



Mercury concentrations in the seepage water discharged to the Puck Bay

B. Szymczycha, M. Miotk, L. Kotwicki, J. Pempkowiak
 Institute Of Oceanology Polish Academy of Sciences, Powstańców Warszawy 55, Sopot, Poland
 beat.sz@wp.pl



Introduction

Besides, typically large, point sources of surface water inputs, the submarine groundwater discharge (SGD) is an important, yet poorly recognized, source of fresh water influencing coastal zone. Contaminated groundwater in many areas has become a source of nutrients, trace metals and organic compounds to the marine environment. This may cause environment deterioration in coastal zones. Fluxes of groundwater are usually temporally and spatially variable, making efforts to characterize site-specific flow regimes more complex. Within the Puck Bay (Gulf of Gdańsk), which is a region of drainage for the groundwater (Fig.1), the SGD has been investigated. It was found that the concentrations of Hg in the collected samples are exceptionally high (up to 235 ng/L).

Methods

During a research cruise (r/v Albrecht Penck) and several field campaigns in the Hel Peninsula (Fig.2). SGDs were identified by salinity measurements and also confirmed by other physical and chemical parameters (e.g. pH, temp., redox potential). Water samples were collected using bathometers, seepage meters and piezometers from SGD- impacted and SGD-unimpacted areas (Fig.3). Several chemical analysis were performed using Multi 34i-meter. (pH, salinity, redox potential), Tekran (Hg), ICP-MS (trace metals), spectrophotometer (nutrients) and HyPerTOC analyser (DIC, DOC). The limits of detection of applied methods are smaller than the measured concentrations by an order of magnitude. The limits of quantification are also substantially smaller than variations of the measured concentrations. The precision of the results is as follow: <3% for the measured nutrients, <3% for the measured metals, <2% for DOC and DIC, and <1% for pH and salinity.

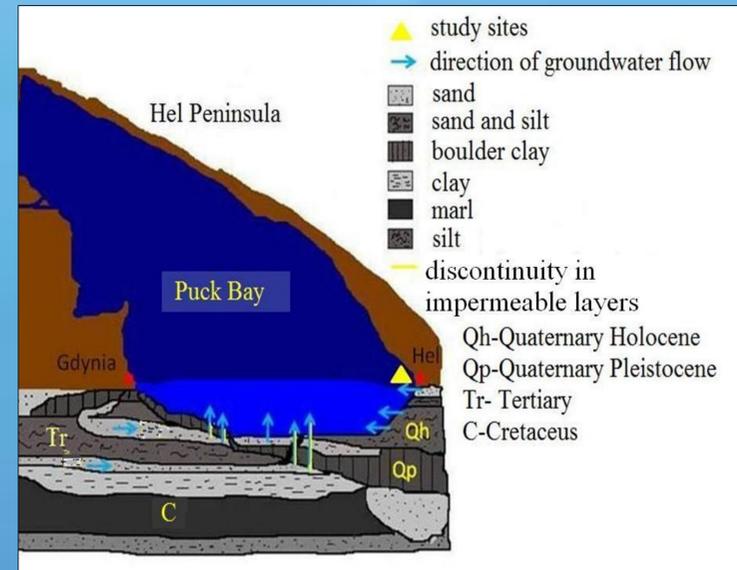


Fig. 1 Hydrogeological layers of the study.



Fig. 2 SGD study sites a) Hel Peninsula, b) Puck Bay.

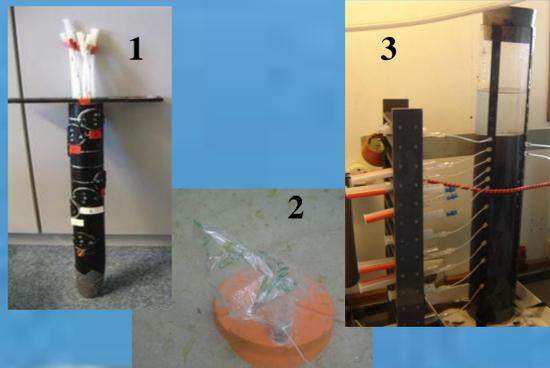


Fig. 3 Groundwater sampling via 1) piezometers, 2) seepage meter, 3) rhizons.

