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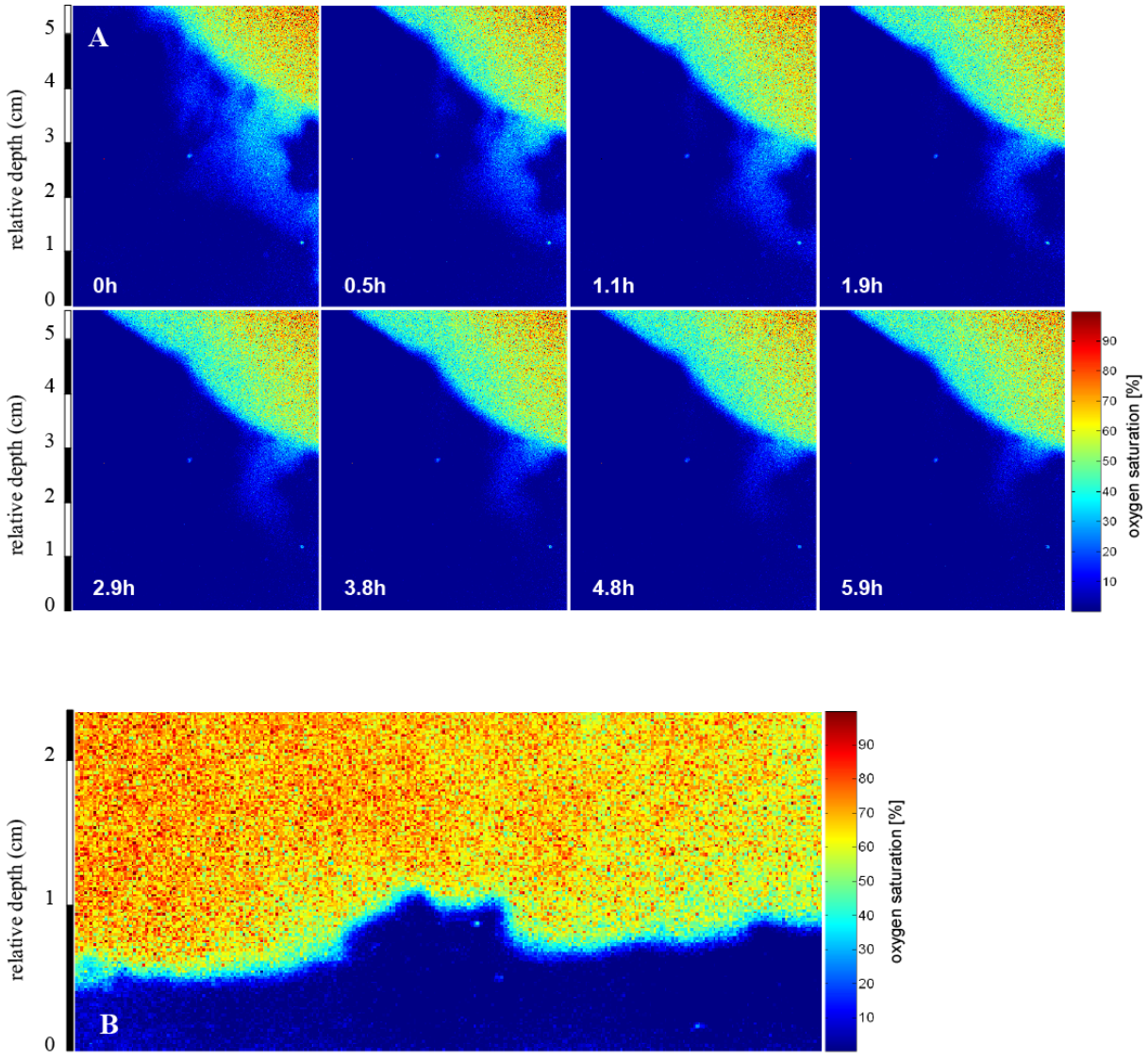
Table 1: Overview of all measurements and sampling stations (PW = Pore water analyses including ex situ methane concentration measurements; AOM = anaerobic oxidation of methane; SR = sulphate reduction; AODC =Acridine Orange Direct Counts) of this study and their PANGAEA event label. Sampling and measurements were performed in 2006 during the M70-2 expedition with the RV Meteor and in 2009 during the MSM 13-3 expedition with the RV Maria S. Merian. The event label are named accordingly. All data of this study is submitted to the PANGAEA data base (http://www.pangaea.de/) and available under the doi:10.1594/PANGAEA.804779.

