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Methods Overview

All analyses in this study followed established micropalaeontological and geochemical protocols. Laboratory work was conducted at the Palaeontology group, Friedrich Schiller University Jena, and the Alfred Wegener Institute (AWI), Bremerhaven. Sampling from sediment core HH17-1085-GC, located north of the Hinlopen Strait, Svalbard (80.274° N, 16.211° E, 322 m water depth, 462 cm length), was supervised by Prof. Matthias Forwick (UiT The Arctic University of Norway). The sediment material was provided by the Korea Polar Research Institute (KOPRI).

Core Sampling and Subsampling

Core HH17-1085-GC was retrieved on 29 July 2017 using a gravity corer, yielding an undisturbed sequence of marine sediments suitable for palaeoenvironmental reconstruction. After recovery, the core was sectioned into 1 m segments, split into working and archive halves, and stored at 4–8 °C.

A continuous sampling strategy was applied to assess the microfossil content throughout the sequence. Every 10 cm interval was sampled, with three 1 cm subsamples per interval (typically 8–9 cm, 9–10 cm, and 10–11 cm). In total, over 140 discrete samples were taken. Additional quarter-core samples from key stratigraphic horizons were collected for potential external analyses. Sampling was conducted using clean spatulas, and all materials were stored under controlled conditions to prevent contamination or alteration.

Micropalaeontological Processing

Initial test samples were wet-sieved with 63 µm and 125 µm mesh sizes to evaluate sediment behavior and microfossil abundance. The >125 µm fraction was analyzed in detail, while the finer fraction was archived. Due to high clay content, sediments were pre-treated with ~5 % H_2O_2 to aid disaggregation before washing. Dried residues were stored in labeled vials.

Ostracods

Ostracods were hand-picked under a stereomicroscope at up to 32× magnification and identified to the species level wherever possible, following Frenzel et al. (2010b), Gemery et al. (2015), and Stepanova et al. (2003), with taxonomy standardized using WoRMS. Cross-verification of identifications was performed by Prof. Peter Frenzel (FSU Jena).

Abundance and diversity were analyzed using PAST software (Hammer et al., 2001). A Principal Component Analysis (PCA) was conducted on taxa exceeding 10 valves in at least one sample, after converting absolute counts to relative abundances. Samples with very low specimen numbers were excluded to avoid statistical bias. A Shannon diversity index (H′) was calculated to assess ecological variability along the core.

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Foraminifera

Foraminifera were investigated in parallel to complement ostracod-based reconstructions. Given the shelf setting, analyses focused on benthic calcitic taxa, while agglutinated forms were documented qualitatively but excluded from quantitative evaluation due to inconsistent preservation.

Taxa representing more than 5 % of total assemblages were quantified, and rare species were recorded qualitatively. Identification followed Murray (2006), Kujawa et al. (2021), and Wollenburg (1995), standardized via WoRMS. Selected identifications were confirmed during personal consultation with Dr. Jutta Wollenburg (AWI).

A PCA with hierarchical clustering (UPGMA, Euclidean distance) was performed on relative abundances, using the same parameters as for ostracods. The microfossil zonation was established based on logarithmically transformed ostracod counts and later refined by integrating the foraminiferal data.

Stable Isotope and Trace Element Analyses

Stable oxygen and carbon isotope analyses ($\delta^{18}O$, $\delta^{13}C$) were carried out at the AWI Marine Geology Laboratory using a MAT 253(+) mass spectrometer coupled with a Kiel IV carbonate device. Three taxa representing different benthic microhabitats were analyzed:

- *Nonionellina labradorica* (infaunal)
- Cassidulinidae (epifaunal)
- *Lobatula lobatula* (attached epifaunal)

Only well-preserved specimens were selected to avoid diagenetic alteration. Each measurement was performed in duplicate or triplicate, and mean values were used for further analyses. Results are reported relative to the VPDB standard.

Mg/Ca analyses were performed at the AWI Marine BioGeosciences group using a Nu AttoM HR-ICP-MS, following the Barker et al. (2003) cleaning protocol, adapted for benthic species. Quality control was ensured through routine measurement of the certified reference material ECRM 752-1, and low Al/Ca and Fe/Ca ratios confirmed efficient removal of contaminants. Due to availability and preservation, Mg/Ca ratios were determined primarily for *Nonionellina labradorica*.

Data Processing and Visualisation

Data validation and trend analyses were performed in Microsoft Excel and PAST. Outliers were detected via interquartile range analysis (Tukey’s fences) but retained unless instrumentally invalid. Long-term stratigraphic trends were tested using the Neumann trend test, and relationships between isotope and elemental datasets were evaluated by pairwise R^2 correlation.

All specimens were imaged using a Keyence digital microscope (FSU Jena), and selected taxa were analyzed by SEM (Thermo Scientific Axia ChemiSEM) at AWI under the supervision of Dr. Oliver Esper. Figures and visualizations were prepared in ProCreate and Excel.