The impact of submarine groundwater discharge (SGD) on a coastal ecosystem of the southern Baltic Sea: Results from the AMBER project

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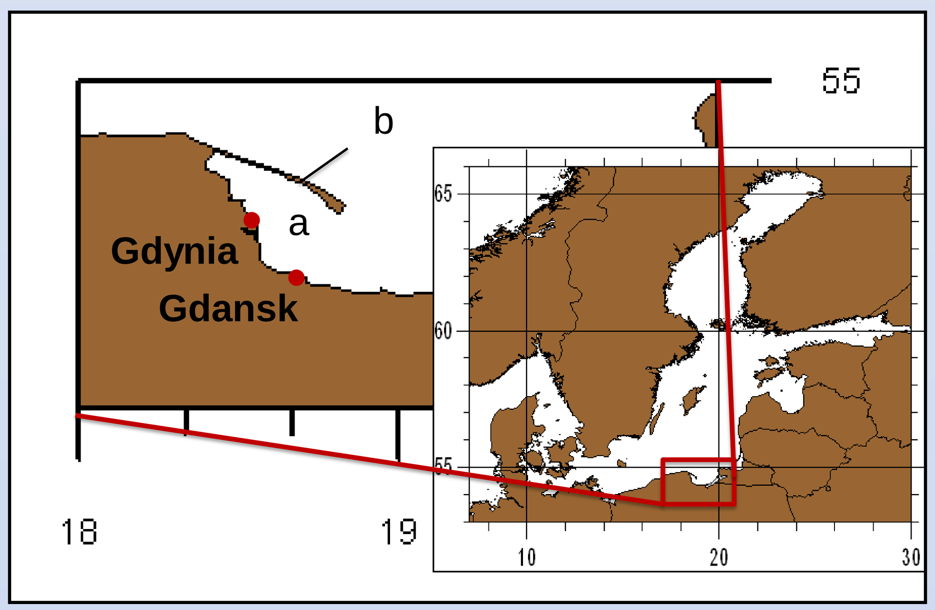

Fig. 1: Study area. Puck Bay (a) and Hel Peninsula (b).

Introduction:

Besides direct riverine input of dissolved and particulate compounds into coastal seas, SGD is increasingly recognized to be an important factor, because these discharges can deliver significant amounts of nutrients, metals and organic matter to the oceans (Burnett et al. 2001) thereby affecting biogeochemical cycles. However, it is difficult to quantify this source of freshwater. The goal of this study is to identify, quantify and characterise SGD in the Puck Bay (Poland) (Fig. 1). Together with Hel Peninsula it forms a semi-enclosed basin in the western part of the Gulf of Gdansk, characterized by relatively low salinity (average 7.6 PSU). Because of the hydrogeological conditions the Puck Bay is the major drainage area of some aquifers (Piekarek-Jankowska 1996) (Fig. 6).

Methods:

During a cruise with RV *Prof. A. Penck* in June 2009 possible sites of SGD should be identified with pump-scan fish and CTD-probe. Furthermore, methane and radon isotope samples were analysed, representing parameters often enriched in groundwater. Sediment cores were taken at promising sites to sample pore water (Fig. 2).

At the near-shore sites (Hel, Fig. 1) 40 cm long groundwater lances (Beck et al. 2007) (Fig. 3) and seepage meters were installed in September 2009.


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Fig. 2 and 3: Pore water sampling via rhizons (2) and groundwater lances (3).

Results and Discussion:

While salinity decreases, methane concentrations increase with depth at certain sites in the water column of Puck Bay, thus indicating groundwater discharge. This finding is likely supported by the relative activity of radon as well as by increasing concentrations of phosphate and manganese (Fig. 4). Pore waters from Hel beach showed low salinities down to 1.0 PSU along with high loads of nutrients and metals, giving strong evidence for groundwater seepage. Furthermore, it was found that the effluent mixture of ground- and seawater was anoxic because of the high sulphide concentrations at the time of sampling (Fig. 5).

