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Geochemistry of nourished sediment;
The mobilisation of trace elements due to pyrite oxidation

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INTRODUCTION

Pilot project "The Sand Motor" is a 21.5 million m^3 nourishment of sea sediment which has been applied along the coast between The Hague and Hoek van Holland in 2011. Due to wind, waves and currents the Sand Motor will gradually change in shape and eventually be fully incorporated into the dunes and beach.

We expect that the transfer of sea sediment from anaerobic conditions to aerobic conditions will lead to changes in biogeochemical processes; interactions between the atmosphere, (fresh) water and sea sediment may affect the mineralogical composition, salinity, trace element availability and buffering capacity.

OBJECTIVE

The objective of this study is to address the possibility of trace element mobilisation due to pyrite oxidation.
As a result, environmental conditions may change, which can affect flora and fauna.

METHODS

1. Sampling of groundwater, pore water and sediment (see figure 1)
2. Water samples were analysed on major and trace elements
3. Sediment samples were analysed on carbon and sulphur contents

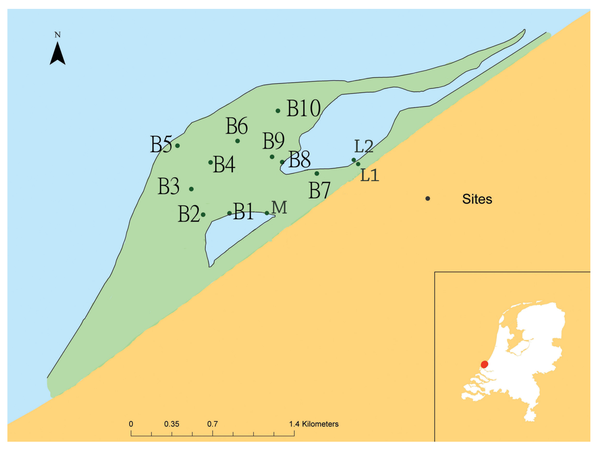

figure 1. Sample locations at the Sand Motor. At locations B1 till B10 sediment cores were taken at different depths: the unsaturated zone, the groundwater tidal zone and the saturated zone. From these cores sediment and pore water samples were obtained. Groundwater samples were collected at the same locations via a monitoring well.

figure 2. Location M. The sediment core shows dark grey coloured spots but also iron oxides causing the orange glow over the sediment between the surface and 18 cm depth. Dark and light grey layers are visible from 18 cm depth till 32 cm depth.

figure 3. Location L2. The sediment core has a very dark grey coloured layer starting at 2 cm depth. Then a light grey colour is dominant with very light grey layers and dark grey coloured spots. From 18 till 28 cm the sediment layers become very dark grey.

