



Characterizing Arctic cold seep habitats from shelf to slope (a case study in the Vestbakken province)

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Understanding methane seepage dynamics in Arctic cold seep systems is crucial for knowing the implications of their impact on the Arctic Ocean habitats. The Barents Sea, characterized by active sub-seafloor fluid flow, serves as an ideal setting for investigating the environmental factors that interact with seepage dynamics in Arctic cold seep habitats. This study presents a multidisciplinary investigation of cold seeps explored during the AKMA3 expedition (May 2023) along the Vestbakken shelf and slope (SW Barents Sea). The research combines (i) detailed visual analyses of seafloor imagery acquired by the Aurora Remotely Operated Vehicle (ROV), (ii) sedimentological and biogeochemical analyses on three ROV-collected push cores and blade corers, and (iii) a preliminary assessment of living benthic foraminiferal communities. ROV video annotation allowed the identification and classification of multiple distinct microhabitats and cold seep indicators along the explored seafloor based on seafloor characteristics. A clear relationship between sediment type and the distribution of chemosynthetic communities on the seafloor is evident in ROV track analysis. Sedimentological and geochemical data provided quantitative evidence of seep-related processes and enabled a refined characterization of the substrate associated with each microhabitat type. Geochemical profiles revealed fine-scale lateral variability in sediment composition and porewater chemistry, reflecting the heterogeneous and dynamic nature of seepage in the area. The analysis of living foraminiferal assemblages revealed systematic differences between shelf and slope sites, indicating biological responses to seep-driven environmental gradients and variations in the depth of the sulfate-methane transition zone (SMTZ). Together, these multidisciplinary observations provide new insight into the significance of seafloor composition in controlling seepage dynamics near the sediment-water interface and, ultimately, shaping these habitats in the high Arctic.