cloud cover and atmospheric water vapor (Meredith et al., 2019; Bruhwiler et al., 2021). This accelerated warming has led to glacier retreat, shrinking and thinning of sea ice, permafrost thawing, and changes in oceanic and atmospheric circulation patterns (IPCC, 2019; Hugonnet et al., 2021; Dunse et al., 2022; Miner et al., 2022; Rantanen et al., 2022; Thoman et al., 2023). Arctic fjords are semi-enclosed coastal systems that receive freshwater, sediment, and organic and inorganic matter from land. These terrestrial inputs mix with marine waters and are transformed within the fjord (Svendsen et al., 2002; Bianchi et al., 2020; Hopwood et al., 2020). Meltwater from surface runoff or frontal ice loss, along with its solutes, influences the hydrography and biogeochemistry of fjord waters, affecting productivity both within the fjords and on the nearby shelf (Hopwood et al., 2016, 2020).

The fjords of western Spitsbergen are characterized by pronounced vertical hydrographic gradients and seasonal stratification. They serve as conduits for the transfer of heat, salt, nutrients, and dissolved carbon between glacier influenced waters and the coastal ocean (Hopwood et al., 2020). The hydrography of these fjords is primarily governed by two contrasting currents: the East Spitsbergen Current, which transports cold Arctic Water, and the West Spitsbergen Current, which carries warmer, more saline Atlantic Water, along with much of the region's heat, carbon, and plankton resources (Cottier et al., 2005; Menze et al., 2020). These source waters also differ in their nutrient and carbon composition; Atlantic Water becomes increasingly depleted in nutrients as it progresses northward (Smoła et al., 2017). Moreover, the relative proportions of Atlantic and Arctic waters influence nutrient supply and cycling on the shelf and within the fjords (Henley et al., 2020; Santos-Garcia et al., 2022; Tuerena et al., 2022). The extent to which Atlantic Water penetrates individual fjords depends on factors such as fjord morphology, sill depth, and circulation patterns, resulting in a gradient of Atlantification along the western coast of Spitsbergen (Oglethorpe et al., 2026). As a consequence, fjords range from Arctic-dominated systems, such as Hornsund, to those strongly influenced by Atlantic waters, such as Kongsfjorden (Cottier et al., 2005, 2007; Nilsen et al., 2008; Promińska et al., 2018; Tverberg et al., 2019). In this context, accelerating glacier retreat, permafrost thaw, and hydrological changes are modifying the delivery of nutrients and carbon to fjord waters and sediments. These alterations impact primary production, organic matter burial, and benthic recycling, processes vital to local ecosystem functionality and the broader

Arctic carbon cycle (Rysgaard et al., 1998; Smith et al., 2015; Tverberg et al., 2019; McGovern et al., 2020).

The interaction among terrestrial inputs, ocean circulation, and sedimentary processes makes Arctic fjords highly dynamic biogeochemical systems. Nutrient availability governs primary production, whereas the production, transformation, and burial of organic matter regulate carbon storage and recycling within the fjord ecosystem. Sediments are essential in these processes, functioning as repositories of organic matter and sites of intense microbial activity where mineralization, nutrient regeneration, and benthic exchange facilitate the return of carbon and nutrients to the overlying water column (Rysgaard et al., 1998; Glud et al., 2000; Koziorowska et al., 2018; Jørgensen et al., 2021; Szymczycha et al., 2025). Pore waters preserve the integrated imprint of sedimentary biogeochemical processes and offer important information on early diagenesis and the coupling between benthic and pelagic systems.

Freshwater reaches the fjords through several pathways, including glacial meltwater, river discharge, and submarine groundwater discharge (SGD), each delivering chemically distinct water and organic matter to the coastal zone and contributing to pronounced spatial heterogeneity in nutrient and carbon concentrations (McGovern et al., 2020; Santos et al., 2021; Kim et al., 2022; Diak et al., 2023; Szymczycha et al., 2025). The influence of these pathways is increasing as permafrost thaw and glacial retreat modify subsurface hydrology and open new routes for nutrient and carbon transport (Diak et al., 2023; Kleber et al., 2023). Where freshwater inputs coincide with restricted circulation and limited deep water renewal, nutrients and carbon may accumulate in bottom waters and pore waters; conversely, nearby, better-ventilated sites tend to remain comparatively depleted, resulting in enriched "hotspots" that may occur immediately adjacent to less enriched areas within the same fjord (Skogseth et al., 2005; Inall and Gillibrand, 2010). The origin of the carbon accumulating in pore waters can be identified isotopically, since inorganic carbon in pore waters may derive from organic matter remineralization, carbonate dissolution, or methane oxidation, each carrying a distinct stable carbon-isotope signature. Furthermore, because pore waters and near bottom waters are interconnected via benthic–pelagic exchange, their chemistry may covary spatially despite significant differences in absolute concentrations. In instances where such covariation exists, sedimentary biogeochemical conditions could be inferred, at least partially, from water column sampling alone (Kostka et al., 1999; Huettel et al., 2014).

