

## Geomicrobiological and Geochemical Study on Pockmarks in the SW Barents Sea

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### Introduction

Widespread areas of the seabed in the southwestern Barents Sea are dominated by pockmarks, being manifestations of hydrocarbon venting and are, therefore, of considerable interest as possible indicators for deeper hydrocarbon reservoirs. Concomitantly, they form specific habitats for microbial communities. These pockmarks and the associated microbial ecosystems are in the focus of the current study using biogeochemical and microbiological approaches. During two research cruises in 2009 and 2011, funded by the Swedish oil company Lundin, about 42 surface sediment cores of up to 2.5 m length were selected. For comparison cores were taken inside and outside of the pockmark structures.

### Results and Conclusion

The analysis of methane within the pockmarks reveals only marginal amounts of gas, indicating that nowadays the pockmarks system is more or less inactive. Also microbial activity is astonishingly low in the entire sampling area as indicated by low sulfate reduction rates. Processes like anaerobic oxidation of methane (AOM) can be excluded for this depth interval since methane concentration and net sulfate consumption are very low.

Different biomarkers have been analyzed being indicators for fossil hydrocarbons (e.g. *n*-alkanes, hopanoids and steranes), or past microbial populations (glycerol dialkyl glycerol tetraethers (GDGTs)). Biomarker profiles do not show significant differences between pockmark and reference sites, inferring that fluid flow through the present pockmarks is currently not taking place. However, in the deeper core section an increase for hydrocarbons and microbial markers is detectable which might indicate the transition to the interval of paleo-seepage.

The results show that the observed pockmarks are rather relicts of paleo-seepage than indicators for active fluid flow. Their formation is most likely related to paleo-events of decaying gas hydrates induced by the pressure release from the melting ice shield during last deglaciation (approx. 13ka B.P.). [1]

Microorganisms, which are involved in the methane cycle, show a characteristic light carbon isotopic composition ( $\delta^{13}\text{C}$ ). [2] Currently, the  $\delta^{13}\text{C}$  values of GDGTs from top and bottom part of the sample cores are investigated to unravel a possible correlation of the biomarker increase to paleo-seepage.

Furthermore, a piece of a carbonate crust, sampled from an active seep in the Norwegian Sea is being analyzed to compare its biomarker composition to our previously investigated samples.

[1] Nickel et al. (2012) *Marine Geology*, in press.

[2] Aloisi et al. (2002) *Earth and Planetary Science Letters*, **203**(1), 195-203.

## Bulk redox status or redox microenvironments: Which is more important for controlling trace element transport?

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The redox form of trace elements is frequently the major control on the transport of those elements within soil and sediment systems. However, what controls the transformation from one redox form to another is much more debatable. Clearly the dominant or bulk redox condition of a system has an important impact on the chemical form of the trace metals therein. However, rarely can trace metal behavior be simply predicted by bulk redox measurements. The current presentation will focus on recent work studying the bioreduction of Cr(VI) to Cr(III) under differing dominant terminal electron acceptor (TEA) conditions (i.e.  $\text{NO}_3^-$ , native Fe(III)-containing minerals, and  $\text{SO}_4^{2-}$ ) and the subsequent remobilization of that Cr via reoxidation.

For the bioreduction phase of the experiment, advective flow laboratory columns packed with Hanford 100H aquifer sediments were subject to oxygen-free, synthetic groundwater containing Cr(VI) and lactate in the presence of different electron acceptors ( $\text{NO}_3^-$ , native Fe(III)-containing minerals, and  $\text{SO}_4^{2-}$ ). Chromate removal was observed under all conditions to varying degrees. The nitrate-treated columns, all of which exhibited denitrifying conditions, as well as in some of the sulfate-amended columns in which fermentative conditions were dominant, showed the most rapid removal of Cr(VI). After approximately one year, selected replicates of the nitrate-amended and sulfate-amended (one fermenting, one not) conditions were removed from the glovebox and presented with oxygen and nitrate containing, lactate- and chromate-free synthetic ground water in order to promote oxidative remobilization of Cr.

Interestingly, the solid-state form of Cr at the end of the bioreduction phase of the experiment appeared to be relatively independent of the dominant TEA present. However, in the reoxidation phase of the experiment, the rate and degree of Cr remobilization was strongly influenced by the bulk redox condition history of the system. These results present an interesting contrast between those behaviors controlled by local conditions and those controlled by bulk conditions.