

The sources of Nd isotopes in Arctic Ocean water

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The Arctic Ocean connects the Pacific and Atlantic Oceans and it also receives a significant freshwater input equivalent to 10% of the global river run-off. The most important exchange of Arctic Ocean water masses occurs through the Barents Sea and Fram Strait with the Nordic Seas (Norwegian, Greenland and Iceland Seas) and this exchange is crucial for the formation of North Atlantic Deep Water. The Nd isotopic composition, $\epsilon_{Nd}(0)$, of the northern North Atlantic is well characterised but it is not clear how the signal is acquired and how it relates to the Arctic Ocean.

We have determined the Nd concentration, C_{Nd} , and $\epsilon_{Nd}(0)$ of the major inflow areas to the Arctic Ocean through the Barents Sea and the Fram Strait, as well as the dominant Arctic outflow through the Fram Strait.

The Barents Sea inflow has a C_{Nd} of 15 pmol/kg and an $\epsilon_{Nd}(0)$ of -10.7, which is similar to waters from the northeastern Nordic Seas and demonstrates that Nd from the Atlantic dominates the Arctic inflow. In contrast to the inflow, the Nd in the major Arctic Ocean outflow, the Fram Strait, is isotopically different with a higher $\epsilon_{Nd}(0)$ of -9.8 throughout the entire water column, down to 1300m depth. This reflects addition of Nd derived from sources that include Pacific water, shelf sediments and rivers within the Arctic Ocean basin. River water inflow is a possible source for the added Nd to the surface waters, but it is also likely that Nd from Pacific waters modified by addition from shelf sediments in the Canada Basin is an important component in the Fram Strait surface outflow. The isotopic shift in the deeper water of the Fram Strait outflow is probably not directly related to river- or Pacific water input but rather to exchange with sediments along the shelf of the Canadian archipelago. It is likely that different sources contribute to the Nd at different depths in the water column. The influence of these sources on the isotopic composition of the northern North Atlantic will be discussed.

Reactivity of nitrates in the near field of type-B nuclear waste cells

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Introduction

B2-type nuclear waste consisting of a dry mixture of bitumen and a mineral phase (mainly NaNO_3 and BaSO_4 salts mixed with radionuclides) is proposed for deep geological storage. After closure the waste cell will progressively re-saturate leading to the dissolution of soluble salts and the diffusion of dissolved species within the compartments of the storage cell (cement engineered barrier and argillite host rock in the French case). Chemical modifications, such as denitrification, catalysed by possibly existing bacterial activity, will affect the system equilibrium. This study is intended to gain a better comprehension of the redox reactions involving nitrates and bacteria and their possible impact on the long term evolution of the B2 waste cells.

Modelling concept

Denitrification processes are modelled with the Phreeqc code, which couples geochemical reactions with dispersive and diffusive transport. Calculations were performed on a 1D column with a nitrate source on one side followed by two major zones in which only diffusion of dissolved species (nitrates, organic matter...) is allowed.

A particular attention is paid to the role of nitrate as an electron acceptor in the presence of micro-organisms and different electron donors (i.e. iron, pyrite, organic matter or hydrogen gas). The consideration of these different redox reactions allows description of the overall denitrification process. The mathematical tool for estimation of the impact of bacterial activity on reaction kinetics proposed by Jin and Bethke (2005) has been implemented in Phreeqc to model microbial controlled kinetics in reactive chemical transport.

Discussion and conclusions

Different denitrification scenarios were modelled showing important nitrate reduction in the first centimeters within the cement barrier. Modifications of gas phase composition and mineralogical assemblages of cement and argillite barriers are also predicted. Results emphasize the lack of experimental data to constrain the model, but help to guide future laboratory experiments, to define the role played by the electron donors and to better estimate nitrate concentrations and microbial implications.

References

Jin Q., Bethke C.M., (2005), *Geochim. Cosmochim. Acta* **69**, 1133-1143.