Results and discussion

In the collected water samples the following concentration ranges were observed: NH_4^+ (5,4-367,0 $\mu\text{mol/l}$), NO_2^- (0,09-1,24 $\mu\text{mol/l}$), NO_3^- (0,12-4,79 $\mu\text{mol/l}$), PO_4^{3-} (0,01-55,63 $\mu\text{mol/l}$), DIC (21,02-324,0 mgC/l), DOC (3,31-8,32 mgC/l), Cr (0,001-13,7 $\mu\text{g/l}$), Co (0,001-0,73 $\mu\text{g/l}$), Mn (0,65 do 149,7 $\mu\text{g/l}$), Hg (1,3-230,0 ng/l). Hg concentrations in water samples correlate well with salinity (Fig.4) and redox potential. The changes of Hg concentrations in water samples of different salinity are caused by mixing Hg-rich groundwater with Hg-poor sea water. Moreover, Hg speciation as well as manganese speciation is determined by redox potential (Fig.5) so it might be another factor influencing Hg concentrations in seepage water. Based on literature data concerning fluxes of groundwater entering the Puck Bay (Piekarek-Jankowska, 1994) and the measured Hg concentrations in seepage water, Hg fluxes to the bay were calculated (Fig. 6). The load of Hg discharged with the rivers is about 10 times lower than that coming from seepage water and is comparable with the atmosphere Hg fluxes (Boszke, 2005).

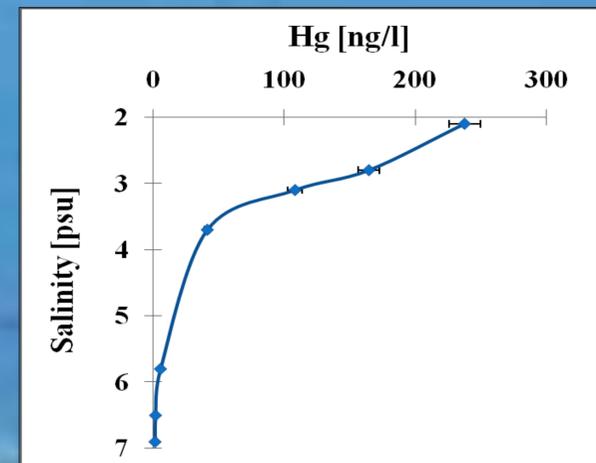


Fig. 4 Hg concentrations in water samples from the SGD impacted area (Hel Peninsula).

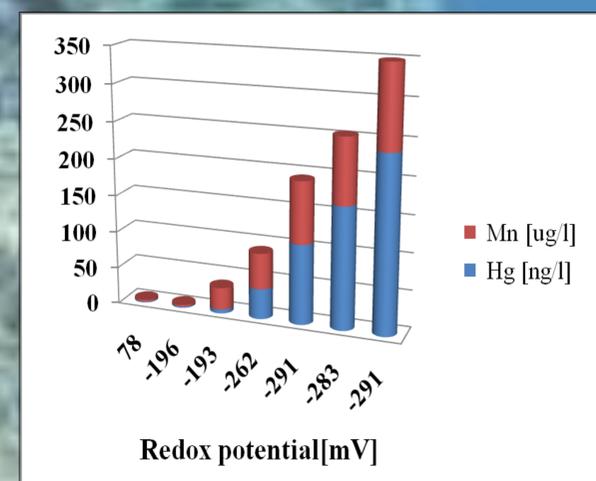


Fig. 5 The correlation between Hg and Mn concentrations and redox potential in water samples from the SGD impacted area (Hel Peninsula).

Submarine groundwater discharge [m ³ * h ⁻¹]	Inner Puck Bay	2300	(120ng/l-235ng/l) 178 ng/l	Hg fluxes with SGD [g * h ⁻¹]	(0,276 -0,545)
	Outer Puck Bay	1200			(0,144-0,282)
	The Puck Bay	3500			(0,42-0,8)
					0,623

Fig. 6 Hg fluxes to the Puck Bay.

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Literature

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 Piekarek-Jankowska H.,1994. Zatoka Pucka jako obszar drenażu wód podziemnych. Gdańsk: Wydaw. Uniw. Gdańskiego.