Despite increasing understanding of Arctic fjord biogeochemistry, large scale studies that integrate observations across multiple fjords or sites are still rare, as most research has focused on individual systems (Codispoti et al., 2013; Kim et al., 2022). Firstly, water column nutrient and carbon distributions, along with their relation to

water mass structure, have seldom been characterized across several fjords using a consistent methodology (Promińska et al., 2017; McGovern et al., 2020). Secondly, although sediment–water nutrient exchange has been studied in a number of the Arctic fjords (Hulth et al., 1996; Rysgaard et al., 1998; Kostka et al., 1999; Glud et al., 2000; Koziorowska et al., 2018; Morata et al., 2020; Barrett et al., 2023), comparative analyses of how benthic fluxes vary among fjords with different glacial regimes and organic matter supply are limited. Thirdly, it remains unclear whether the chemical signatures in surface waters, deep waters, and sediment pore waters are driven by shared environmental factors or are affected by layer-specific processes (Huettel et al., 2014). Fourthly, pore water freshening caused by SGD has been observed in several Svalbard fjords (Hong et al., 2019; Kim et al., 2022; Diak et al., 2023; Kleber et al., 2023; Szymczycha et al., 2025) and in deeper Arctic margin settings (Saghravani, 2026), yet its spatial distribution and biogeochemical significance are not well understood. This thesis aims to fill these gaps in the fjord systems of western Spitsbergen, Hornsund, Isfjorden, Kongsfjorden, and Krossfjorden, which span an Arctic-to-Atlantic influence gradient, presenting varying degrees of Atlantification and climate induced changes. Although these fjords lie along a common shelf gradient, they are treated separately in the research articles presented here, where their specific characteristics and local processes are examined.

Purpose of Research

The main purpose of this dissertation is to delineate the distribution and cycling of carbon and nutrients within the western Spitsbergen fjords, encompassing surface waters, the water column, and sediment pore waters. It aims to identify the physical and biogeochemical processes that govern their distribution, exchange, and stoichiometry in the context of ongoing Atlantification and cryospheric change. Key processes include water mass mixing and transformation, density stratification, organic matter remineralization and early diagenesis, diffusive benthic exchange, and pore water freshening. This investigation is guided by the hypothesis that nutrient and carbon distributions are influenced by water mass identity, basin morphology, and local environmental inputs, such as freshwater from SGD, rather than by geographic gradients like the proximity to glacier fronts. As a result, biogeochemical variability is anticipated to be organized at the level of individual basins and biogeochemical "hotspots" (areas of intense biogeochemical processing), rather than exhibiting uniform patterns across entire fjords. The research is structured around three main objectives.

Objective 1: Characterize the spatial variability of carbon and nutrient distributions in the water column of western Spitsbergen fjords

Hypothesis: The spatial distribution of nutrients and dissolved carbon in the western Spitsbergen fjords is mainly regulated by the mixing and transformation processes of Atlantic and Arctic water masses.

Research Questions:

- What are the concentration ranges of the key nutrients (nitrate: NO_3^-; ammonium: NH_4^+; phosphate: PO_4^{3-}; dissolved silica: DSi) and dissolved carbon species (dissolved inorganic carbon: DIC; dissolved organic carbon: DOC) present in the water column and sediment pore waters of the fjords?
- How do these constituents (NO_3^-, NH_4^+, PO_4^{3-}, DSi, DIC, DOC) vary among different fjords and among various water masses within individual fjords?
- Do the water masses identified from temperature-salinity properties carry statistically distinct nutrient and carbon signatures, both within and between fjords?
- Which water masses show the most distinctive nutrient and carbon composition, and how do locally formed and modified waters compare with those of Atlantic and Arctic origin?