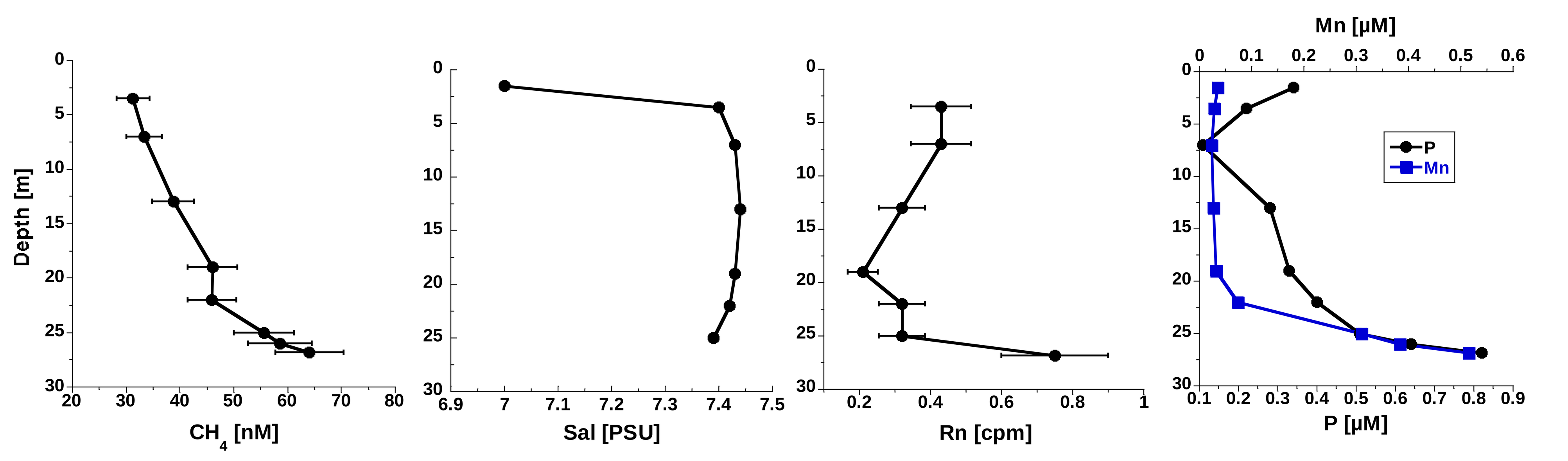


Fig. 4: Results Puck Bay June 2009. Concentrations of methane (CH_4), salinity (Sal), relative activity of radon (Rn) in counts per minute (cpm), concentrations of manganese (Mn) and phosphate (P) in the water column at a site with possible groundwater input.

