# *Supplementary Material*

## 1 Supplementary Data

Sediments of the *Siboglinidae* field from MUC 10 showed also strong indications for bio-irrigation by the tubeworms (Fig. 4B). Sulfate (~28 mmol $L^{-1}$), total alkalinity (~3 mmol $L^{-1}$), sulfide (<0.2 mmol $L^{-1}$, except 3 mmol $L^{-1}$ at 3–4 cm), and methane concentrations (<0.1 mmol $L^{-1}$) remained relatively unchanged in the topmost 4–6 cm with a bright brown coloring (Fig. 4B) indicative of presence of oxidized sediment. Below 4–6 cm, sulfate decreased while total alkalinity, sulfide, and methane increased (Fig. 4K, N). Sulfate declined to a minimum of 16.8 mmol $L^{-1}$ at the bottom of the core, while total alkalinity and methane increased to 18.5 and 1.1 mmol $L^{-1}$, respectively. Sulfide peaked with 7 mmol $L^{-1}$ at 9 cm and then declined with depth to reach 1.5 mmol $L^{-1}$ at the bottom of the core. Sediment color changed to black and deeper in the core to grey typical of reducing conditions (Fig. 4B). In all three replicates, the majority of methane oxidation occurred in the top 4 cm of the sediment with high rates in the top (0–1 cm) sediment layer (Fig. 4E). Since this activity did not match with sulfate reduction (Fig. 4H), it was interpreted as coupled to MOx (Melaniuk et al. 2022). Methane oxidation reached a minimum (~0.4 nmol $cm^{-3}$ $d^{-3}$) at 5–6 cm, below which rates increased again (see insert in Fig. 4E) to a maximum of 4.8 nmol $cm^{-3}$ $d^{-1}$ at 7–8 cm (Fig. 4E). This double peaking indicated a change from an aerobic to an anaerobic methane oxidation pathway likely coupled to sulfate reduction below the bio-irrigation activity of the tubeworms (Melaniuk et al. 2022). Methane oxidation declined below the second peak towards the bottom of the core. Sulfate reduction was low (<3 nmol $cm^{-3}$ $d^{-3}$) in the top 0–1 cm, but steeply increased in all three replicates reaching values between 11 and 23 nmol $cm^{-3}$ $d^{-3}$ at 2–3 cm (Fig. 4E). Below 3 cm, sulfate reduction steadily declined reaching values ~1 nmol $cm^{-3}$ $d^{-3}$ at 10 cm, which remained consistently low down to the bottom of the core. The decoupling of methane oxidation and sulfate reduction in the surface sediment suggest that sulfate reduction was coupled to organic matter degradation in the top 6 cm, while part of it was likely also coupled to AOM below 6 cm.

Very steep geochemical gradients were found in the top 3–4 cm in the sediment covered by bacterial mats (MUC 12). Sulfate and sulfide concentration declined, respectively, while total alkalinity increased (Fig. 4O). Methane peaked with concentrations ~11 mmol $L^{-1}$ at 2-4 and 28.5 cm and varied between 2 –5 mmol $L^{-1}$ in other depths with no clear trend (Fig. 4L). Concentrations were most likely below in-situ levels and Melaniuk et al. (2022) suggested that the true methane profile could have been blurred due to degassing after sample recovery. Degassing was clearly noticeable during core handling (Fig. 4C). Methane oxidation was low at the surface (<13 nmol $cm^{-3}$ $d^{-1}$) and steeply increased in all three replicates to a maximum of up to 181 nmol $cm^{-3}$ $d^{-1}$ between 2–5 cm (Fig. 4F). Oxidation in all three replicates declined sharply below the maxima. Profiles of all three sulfate reduction samples showed a general alignment with methane oxidation (Fig. 4I), indicating a coupling to AOM (Melaniuk et al. 2022). The sulfate reduction was about two times higher than methane oxidation in the surface sediment (maximum 408 nmol $cm^{-3}$ $d^{-1}$) and likely also coupled to other processes, probably organic matter degradation.