Approach: Conduct a hydrographic and biogeochemical survey of the fjords during the summer melting season of 2021. Classify water masses based on established temperature–salinity criteria for Svalbard fjords, and analyze spatial variability among fjords and water masses employing nonparametric statistical methods (Kruskal-Wallis test). Interpret the observed biogeochemical patterns in relation to hydrographic structure and environmental gradients.

Objective 2: Quantify the exchange between sediment and water, as well as benthic nutrient recycling, and evaluate the impact of SGD

Hypothesis: Sediment pore water chemistry is interconnected with overlying bottom waters, and diffusive benthic fluxes represent a substantial source of regenerated nutrients to the water column. Nonetheless, benthic recycling deviates from the canonical Redfield-Brzeziński stoichiometry due to differential remineralization and retention of nitrogen, phosphorus, and silica. Furthermore, pore water freshening influences nutrient and carbon gradients, thereby modifying both the magnitude and stoichiometry of benthic exchange.

Research Questions:

- What are the magnitudes and directions of diffusive benthic fluxes for DIC, DOC, NO_3^-, NH_4^+, PO_4^{3-}, and DSi across the sediment-water interface?
- Do the flux stoichiometries follow the Redfield-Brzeziński ratio of nitrogen to phosphorus to silicon (N:P:Si = 16:1:15, where Si denotes DSi), or are there systematic deviations?
- How do benthic fluxes and ratios of DIC, DOC, NO_3^-, NH_4^+, PO_4^{3-}, and DSi vary among fjords with different oceanographic and glacial conditions?
- What are the dominant sources of pore water DIC, as inferred from the relationship between DIC concentration and stable carbon isotope composition of DIC ($\delta^{13}C_{DIC}$)?
- Where does SGD occur?

Approach: Sampling was conducted in 2022 aboard r/v Oceania during a research cruise to Svalbard, yielding 12 sediment cores up to about 1.5 m in length. Estimate diffusive fluxes from pore water concentration gradients utilizing Fick's first law (Berner, 1980), with diffusion coefficients corrected for temperature and converted to sediment conditions using measured porosity and tortuosity. Delineate sediment geochemical zones using hierarchical cluster analysis (HCA) and separate them using linear discriminant analysis (LDA). Trace pore water freshening and SGD by employing Chloride (Cl^-) as a conservative tracer. Attribute pore water DIC sources based on the relationship between DIC and $\delta^{13}C_{DIC}$. Finally, compare flux ratios to the Redfield–Brzeziński values (Redfield, 1963; Brzeziński, 1985).

Objective 3: Resolve vertical biogeochemical connectivity between the water column and sediment pore waters, and identify sites of pronounced subsurface enrichment

Hypothesis: The chemical composition of the water column and sediment pore waters is interconnected through hydrodynamic mixing, sedimentation, and early diagenetic processes. Although the absolute concentration disparities between the water column and pore waters can reach several orders of magnitude, it is anticipated that benthic-pelagic coupling will induce significant spatial covariation between the deep water and pore water layers. Nonetheless, summer stratification diminishes the coupling between surface and deeper waters, resulting in distinct biogeochemical signatures for each layer and fostering the emergence of local biogeochemical hotspots, areas where restricted circulation coincides with an increased supply of organic matter. If such covariation is present, the biogeochemical conditions of pore waters, including the locations of hotspots, should be at least partially inferable from water column sampling alone.

Research Questions:

- How do nutrient and carbon concentrations covary across the five vertical layers (surface water, bottom water, water above sediment, and upper and lower sediment pore water)?
- How are sedimentary biogeochemical signals connected to the overlying water column, and which layers show the strongest coupling?
- Which sites contribute disproportionately to subsurface variability, and what basin and environmental characteristics do they share?

Approach: Integrate the water column and sediment datasets from the 2021 and 2022 campaigns. Apply multiple factor analysis (MFA) on the six chemical variables measured across each of the five layers at the 19 stations where all layers were sampled, with hydrographic and site variables incorporated as supplementary information. Identify hotspot stations based on their contributions to the primary ordination axis, and evaluate whether bottom water chemistry reflects pore water conditions.

