New Rhizon in situ sampler for pore water studies in aquatic sediments:
For example nutrient input from submarine groundwater discharge in costal areas.

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1 Introduction

This study presents a new developed Rhizon In Situ Sampler (RISS). Rhizon soil moisture samplers (Rhizon SMS) are usually used in soil and agriculture sciences. They offer the opportunity to sample fluids from unsaturated soils by a non-destructive technique (Meijboom and Van Noordwijk 1991). The RISS supports studies of seasonal variations in pore water composition, e.g. due to a minimal impact of the sampler on the sediment-pore water system. The RISS can easily be combined with benthic chambers, allowing pore water sampling at the same location as the flux studies.

2 Material and Procedures

Fig. 1: **Study area**: A tidal flat influenced by ground water discharge near Sahlenburg/Cuxhaven

To minimize any disturbance caused by inserting the sampling device, the basic idea of the Rhizon in situ pore water sampler is to bring Rhizons into the sediment depth where pore water samples should be obtained and then move the Rhizons sideways into the sediment. For this purpose we built the Rhizon in situ sampler (RISS) (Fig. 5) which consists of a platform which can be pushed gently into the sediment. Within a the groove the Rhizon is protected during insertion of the platform into the sediment. With two nylon chords the Rhizon can be moved out of the groove as well as back into it and is guided to the sampling location. This ensures that the filter section of the Rhizon is several centimeter away from the platform. The Rhizons are connected to a sampling device (e.g. syringe sampler or peristaltic pump) by tubes.

The combination of the RISS with a benthic chamber system (Fig. 4+5) permits the measurement of the in situ flux and to determine a pore water profile at the same location without bringing the sediment underneath the chamber shipboard, which is prone to artifacts by sediment sampling.

3 Assessment

Tracer studies

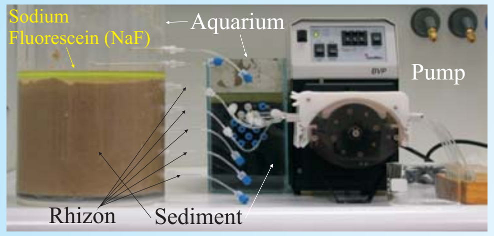

Fig. 2. Laboratory setup for **Sodium Fluorescein (NaF) tracer tests.** Rhizons are installed in sediment filled aquariums. NaF was added to the water overlying the sediment directly before the peristaltic pump starts to sample from the Rhizons. The retrieved fluids were separated into fractions of 1 ml.

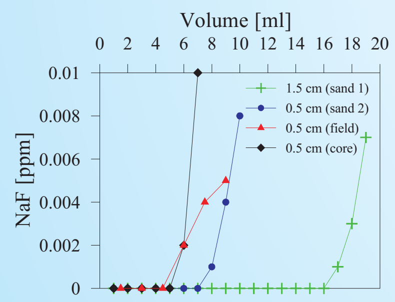

Fig. 3. The **concentration of NaF as function of the extracted volume** of pore water through Rhizons for 4 tracer experiments. Experiment "sand 1": Rhizon inserted into fine-grained sand 1.5 cm below sediment water interface (SWI). Depth of Rhizons in experiment "sand 2": Rhizons 0.5 and 2.5 cm. The experiment "field" was conducted near Cuxhaven/Germany on a tidal flat with the RISS and a benthic chamber, Rhizon depths: 0.5, 1.5 and 3.5 cm. The experiment "core": Rhizons were inserted 0.5, 2.5 and 4.5 cm below SWI into a multicorer tube with sediment taken from the same tidal flat above

Fig. 4. **Chamber deployment**: Rhizon in situ sampler (RISS) combined with a benthic flux chamber.

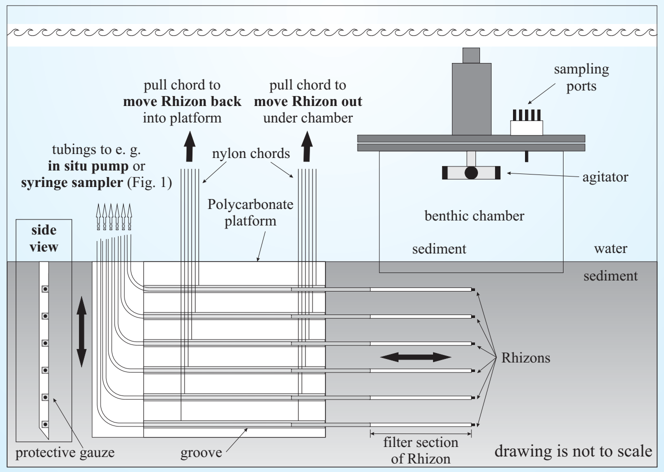

Fig. 5. Schematic diagram of a **Rhizon in situ sampler (RISS)** combined with a benthic flux chamber. The platform made of poly carbonate (thickness 0.6 cm) can be pushed into the sediment with minimum disturbance and the Rhizons are then moved horizontally into the sediment as well as back into the protective grooves by nylon chords. Pore water profiles can be determined underneath the benthic chamber, with negligible effect for the benthic flux measurement.