RESULTS

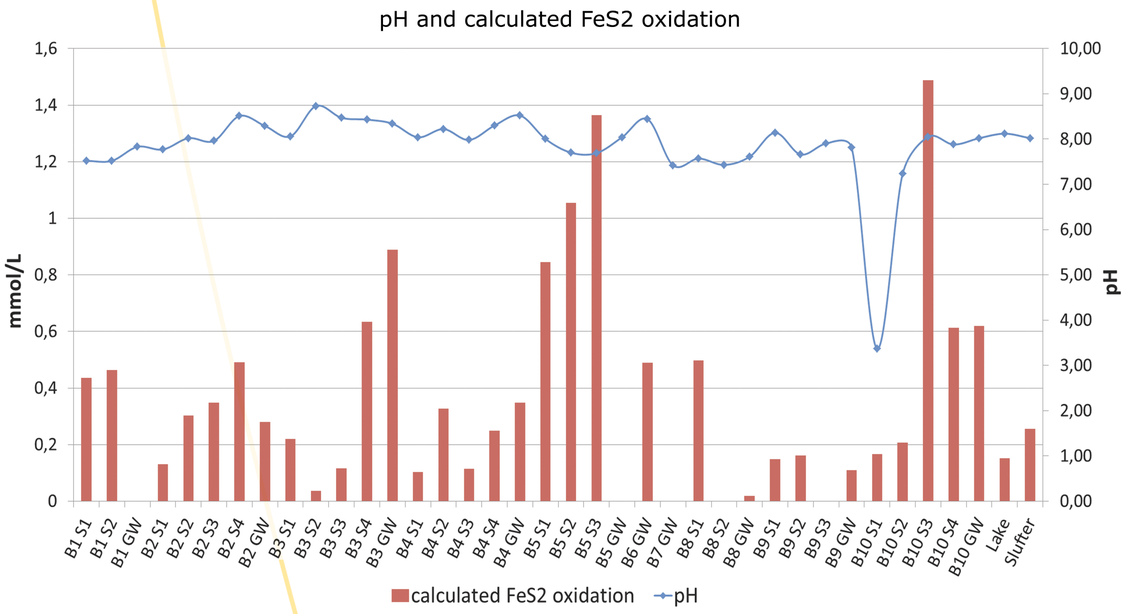

figure 4. The pH is slightly alkaline at the Sand Motor. The intensity of pyrite oxidation is spatially variabel. Here, the intensity was calculated from the sulphate excess. First, the chloride concentration was used to obtain the mixing ratio of freshwater and seawater. Then, the expected sulphate concentration was calculated using the mixing ratio. Finally, the sulphate excess was obtained by substracting the expected concentration from the measured sulphate concentration.

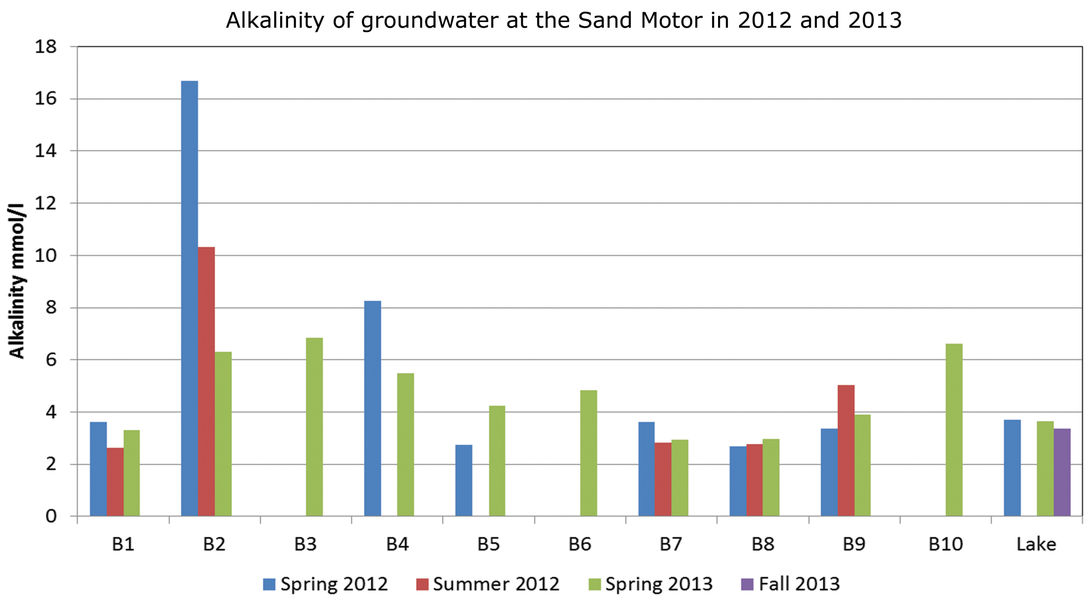

figure 5. Alkalinity of groundwater at the Sand Motor. When available, measurements taken in 2012 are also presented in the figure. An interesting location is B2 where the groundwater shows a strong decrease in alkalinity over time.

table 1. Results of trace elements (ug/L) of pore water from the sediment cores M, L1 and L2. Note that the last numbers indicate with increasing depth for the individual sampling locations. High variations are present for Manganese, Zinc and Arsenic. This illustrates that mobilisation of trace elements involving Manganese, Zinc and Arsenic occurs locally on the Sand Motor.

Core	Sample	Manganese (Mn)	Iron (Fe)	Cobalt (Co)	Nickel (Ni)	Copper (Cu)	Zinc (Zn)	Arsenic (As)
		ug/L						
L1	L1.2	122	<	1	<	<	60	87
	L1.3	318	1	1	2	<	27	18
	L1.5	228	2	0	1	<	24	19
L2	L2.3	1078	6	0	1	<	49	13
	L2.4	869	5	0	2	<	55	14
M	M.1	250	<	0	3	2	31	4
	M.2	1698	<	5	5	2	31	4
	M.3	183	<	1	7	<	33	26
	M.4	503	<	<	2	<	13	67
	M.5	391	<	0	5	<	22	92
	M.6	517	<	0	2	<	28	37

CONCLUSIONS

- Analyses show high variations of dissolved SO_4 , iron and trace elements.
- Acid conditions are present locally when a thick unsaturated zone is present and freshening has occurred.
- Results indicate that pyrite oxidation has occurred at the Sand Motor and mobilisation of trace elements is locally present.

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