Study area

The fjords extend across the Arctic-to-Atlantic gradient of western Spitsbergen, along which the West Spitsbergen Current penetrates individual fjord systems to varying extents, contingent upon fjord morphology and sill depth (Cottier et al., 2005; Nilsen et al., 2008). Hornsund, situated in the south, is affected by cold Arctic and coastal waters (Włodarska-Kowalczuk et al., 1998; Promińska et al., 2018) and is separated by a shallow sill into a main basin and the inner Brepollen basin (Moskalik et al., 2014; Błaszczyk et al., 2019). Isfjorden, the largest Svalbard fjord system, consists of several secondary fjords with contrasting hydrographic characteristics, ranging from Atlantic-influenced outer regions to cold, silled inner basins such as Billefjorden (Szczuciński et al., 2009; Skogseth et al., 2020). The connected Kongsfjorden-Krossfjorden system in the north exhibits relatively open shelf connections that facilitate frequent intrusion of Atlantic Water (Hop et al., 2002; Svendsen et al., 2002; Tverberg et al., 2019). All fjords receive freshwater and sediment contributions from glaciers terminating in marine and land environments (Smith et al., 2015; Halbach et al., 2019; Hopwood et al., 2020), and rest upon diverse catchment geologies, ranging from the Precambrian crystalline basement of Hornsund (Görlich, 1986; Dallmann, 2015) to carbonate and sandstone sequences surrounding Kongsfjorden (Svendsen et al., 2002). These geological differences influence pore water chemistry through processes such as carbonate dissolution and silicate weathering (Wallmann et al., 2008; März et al., 2015). The fjords provide a natural environment for investigating biogeochemical responses to

varying degrees of Atlantification and glacial influence (Svendsen et al., 2002; Promińska et al., 2018).

Methods

Overview of the methodologies employed in the manuscripts presented herein, with comprehensive analytical and statistical details provided in the respective manuscripts.

Fieldwork was conducted aboard r/v Oceania during the 2021 and 2022 summer melting seasons, and the three studies draw on partially overlapping sets of stations and cores rather than a single combined dataset. Paper 1 is based on a 2021 multi-fjord water column survey, with three to five depths per station at 33 stations, measured with a conductivity, temperature, depth (CTD) rosette, together with Niemistö and/or GEMAX cores up to about 40 cm. Paper 2 is based on twelve deeper sediment cores, up to about 1.5 m long, recovered with gravity and GEMAX corers in 2022. Paper 3 combines water column and sediment data from both campaigns (2021–2022) at the 19 stations where all five vertical layers were available, using cores of variable length. Pore waters were extracted with Rhizon samplers, and station water depths across the three studies ranged from about 17 to 374 m. The measured variables include in situ temperature, salinity, and dissolved oxygen, together with the dissolved inorganic nutrients (NO_3^-, NH_4^+, PO_4^{3-}, DSi), dissolved inorganic and organic carbon (DIC, DOC), Cl^-, the major cations (Na^+, K^+, Ca^{2+}, Mg^{2+}), and, in sediment pore waters, the stable carbon-isotope composition of DIC ($\delta^{13}C_{DIC}$). All constituents were determined by standard analytical methods with quality control against certified reference materials.

Water masses were classified by their temperature-salinity properties using established Svalbard definitions (Cottier et al., 2005; Nilsen et al., 2008; Promińska et al., 2018), the standard approach for separating Atlantic, Arctic, and locally formed waters in these fjords. Diffusive benthic fluxes across the sediment–water interface were calculated from pore water concentration gradients using Fick's first law (Berner, 1980). This approach is appropriate for fine-grained, diffusion dominated fjord muds and yields fluxes directly from measured pore water profiles. Pore water freshening and SGD were traced with Cl^-, which behaves conservatively in marine sediments, and pore water DIC sources were characterized using $\delta^{13}C_{DIC}$, since remineralized organic matter, dissolving carbonates, and methane-derived carbon carry distinct isotopic signatures. Spatial patterns were analyzed using the non-parametric Kruskal-Wallis test with Dunn's post hoc comparisons (chosen because the concentration data are non-normally distributed and group sizes are unequal), HCA (Ward's method, which delineates geochemical zones without prescribing groups in advance), LDA (used to test the separability of the resulting clusters), and MFA (which weights each sampled

layer equally, so that covariation among layers can be assessed without any single layer dominating the ordination).

Synopsis of Research Works

The dissertation is organized into three interconnected studies, progressing from the characterization of spatial biogeochemical patterns, through the identification of fundamental sedimentary processes, to an integrated analysis of water column-sediment interactions in the fjords of western Spitsbergen. Together, these studies are a systematic evaluation of carbon and nutrient distribution and cycling throughout the vertical continuum of Arctic fjord ecosystems.

