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Positive side effect of enhanced denitrification: fixation of trace elements

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Enhanced denitrification is a promising treatment method which is intensively investigated to combat the global problem of nitrate (NO_3^-) pollution. In most cases, enhanced denitrification is achieved by the addition of organic carbon. However, unwanted mobilization of trace element is often associated with naturally occurring NO_3^- reduction in aquifers and may lead to concentrations exceeding drinking water limits.

In this study, two different types of sandy sediments from aquifers in Denmark (Quaternary) and Germany (Cretaceous) were used. In both, the geogenic NO_3^- degradation capacity is almost exhausted. In column experiments, the NO_3^- degradation, but especially the behavior of the trace elements, was investigated. Selected trace elements (As, Co, Ni, V and Zn) were added at a concentration of 100 µg/L to the nitrate-bearing water circulating through the column. In both sediments, a reduction of the trace element concentrations could be observed in the circulating water. The decrease in trace element concentrations occurs with the addition of organic carbon, used as an electron donor for enhanced denitrification. Sinks of trace elements were studied in detail by a six-step sequential extraction procedure. For this, sediment samples were taken at five equally spaced locations along the columns and the change in trace element content was compared with the initial sediment. Results show sorption of trace elements, but also binding by amorphous oxyhydroxides, where these are newly formed over time. Differences also occur between the sediments. In the experiments with sediment from the Haltern Formation (Germany), water has a low pH value (approx. 5.5). In Quaternary meltwater deposits from Denmark, the pH of the water is considerably higher (approx. 7.8) and trace elements also bind to extractable carbonates.

As the trace element concentrations do not increase after NO_3^- reduction has ceased, the enhanced denitrification has a positive side effect– the fixation of trace elements.