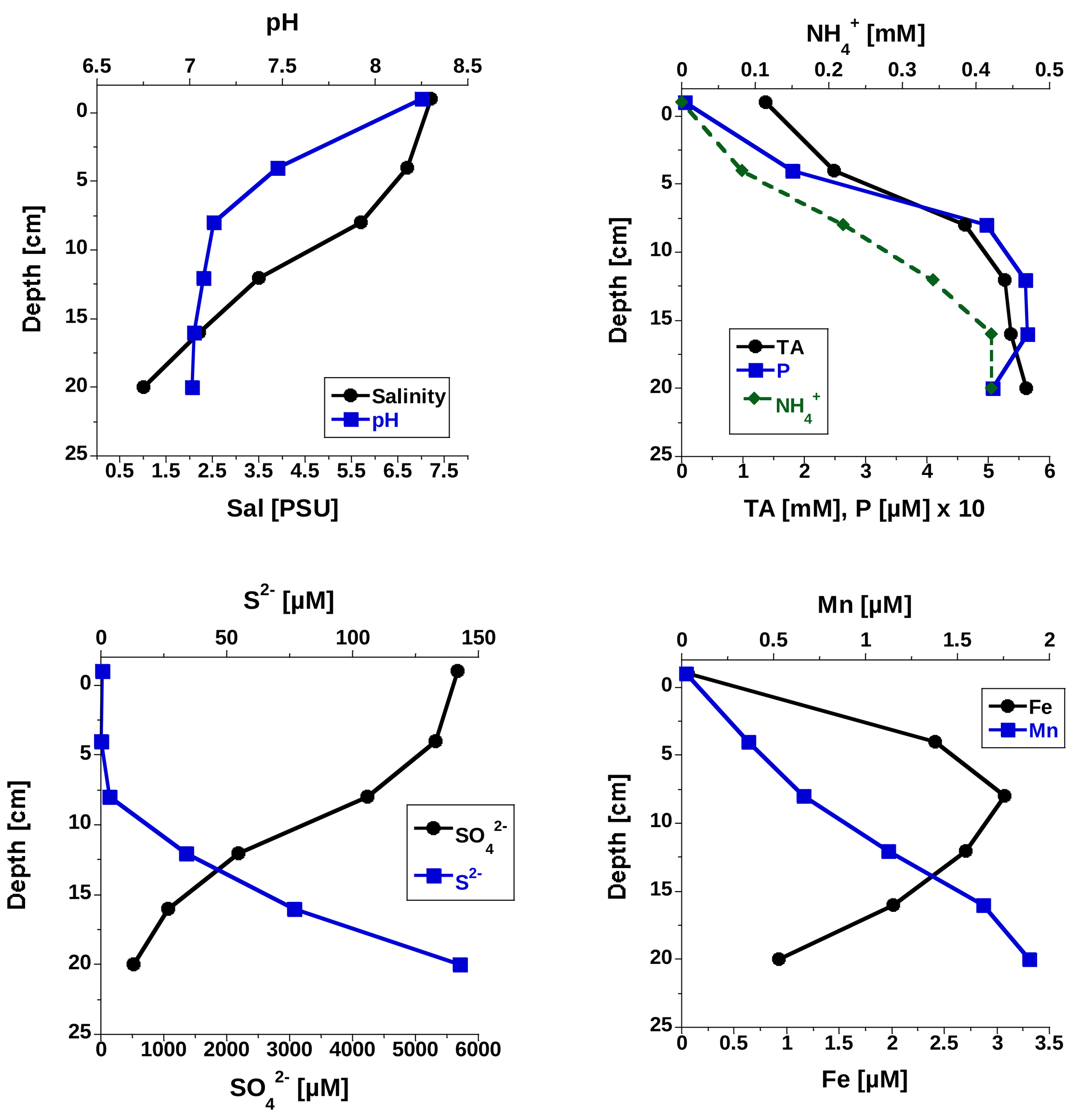
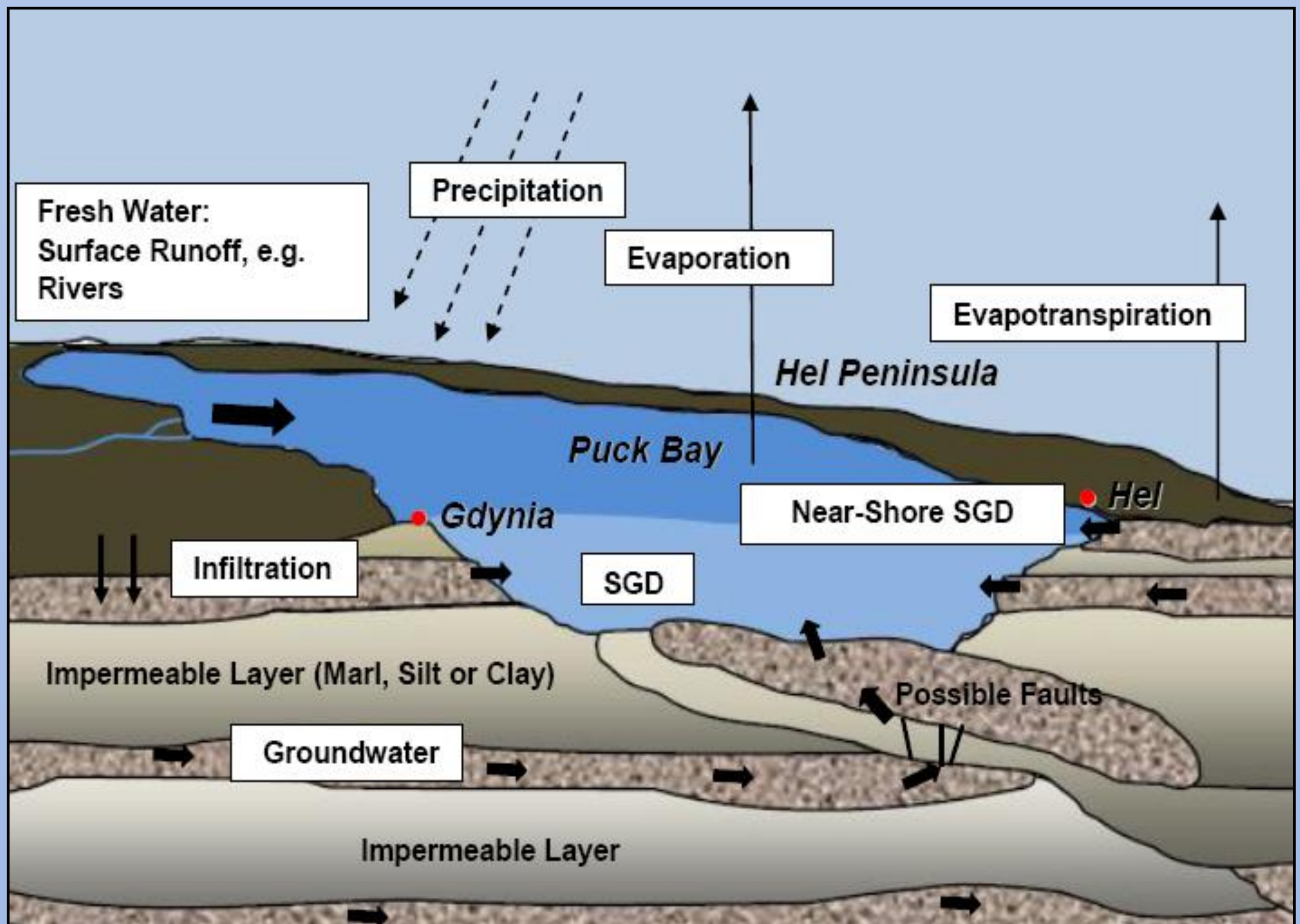


Fig. 5: Results pore water Hel beach September 2009. Profiles of salinity (Sal), pH, total alkalinity (TA) and concentrations of phosphate (P), ammonium (NH_4^+), sulphate (SO_4^{2-}), sulphide (S^{2-}), manganese (Mn) and iron (Fe).



Outlook:

Measurements will be continued on a seasonal base to extend the data base on seasonal changes of SGD in comparison to the impact of fresh surface water inflow. The vertical areal efflux rates and geochemical compositions of ground waters and their mixing proportions with bottom waters will be estimated by the applications of seepage meters and temperature lances as well as radon and radium isotope measurements. In addition, it is planned to use hydrological and meteorological data to make a water balance of the investigated area as an independent comparison to the results obtained by geochemical and isotope mixing calculations.

Fig. 6: Local water cycle and hydrogeological layers of the study area. SGD can take place as diffuse seepage, generally confined to the near-shore coarse-grained aquifers. Alternatively, it can occur rapidly through faults or as submarine springs (hydrogeological layers modified after Piekarek-Jankowska 1996).

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