**Table S1.** Direct counts of Rose Bengal stained foraminifera.

| **Core ID** | **MC 893A** | **BC 1090** | **BC 1101** | **MC 886** | **MC 893B** | **MUC 12A** | **MUC 12B** | **BC 1088** | **BC 1098** | **BC 1099** | **BC 1081** | **BC 1082** | **MUC 10C** | **MUC 10A** | **MU8** | **MUC 11A** | **MUC 11B** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Astronion galloway* (Loeblich & Tappan 1953) | | | | | | 3 | 2 | | | | | | | | | | |
| *Bolivina pseudopunctata* (Höglund 1947) | | 1 | 2 | | | | | 42 | 6 | 4 | 7 | 5 | | | | | |
| *Buccella frigida* (Cushman, 1922) | 14 | 7 | 1 | | | | | 2 | 2 | | 2 | | | | | | |
| *Cassidulina neoteretis* (Seidenkrantz, 1995) | 22 | 17 | 6 | | | 1 | | 18 | 42 | 37 | 79 | 50 | 107 | 154 | 107 | 160 | 136 |
| *Cassidulina reniforme* (Nørvan, 1945) | 10 | 2 | 2 | 1 | | 1 | | 27 | 14 | 20 | 25 | 28 | 40 | 24 | 103 | 17 | 9 |
| *Cibicides wuellerstorfi* (Schwager, 1866) | 3 | 1 | | | | 1 | | 2 | 1 | 3 | | 1 | 4 | 58 | 6 | 29 | 19 |
| *Lagena* sp. | 1 | | 11 | | | | | 2 | 4 | 9 | 4 | 4 | | | | | |
| *Melonis barleeanus* (Williamson, 1858) | 64 | 13 | 4 | 1 | 16 | | 2 | 16 | 37 | 95 | 33 | 54 | 11 | 25 | 30 | 8 | 11 |
| *Nonionella stella* (Cushman & Moyer, 1930) | 2 | | 1 | | | | | 1 | 2 | 3 | 4 | 7 | | | | | |
| *Oolina* sp. | | 1 | | | | | | | 3 | | 3 | | | | | | |
| *Oridorsalis* sp. | | | | | | | | | | | | | 3 | 3 | 13 | 8 | 2 |
| *Pullenia bulloides* (d´Orbigny, 1846) | 3 | | 5 | 1 | 2 | | | 3 | 2 | 1 | 10 | 2 | 21 | 17 | 29 | 27 | 21 |
| *Robertinida* | | | 1 | | | | | 2 | | | | | | | | | |
| *Stainfortia* sp. | | 1 | | 1 | | | | 7 | 2 | 1 | | 1 | | | | | |
| *Trifarina* sp. | | | | | | | | | | | 1 | | | | | | |
| *Quinqueloculina* sp. | | | | | | | | | | | | | 27 | 12 | 46 | 0 | 6 |
| calcareous individuals | | 1 | | 1 | 3 | | | 15 | 3 | 12 | 9 | 4 | | 6 | | | |
| *Adercotryma glomerata* (Brady, 1878) | | 8 | | | | | | 4 | 21 | 22 | | 18 | 22 | | 14 | 10 | 2 |
| *Cribrostomoides crassimargo (Norman, 1892)* | | 3 | 6 | 7 | | | | 12 | 10 | 4 | | 1 | 73 | 151 | 74 | 102 | 21 |
| *Reophax gracilis* Earland, 1933 | | | | | | | | 3 | 1 | | | 4 | | | | | |
| *Reophax guttifera* (Brady, 1881) | | 10 | 4 | | | | | 6 | 34 | 19 | 41 | 8 | 80 | 57 | 85 | 107 | 39 |
| *Reophax scorpiurus* (Montfort, 1808) | | | | | | | | | | | | | 1 | | 11 | 36 | 27 |
| *Reophax* sp. | 13 | 6 | 2 | | 7 | 4 | | 19 | 15 | 9 | 18 | 6 | 209 | 98 | 262 | 39 | 123 |
| *Saccammina* sp. | | | 8 | | | | | | 37 | | | | | | | | |
| *Saccorhiza ramosa* (Brady 1879) | | | | | | | | | | | | | 10 | 6 | | 9 | 25 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Spiroplectammina* sp. | 1 | | | 4 | | | | 1 | 4 | 1 | 2 | 4 | | 2 | | | |
| agglutinated individuals | | 1 | | | | | | 10 | 4 | 11 | 20 | 2 | | 16 | | | |
| Taxa N# | 10 | 14 | 13 | 7 | 4 | 5 | 2 | 19 | 20 | 16 | 15 | 17 | 13 | 14 | 12 | 12 | 13 |
| Individuals N# | 133 | 72 | 53 | 16 | 28 | 10 | 4 | 192 | 244 | 251 | 258 | 199 | 608 | 629 | 780 | 552 | 441 |
| Foraminifera N# per $10cm^3$ | 25,57 | 9,17 | 6,75 | 3 | 5,38 | 1,27 | 0,5 | 24,45 | 31,08 | 31,97 | 32,86 | 25,35 | 77,45 | 80,12 | 99,36 | 70,31 | 56,17 |
| Shannon index | 1, 65 | 2, 28 | 2, 42 | 1, 76 | 1, 14 | 1, 61 | 0, 81 | 2,52 | 2,47 | 2, 11 | 2, 17 | 2, 16 | 1, 96 | 2, 07 | 2, 03 | 2, 03 | 1, 98 |
| Evenness index | 0, 52 | 0, 69 | 0, 87 | 0,83 | 0, 78 | 1, 00 | 1, 13 | 0, 65 | 0, 59 | 0,51 | 0, 58 | 0, 51 | 0, 55 | 0,56 | 0, 63 | 0, 63 | 0, 56 |
| Chao-1 | 10, 5 | 21, 4 | 12, 74 | 6, 38 | 4 | 7, 7 | 2 | 19, 2 | 20, 2 | 18, 99 | 15, 25 | 17, 99 | 13 | 14 | 12 | 12 | 13 |