

## Mineral weathering and mobilization of trace metals in the rhizosphere: The role of root exudates

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The mobilization of trace elements in the soil-plant system takes place essentially in the rhizosphere, where roots are intimately in contact with soil. In the rhizosphere, conditions such as pH modification, changes in red-ox potential, high concentrations of organic ligands (either of vegetal or microbial origin), and the modulation of soil-enzyme and microorganism activities, can strongly influence and modify the biogeochemical cycles of several elements, thus causing changes in their availability for plant nutrition.

One class of these elements is composed by the trace metals; some of them are essential for plants even if in small concentrations and are amongst the micronutrients, such as Fe, Zn, Mn. Trace-metal solubility and availability can be influenced, among other factors, by the presence in soil of organic complexing agents that can induce metal mobilization from stable mineral phases. Among these compounds, root exudates such as low molecular weight organic acids (e.g. citric acid, malic acid, oxalic acid), phenolic compounds (e.g. flavonoids), siderophores, can be cited. These molecules can strongly contribute to mineral weathering in rhizosphere and, therefore, to the mobilization of trace metals. The mobilized trace metals, in function of the element and of its concentration, can be either essential nutrients or toxic elements for plants.

Within this context, the objective of this research is to study the mineral weathering processes occurring in the rhizosphere, with particular attention addressed toward the processes involved in trace-metal mobilization and the role of natural organic chelating agents, such as low molecular weight organic acids, phenolic compounds and siderophores. Possible synergic or competitive effects, using pure chemicals as well as exudates collected from plants, on trace-metal solubilization and on mineral weathering occurring among these compounds are being evaluated.

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## Plio-Pleistocene evolution of water mass exchange and erosional input in the Fram Strait

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We determined the isotopic composition of neodymium (Nd), lead (Pb) and beryllium (Be) of past seawater to reconstruct water mass exchange and erosional input between the Arctic Ocean and the Norwegian-Greenland Seas (NGS) over the past approximately 5 Myr. For this purpose, sediments of ODP site 911 (leg 151) from 900 m water depth on Yermak Plateau in the Fram Strait were leached to extract the isotopic composition of past bottom water from early diagenetic metal oxide coatings on the sediment particles [1].

Nd isotope signatures extracted from site 911 agree well with the present day deep water  $\epsilon\text{Nd}$  signature of  $-11.8 \pm 0.4$  [2]. Overall the Nd isotope composition was more radiogenic in the core section older than 2.7 Ma ( $\epsilon\text{Nd} = -9$  to  $-10$ ) and then progressively decreased to less radiogenic values ( $\epsilon\text{Nd} = -11$  to  $-12$ ) similar to the present isotopic composition.  $^{206}\text{Pb}/^{204}\text{Pb}$  ratios evolved from 18.7 to more radiogenic values around 19.2 between 2 Ma and today.

The  $\epsilon\text{Nd}$  data indicate that mixing of water masses from the Arctic Ocean and the NGS has controlled the Nd isotope signatures of deep waters on the Yermak Plateau since the onset of the Northern Hemisphere Glaciation (NHG). In contrast, the  $^{206}\text{Pb}/^{204}\text{Pb}$  of deep waters in the Fram Strait appears to have been dominated by glacial weathering inputs from old continental landmasses, such as Greenland or parts of Svalbard since 2 Ma. The changes in the  $\epsilon\text{Nd}$  and  $^{206}\text{Pb}/^{204}\text{Pb}$  were similar to those found for the central Arctic Ocean and the North Atlantic (derived from Fe-Mn crusts).

A record of cosmogenic  $^{10}\text{Be}$  normalized to  $^9\text{Be}$  in the same leaches shows a strikingly similar short term variability to those of  $\epsilon\text{Nd}$  and  $^{206}\text{Pb}/^{204}\text{Pb}$  suggesting that all three isotope systems have been influenced by the same process controlled by the extent of continental ice sheets and the associated weathering inputs.

[1] Gutjahr *et al.* (2007) *Chemical Geology* **242**, 351–370.

[2] Andersson *et al.* (2008) *GCA* **72**, 2854–2867.