# TIDAL DYNAMICS OF $O_2$, $H_2S$ AND pH IN PERMEABLE SANDS

E. Walpersdorf[1*], U. Werner[1], L. Polerecky[1], U. Franke[1], P. Bird[1,2], D. de Beer [1]

[1]Max-Planck Institute for Marine Microbiology, Celsiusstr.1, 28359 Bremen, Germany,*e-mail: ewalpers@mpi-bremen.de
[2]Botany Department, University of Queensland, Brisbane, Queensland, Australia. 4072

## INTRODUCTION.

We studied the dynamics of $O_2$, $H_2S$, and pH in intertidal sediments to assess the temporal and spatial scales of change in environmental conditions, their effects on transport phenomena and microbial activities. Research area was a permeable sand flat, Janssand, in the back-barrier tidal region of Spiekeroog Island, German Wadden Sea.

## RESULTS.

### SEASONAL DYNAMICS.

$O_2$ concentrations in the overlying water reflected temperature-dependent saturation with about 310 µmol/L at 5-7 °C in March and 250 µmol/L at 11-18 °C in October 2002 (Fig. 2., top of the sand flat). $O_2$-penetration in March was ± 2 cm, highest observed depth was 4 cm. The seasonal difference in the thickness of the oxic layer was related to intense microbial mineralisation of organic matter in October (algal bloom) . $H_2S$ was detectable at depths below 3 cm. Highest benthic respiration occurred in autumn with a total $O_2$ consumption of ± 120 mmol/m² over a 6 h tidal cycle.

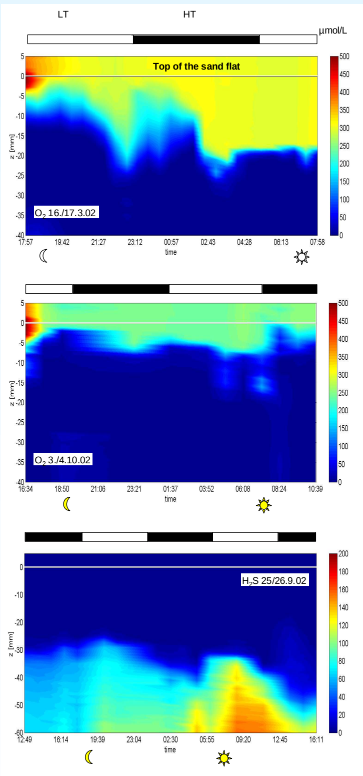


**Fig. 2.** Seasonal changes of $O_2$ and $H_2S$ concentrations and penetration depth on top of the sand flat (LT: low tide, HT: high tide)

## ACKNOWLEDGEMENTS.

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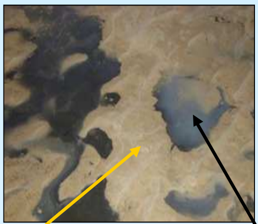
## METHODS.

In-situ microsensor measurements at the sediment/water interface were conducted over a 24 h tidal cycle by use of an autonomous profiling lander (Fig.1). Simultaneously, depth profiles of $O_2$, $H_2S$, pH and temperature were recorded half-hourly.



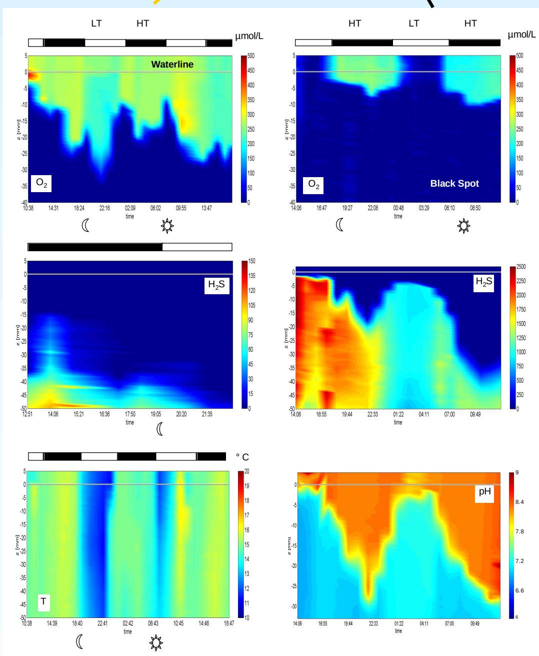



**Fig. 3.** $O_2$, $H_2S$, pH and T dynamics at the waterline (Sept./Oct. 2002) measured in oxic surface sediments (left) and directly on a black spot emitting sulfur milk (right).

## REFERENCES.

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**Fig. 1.** Lander used for in-situ microsensor measurements.

### TIDAL AND SPATIAL DYNAMICS.

At low tide photosynthetic activity caused a fourfold $O_2$ oversaturation at the sediment surface in Sept./Oct. 2002 (not shown in Fig. 2). At high tide photosynthesis may be light-limited by resuspended particles. Lower $O_2$ penetration depths at high tide could be related to changes in flow velocity and topographic effects such as ripple migration (Huettel et al., 1996, Ziebis et al. 1996). Temperatures in the sediment were very homogeneous but showed a very sharp transition between seawater temperature of 15-16 °C at high tide and 11 °C at low tide during the night (Fig. 3).

### BLACK SURFACE SEDIMENTS.

Spots and ripple troughs could be observed near the waterline where black anoxic iron sulfide-rich sediments (Böttcher et al., 1998) cropped out (Fig. 3). Here, an extremely tidal-dependent periodic upward movement of anoxic porewater was visible. During low tide $O_2$ was depleted in the overlying water combined with a surface-directed increase in $H_2S$ and decrease in pH. During high tide $O_2$-rich seawater penetrated deep into the sediment.

## CONCLUSIONS.

- Seasonal effects and in particular advective transport processes (tidal pumping) and surface topography control $O_2$, $H_2S$, T and pH dynamics in permeable sandy sediments. At high tide sediments were supplied to several cm depth with oxygen-rich seawater, whereas anoxic porewater drained off the sand flat during low tide.
- Black spots or channels could act as windows for transport of anoxic porewater to the surface.
- Enhanced transport of $O_2$ (and $C_{org}$) into permeable sediments can increase microbial activity. But mineralisation rates are influenced by rapid changes of temperature ≥ 5 °C during the intermediate seasons. Furthermore, microorganisms have to overcome changes from oxic to suboxic or even anoxic redox conditions in a few hours**.**