Habitat	measurements	PANGAEA database event labels
central dome (I)	Benthic chamber	MSM13/3_929-1_CHAM1; MSM13/3_937-1_CHAM5; MSM13/3_971-1_CHAM12
	Microprofiler	M70/2b_825_PROF-2; MSM13/3_971-1_MICP11
	PW	M70/2a_757_PUC-22; M70/2a_760_PUC-45; M70/2a_760_PUC-48; M70/2b_791; M70/2b_804
	SR	M70/2a_760_PUC-25; M70/2a_760_PUC-53; MSM13/3_933-1_PUC2; MSM13/3_933-1_PUC24
	AOM	M70/2a_760_PUC-15; M70/2a_760_PUC-25
	AODC	M70/2a_760_PUC-33
northern transition (Ia)	PW	M70/2a_757_PUC-10; M70/2a_757_PUC-22
	SR	M70/2a_757_PUC-11
	AODC	M70/2a_757_PUC-52
bacterial mats (II)	Benthic chamber	M70/2b_825_CALMAR-1; MSM13/3_929-1_CHAM3; MSM13/3_933-1_CHAM4; MSM13/3_971-1_CHAM13
	Microprofiler	M70/2b_825_PROF-1; MSM13/3_971-1_MICP12
	Planar Optode	(M70/2b_825_PO-2)
	PW	M70/2a_760_PUC-39; M70/2a_760_PUC-41
	SR	M70/2a_760_PUC-12; M70/2b_825_PUC-9; MSM13/3_929-1_PUC1; MSM13/3_929-1_PUC9
	AOM	M70/2a_760_PUC-44; M70/2b_825_PUC-9; M70/2b_825_PUC-11; M70/2b_825_PUC-12
	AODC	M70/2a_760_PUC-40; M70/2b_825_PUC-9
biogenic mounds (III)	Benthic chamber	M70/2b_825_CALMAR-2
	Planar Optode	M70/2b_825_PO-1
	PW	M70/2a_765_PUC-14; M70/2a_765_PUC-52
	SR	M70/2a_765_PUC-26; M70/2a_765_PUC-42
	AOM	M70/2a_765_PUC-6; M70/2a_765_PUC-38
	AODC	M70/2a_765_PUC-26
sulfur band (IV)	Benthic chamber	M70/2b_790_CALMAR-1; M70/2b_798_CALMAR-1; MSM13/3_953-1_CHAM6
	Microprofiler	M70/2b_790_MICP-1; M70/2b_825_PROF-1; M70/2b_825_PROF-2; MSM13/3_944-1_MICP3; MSM13/3_947-1_MICP7
	PW	M70/2a_765_PUC-46; M70/2a_765_PUC-47
sulfur band (IV)	SR	M70/2a_765_PUC-8; M70/2a_765_PUC-49; M70/2a_765_PUC-68;

Habitat	measurements	PANGAEA database event labels
		MSM13/3_947-1_PUC27; MSM13/3_947-1_PUC32; MSM13/3_968-1_PUC8; MSM13/3_968-1_PUC110; MSM13/3_968-1_PUC117; MSM13/3_968-1_PUC19; MSM13/3_968-1_PUC23
	AOM	M70/2a_765_PUC-8; M70/2a_765_PUC-49; M70/2a_765_PUC-68
	AODC	M70/2a_765_PUC-46
reference	SR	M70/2a_763
	AOM	M70/2a_763
	AODC	M70/2a_763