Numerical modeling of catchment area

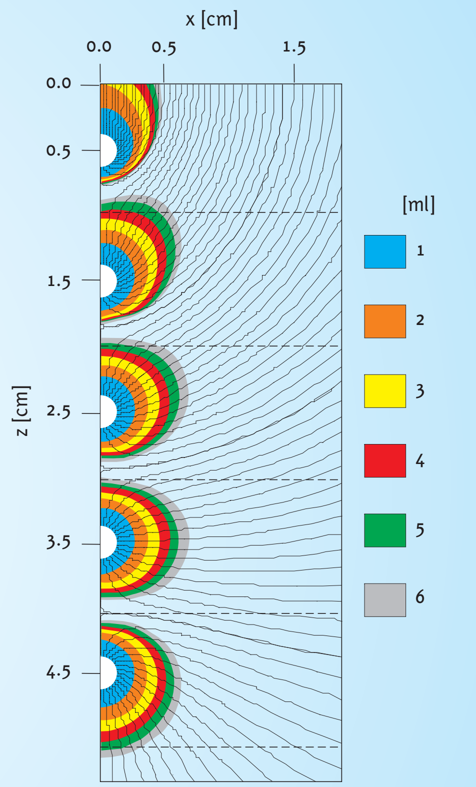

Fig. 6. : Results of **numerical modeling**, applying MATLAB/FEMLAB software package, of the flow field and the catchment areas around Rhizons assuming Darcy flow. The entire model domain of 50 cm in width and 20 cm in depth is considered by a finite element mesh. A **porosity** of **0.6** and a **hydraulic conductivity** of **1e-3 m s-1**, representative for unconsolidated sand is applied. The Rhizons with a **filter section** of **10 cm length** are located at 0.5, 1.5, 2.5, 3.5, and 4.5 cm depth at the left symmetry plane of the model. Suction occur at the same time at all Rhizons. The catchment areas representative of fluid volumes of 1 to 6 ml are indicated by the color code. Even for this case of low porosity a pore water volume of at least 2 ml can be extracted without bias between adjacent sediment layers (indicated by dashed lines) to obtain pore water profiles with 1 cm vertical resolution.

Results

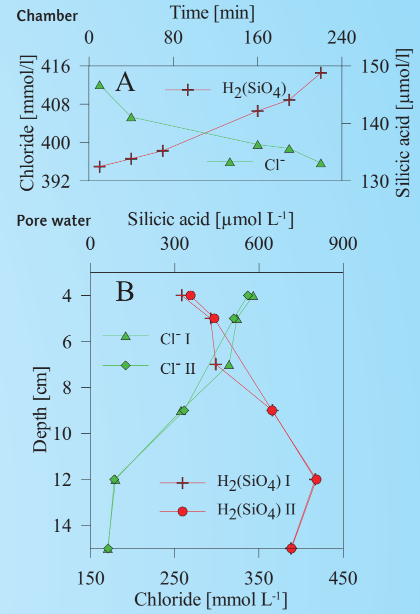

Fig. 7. A) **Change of chloride and silicic acid** over time in a benthic chamber deployment on a tidal flat near Sahlenburg/Cuxhaven Germany. B) Two **silica** and two **chloride profiles** taken with a Rhizon in situ sampler beneath the benthic chamber at the: **I)** beginning of chamber deployment, **II)** end of chamber deployment.

4 Conclusion

The results from the RISS indicate it is a very useful tool to sample pore water with minimum disturbance and it is even possible to apply a RISS underneath devices investigating the sediment-water interface (e.g. benthic chamber). Due to the distance of the filter section to the platform used to place the Rhizon in the sediment this technique is less prone to artifacts as channeling of bottom water along sediment corers or suction samplers. This allows long term deployment and repetitive sampling of pore water at one site.

References:

Meijboom, F., and M. Van Noordwijk. 1991. Rhizon soil solution samplers as artificial roots, p. 793-795. In L. Kutschera, E. Huebl, E. Lichtenegger, H. Persson and M. Sobotnik [eds.], Root Ecology and its Practical Aplication 3. ISRR Symposium. Verein für Wurzelforschung, A-9020 Klagenfurt Austria.

Seeberg-Elverfeldt, J., M. Schlüter, T. Feseker, and M. Kölling.(subm.) A Rhizon in situ sampler (RISS) for pore water sampling from aquatic sediments. Limnology and Oceanography: Methods.

Seeberg-Elverfeldt, J., and M. Schlüter. patent (subm.) Probennahmegerät zur simultanen Sammlung von Porenwasser aus benachbarten aquatischen Sedimentbereichen und Anwendung davon - Sampling device for simultaneous collection of pore water from related aquatic sediment areas and applications about it. Reference number: 10 2004 053 111.0-24. Germany