The first article, "*Distributions of in-situ parameters, dissolved (in)organic carbon, and nutrients in the water column and pore waters of Arctic fjords (western Spitsbergen) during a melting season*" (Saghravani et al., 2024), laid the observational groundwork for the thesis and addressed Objective 1. During the 2021 melting season, it characterized variables such as temperature, salinity, oxygen, inorganic nutrients, and dissolved carbon in the water columns and shallow pore waters of Hornsund, Isfjorden, Kongsfjorden, and Krossfjorden. Seven distinct water masses were identified based on their temperature-salinity profiles, including surface, Arctic, winter-cooled, intermediate, local, transformed Atlantic, and Atlantic Water. The Kruskal-Wallis test indicated that most constituents differed significantly among fjords and between water masses. Hornsund, which was devoid of Atlantic or transformed Atlantic Water, emerged as the most nutrient- and DIC-enriched system, influenced primarily by Arctic and coastal waters (Włodarska-Kowalczuk et al., 1998), whereas Kongsfjorden exhibited the most pronounced Atlantic signature. The Local Water, exclusive to Isfjorden, displayed the highest concentrations of NO_3^-, PO_4^{3-}, DSi, and DIC among all water masses. Surface pore waters were enriched in NH_4^+, PO_4^{3-}, DSi, and DIC relative to the overlying bottom waters, at times exceeding an order of magnitude, indicating a substantial potential for benthic–pelagic exchange. By employing a uniform methodology across fjords and depositing the complete dataset into an open repository, the publication established a spatial and compositional baseline for subsequent process-based studies.

Building on these patterns, the second article, "*Nutrients and carbon cycling in marine sediments of Arctic fjords*" (Saghravani et al., under review), shifted from descriptive to mechanistic analysis, addressing Objective 2. In 2022, twelve sediment cores up to about 1.5 m long were collected and analyzed for pore water nutrients, dissolved carbon, Cl^-, and the stable carbon isotope composition of DIC. HCA identified five geochemical zones (HC1 to HC5) that mapped onto sediment depth: an oxygenated, nitrate-rich shallow zone interacting with bottom water; mid-depth zones enriched in

DSi, NH_4^+, DOC, and PO_4^{3-} where labile organic matter undergoes remineralization; and deeper zones with the highest DIC, DOC, PO_4^{3-}, and DSi, where low-permeability mud and mineral dissolution promote solute accumulation. The $\delta^{13}C_{DIC}$ values, ranging from approximately +1 to -14‰, along with the negative relationship between DIC and $\delta^{13}C_{DIC}$, indicate that carbonate dissolution and organic matter remineralization, rather than methane oxidation, dominate the carbon dynamics. Cl^- concentrations decrease with depth at two Hornsund sites, indicating pore water freshening consistent with SGD (Kim et al., 2022). Comparison between affected and unaffected deep clusters suggests that this freshwater source introduces inorganic nitrogen and dilutes DIC, phosphate, and silica. Diffusive benthic fluxes, calculated via Fick's first law, deviated from Redfield–Brzeziński stoichiometry: the nitrogen to phosphorus (N:P) flux ratios averaged 0.2 in Hornsund, 6.2 in Isfjorden, and 10.1 in Kongsfjorden, all below the expected 16:1. In Krossfjorden, negative fluxes into sediments indicated net uptake or accumulation, leading to their exclusion from ratio analysis. The N:DSi flux ratios were 2.9 in Hornsund, 6.5 in Isfjorden, and 43.4 in Kongsfjorden, all exceeding the expected ~1.1 (16:15), with the largest nitrogen excess over silica observed in Kongsfjorden. Hornsund exhibited noticeable phosphorus and silica release relative to nitrogen, but a low nitrogen flux, which does not necessarily indicate nitrogen limitation in the overlying waters. Conversely, Kongsfjorden showed the greatest nitrogen excess relative to silica. Overall, deviations from Redfield–Brzeziński stoichiometry varied across the fjords, reflecting regional heterogeneity (Koziorowska et al., 2018; Morata et al., 2020).