Figure 1: Two-dimensional oxygen distribution in sediments of a (A) biogenic mound and (B) a bacterial mat (scale-oxygen saturation %) recorded in situ by a planar optode. The (A) During the deployment at a mud shrimp burrow, the oxygen content was decreasing to background values within 6 hrs. (B) Oxygen penetration in the bacterial mat is limited to 0.17 mm. The picture results from averaging nine single oxygen pictures taking during one deployment.



Material & Methods Supplements

Planar Optode

The two dimensional oxygen distribution in the sediment was measured in 2006 with an autonomous in situ planar optode module (Glud et al., 2001; Glud et al., 2005). The planar optode foil was produced according to the method described by Precht and coworkers (2004). The oxygen sensitive layer is based on a platinum(II)mesotetra-(pentafluorophenyl)-porphyrin (Frontier Scientific, Inc.) embedded in polystyrene and immobilized on a transparent polyester support foil by a knife-coating procedure. The sensing layer had a thickness of 15-20 µm. The optode foil was placed in front of the inverse periscope of the planar optode module (detailed description see Glud et al., 2001; Wenzhöfer and Glud, 2004; Glud et al., 2005). The oxygen-quenched fluorescence emitted by the fluorochrome was recorded using a modulated digital charge coupled device (CCD) camera (Sensi Cam, PCO Computer Optics). The planar optode was calibrated on board with oxygen saturated and anoxic seawater at in situ temperature. The calibrated oxygen image covered an area of 6 x 8 cm with a spatial pixel resolution of 128 µm (CCD camera chip size, 1280 x 1024 pixel, two pixels horizontal and vertical binning). Oxygen images were calculated based on a modified version of the Stern-Vollmer equation (Holst et al., 1998). The image analysis and the calculations of lifetime and oxygen images were done with homemade software using the program MATLAB 6.5 (MatchWorks Inc.)

Benthic chamber

Total benthic oxygen uptake (TOU) and total methane efflux (only measured in 2009) were determined with a benthic chamber module equipped with two Clark-type oxygen mini-

electrodes or oxygen optodes (AADI, Norway) by the ROV QUEST to ensure targeted measurements at selected spots. A valve in the chamber lid releases the enclosed water during the careful placement of the chamber on the seafloor by the ROV. The centrally stirred chamber had a radius of 9.5 cm and hence enclosed an area of 284 cm^2 together with 10-20 cm (equivalent to 4-6 L) of overlying bottom water. During each deployment the exact water height inside the chamber was determined by visual inspection with the ROV camera system. The oxygen concentration in the enclosed water volume was continuously recorded with either two Clark-type oxygen mini-electrodes or oxygen optodes (AADI, Norway) that were mounted to the chamber lid (Glud et al., 2009). The sensors were calibrated against bottom water samples and a zero reading was recorded at in situ temperature on board. During the chamber deployment up to 5 water samples with 50 mL syringes were taken in pre-programmed time intervals. After recovery in 2009, the water samples were injected into airtight glass vials containing NaOH pellets to release the dissolved methane into the headspace. Methane concentrations were determined by injecting 100 µL of the glass bottle headspace into a gas chromatograph (5890A, Hewlett Packard). At the "sulfur band" habitat sampled in 2006, water samples were preserved already at the seafloor in 5 mL 5% ZnAc solution, which were added to the syringes before the deployment in order to measure in situ sulfide flux from the sediment into the water column.

