Measuring the isotope fractionation of denitrification in permeable sediments

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Permeable sediments cover a significant proportion of the continental shelf, yet denitrification and other redox biogeochemistry in these sediments remains poorly understood. This is mostly due to the complex advective transport patterns in such sediments [1].

Despite benthic denitrification accounting for a significant oceanic nitrogen sink, no isotope effect (ε) associated with denitrification in permeable sediment has been published. Rather, most models assume an isotope effect of zero for this process, based on work solely in cohesive sediments [2]. However, permeable sediments could potentially impose substantial fractionation if nitrate is only partly comsumed during advective transport through the sediment.

We performed flow-through column experiments to quantify the organism-scale nitrate N isotope effect (ε_{cell}) during benthic nitrate reduction, the first step of denitrification using sand from Kerteminde, Denmark. The value of ε_{cell} was 18 ± 1‰, consistent with ε_{cell} values reported in cohesive sediments [3].

In order to estimate the apparent isotope effect (ε_{app}) on the overlying water, a computational model was employed to simulate denitrification and associated N isotope fractionation in a rippled permeable sediment under varied conditions. Simulations indicate that ε_{app} varies between 2‰ and 5‰, driven by advection of partially denitrified nitrate out of the sediment.

This work has significant implications for the global marine nitrogen isotope budget, and may help to explain discrepancies between modelled and measured ocean isotope signatures [2].

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Geochemical fingerprinting of corundum from Fiskenæsset, Greenland

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Since the late 1960s it has been known that pink and red corundum occurs in the area near Fiskenæsset (Qeqetarsuatsiaat) in southern West-Greenland. Corundum is hosted in the Fiskenæsset complex, which is part of the Archaean basement of the North Atlantic Craton. To date, *c*. 40 corundum localities are known in the area – a few localities yield stones of gem quality. The most promising locality, Aappaluttoq, is likely to be mined in the near future by the Canadian company True North Gems.

This study is a first attempt to find geochemical characteristics that can be used to tie the Greenlandic rubies to their area of origin. Here, we present laser ablation-ICP-MS trace element geochemistry data and oxygen isotope investigations on samples from the Fiskenæsset area and other known localities in Greenland (Storø, Maniitsoq, Kapisilit, and Nattivit).

Trace element investigations of corundum grains separated from 21 handspecimen from ten localities in the Fiskenæsset complex were performed on 24 different elements with LA-SF-ICP-MS at GEUS, however most of them were not detected. Our investigations of the Greenlandic corundum were concentrated on the elements Mg, Si, Ti, V, Cr, Fe, and Ga. Results are compared with data from other localities in Greenland and from internationally, well-known, ruby occurences. Samples from Fiskenæsset show a considerably higher amount of Cr (up to 14000 ppm) than found in measurements on samples from other areas in Greenland and literature data on most international samples. The Fiskenæsset rubies are relatively rich in Fe and Si, but relatively poor in Ti and Ga, while V and Mg do not show very distinctive values compared to samples from other areas.

Oxygen isotope composition measurements were performed on 11 samples from Greenland at the University of Lausanne, Switzerland using an isotope ration mass spectrometer. Samples from the Fiskenæsset region yield $\delta^{18}O$ values between 1.62 and 4.20‰, which is low compared to the other areas in Greenland and world-wide.

The two methods discussed here are efficient in characterising the Fiskenæsset rubies. More independent methods are necessary for a high-confidence fingerprinting.

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