The third article, "*Covariation of dissolved nutrients and carbon in seawaters and sediment porewaters of western Svalbard fjords*" (Saghravani et al., 2026), combined water column and sediment data to address Objective 3. It investigates how sedimentary signals are connected to the overlying water column, and which sites contribute disproportionately to subsurface variability. MFA of six chemical variables across five layers, surface water, bottom water, water above sediment, and upper and lower pore water at nineteen stations showed that deep water and pore water form a single system: bottom water, water above sediment, and pore water strongly loaded on the first ordination axis (0.65–0.72), while surface water was decoupled, reflecting summer stratification. The close association between bottom water and pore water chemistry suggests that bottom water composition reflects underlying sediment signals, providing a practical way to detect benthic activity through water column sampling, thereby directly addressing Objective 3. Notably, three sites in silled Billefjorden and the deep main basin of Hornsund contributed disproportionately to this axis, accounting for roughly 73% of its variance, and appeared as enriched end-members compared to the lower concentration baseline from other sites. These hotspots shared restricted deep water renewal and organic matter input; where these

conditions did not overlap, as in inner Brepollen, hotspots were less developed, indicating that basin restriction alone is insufficient. Variability among basins within a fjord often surpassed differences between fjords, leading to the conclusion that western Spitsbergen fjords behave as a mosaic of distinct biogeochemical environments. A small number of locally controlled hotspots, rather than systematic fjord-scale gradients, primarily influence subsurface nutrient and carbon cycling (Cottier et al., 2005; Skogseth et al., 2020).

The three studies found that Arctic fjords operate as mosaics in which physical separation and organic matter supply, acting synergistically, concentrate carbon and nutrient cycling at specific sites. This spatial configuration is often overlooked in geographic or fjord-averaged descriptions and is anticipated to change as winter water formation, Atlantic water intrusion, and freshwater input continue to alter the environment (Tverberg et al., 2019; Diak et al., 2023).

Achievements

- Established a comprehensive observational dataset encompassing nutrients, dissolved inorganic and organic carbon, and hydrographic parameters in western Spitsbergen fjords. This dataset extends through the water column and sediment pore waters, and has been made publicly accessible for subsequent Arctic research [Research Articles 1, 2, 3].
- Demonstrated strong biogeochemical differentiation among water masses and fjord systems. Statistical analyses showed that nutrient and carbon concentrations differed significantly among fjords and water masses, revealing distinct biogeochemical signatures associated with Arctic- and Atlantic-influenced waters. Arctic Water was relatively enriched in nutrients (except NH_4^+) and DIC in Hornsund compared with Isfjorden, whereas Local Water in Isfjorden exhibited the highest concentrations of NO_3^-, PO_4^{3-}, DSi, and DIC among the investigated water masses [Research Article 1].
- Resolved five depth-related sediment geochemical zones using hierarchical clustering and LDA, and used the $\delta^{13}C_{DIC}$ relationship to attribute deep pore water carbon to carbonate dissolution and organic matter remineralization [Research Article 2].
- Identified pore water freshening at two Hornsund sites and demonstrated its influence on sediment biogeochemistry. Cl^- depletion in deep pore waters was interpreted as evidence of freshwater mixing consistent with SGD. Comparison of freshened and non-freshened pore waters showed higher inorganic nitrogen

but lower DIC, PO_4^{3-}, and DSi concentrations in the freshened waters [Research Article 2].

- Quantified spatially variable diffusive benthic fluxes of carbon and nutrients and demonstrated deviation from Redfield–Brzeziński stoichiometry. The results showed that sediments can act as either sources or sinks of nutrients depending on the site, with high phosphorus release in Hornsund and negative nitrogen and phosphorus fluxes at some Kongsfjorden sites. The observed N:P and N:DSi flux ratios differed from the Redfield–Brzeziński reference ratios (N:P of 0.2–10.1 versus 16:1; N:DSi of 2.9–43.4 versus ~1.1=16:15), demonstrating that benthic nutrient regeneration is strongly fjord- and site-specific [Research Article 2].
- Revealed strong basin scale heterogeneity and identified biogeochemical hotspots within western Spitsbergen fjords. Three stations accounted for approximately 73% of the variance along the dominant MFA dimension. These hotspots occurred in restricted basins characterized by limited deep-water renewal and a supply of labile organic matter. Differences among basins within individual fjord systems were often as large as or larger than those among fjord systems, supporting a mosaic rather than a fjord-wide gradient in subsurface biogeochemistry [Research Article 3].
- Demonstrated strong link between bottom water and sediment pore water biogeochemistry at the site scale. MFA showed that bottom water, water above sediment, and upper and lower pore waters covaried strongly, whereas surface waters were largely separated. This suggests that bottom water chemistry integrates spatial variability in the underlying sedimentary biogeochemical environment, allowing pore water hotspots to be identified, at least in part, from water column sampling [Research Article 3].