TOU, methane, and sulphide fluxes (mmol m^{-2} d^{-1}) were calculated from the linear regression of the respective concentration versus time (Wenzhöfer and Glud, 2002):

(3) $$\mathrm{TOU/CH_4/H_2S\text{-}flux} = \frac{dC}{dt} \times \frac{V_{chamber}}{A_{chamber}} \quad \mathrm{TOU/CH_4/H_2S\text{-}flux} = \frac{dC}{dt} \times \frac{V_{chamber}}{A_{chamber}}$$

where dC/dt is the change of the concentration over the incubation time, $V_{chamber}$ is the volume of the enclosed water, and $A_{chamber}$ is the area of the sediment enclosed by the chamber.

Microprofiler

Bases on the microsensor measurements diffusive oxygen uptake (DOU) and sulphide flux were calculated using Fick's first law of diffusion as described previously (Revsbech et al., 1983):

(4) $J = D \times \frac{\delta C}{\delta z}$

where J is the diffusive flux (mmol m^{-2} d^{-1}), D is the diffusion coefficient of oxygen in water (D= 1.64 x 10^{-9} m^2 s^{-1}) corrected for temperature and salinity (Li and Gregory, 1974) and δC/δz is the concentration gradient (δC (mmol m^{-3}); δz (m)). To calculate fluxes in the sediment, the diffusion coefficient (D) had to be corrected for the porosity (φ) of the sediment with the following equation (Iversen and Jørgensen, 1993):

(5) $D_{Sed} = \frac{D}{1 + 3 \times (1 - \varphi)}$

Sulphide fluxes were calculated from the highest concentration gradients in the profile (Iversen and Jørgensen, 1993) with the specific diffusion coefficient for sulphide (D_{Sed}= 0.66 x 10^{-9} m^2 d^{-1}, (Schulz and Zabel, 1999)) and the following equation:

(6) $J = \varphi \times D_{Sed} \times \frac{\delta C}{\delta z}$

References:

Glud, R. N., Tengberg A., Kuhl M., Hall P. O. J., Klimant I., and Host G.: An in situ instrument for planar O_2 optode measurements at benthic interfaces, Limnol. Oceanogr., 46, 2073-2080, 2001.

Glud, R. N., Wenzhöfer F., Tengberg A., Middelboe M., Oguri K., and Kitazato H.: Distribution of oxygen in surface sediments from central Sagami Bay, Japan: in situ measurements by microelectrodes and planar optodes, Deep-Sea Res. I, 52, 1974-1987, 2005.

Holst, G., Kohls O., Klimant I., König B., Kühl M., and Richter T.: A modular 4 luminescence lifetime imaging system for mapping oxygen distribution in 5 biological samples, Sens. Actuators, 163-170, 1998.

Iversen, N., and Jørgensen B. B.: Diffusion-coefficients of sulfate and methane in marine-sediments - influence of porosity, Geochim. Cosmochim. Acta, 57, 571-578, 1993.

Li, Y. H., and Gregory S.: Diffusion of ions in sea-water and in deep-sea sediments, Geochim. Cosmochim. Acta, 38, 703-714, 1974.

Precht, E., Franke U., Polerecky L., and Huettel M.: Oxygen dynamics in permeable sediments with wave-driven pore water exchange, Limnol. Oceanogr., 49, 693-705, 2004.

Revsbech, N. P., Jørgensen B. B., Blackburn T. H., and Cohen Y.: Microelectrode studies of the photosynthesis and O_2, H_2S, and pH profiles of a microbial mat, Limnol. Oceanogr., 28, 1062-1074, 1983.

Schulz, H. D., and Zabel M.: Marine Geochemistry, 1st ed., Springer Verlag, Berlin Heidelberg, 1999.

Wenzhöfer, F., and Glud R. N.: Benthic carbon mineralization in the Atlantic: a synthesis based on *in situ* data from the last decade, Deep-Sea Res. I, 49, 1255-1279, 2002.

Wenzhöfer, F., and Glud R. N.: Small-scale spatial and temporal variability in coastal benthic O_2 dynamics: effects of fauna activity, Limnol. Oceanogr., 49, 1471-1481, 2004.