



Denitrification activity of aquifer material from two different sandy aquifers in northern Germany measured by laboratory incubation experiments in relation to influencing sediment parameters

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In NO_3^- -contaminated aquifers containing reduced compounds like organic carbon or sulfides, denitrification is an intense process. Its characterization is of interest because NO_3^- consumption improves water quality and N_2O production can cause emission of this greenhouse gas to the atmosphere. Spatial distribution of NO_3^- and N_2 produced by denitrification in groundwater (excess N_2) reflects the NO_3^- input as well as cumulative denitrification during aquifer passage. The amount and spatial distribution of reduced compounds within denitrifying aquifers is not well known. Recent findings from parallel investigations on in situ denitrification and reactive compounds suggests that single-well ^{15}N tracer tests might be suitable to characterize the stock of reduced compounds in aquifers (Konrad 2008), but an evaluation of this approach has not been realized until now.

The overall objective of our studies is to measure the spatial and long-term dynamics of denitrification within two sandy aquifers in northern Germany. This includes measurement of the actually occurring denitrification process in the field by ^{15}N -tracer experiments and incubation experiments with corresponding aquifer material. Beside the comparison of field and laboratory data concerning the denitrification activity, we also want to determine the long-term denitrification potential which is governed by the stock of reactive material within these sediments.

Here we present the first results of these long-term incubation experiments to investigate the stock of reactive material present in these sediments and its denitrification activity. In these batch experiments we filled the aquifer material from different depths between two and 68 m below ground in glass bottles, supplemented it with K^{15}NO_3 solution, sealed the bottles airtight with rubber septa and flushed the headspace with pure N_2 . Afterward the bottles were stored in the dark by 10°C to obtain aquifer like conditions. The labeled denitrification products ($^{15}[\text{N}_2\text{O}+\text{N}_2]$), N_2 , N_2O , CO_2 , Nitrate, Sulfate and pH were analyzed six times during the experiment. In order to study the stock of reduced compounds within the incubated sediments we also performed other laboratory measurements with the aquifer material. We measured its capability to reduce potassium permanganate and the concentrations of extractable sulfate, dissolved organic carbon, hot water soluble organic matter and total C, N and S per kilogram sediment.

Results up to now show for most of the incubated glass bottles with sediments an almost linear increase of the denitrification products over time. The measured denitrification rates for aquifer material from the zone of heterotrophic denitrification and for sediments from the zone of autotrophic denitrification range from 0.2 to 42 $\mu\text{g N kg}^{-1}\text{d}^{-1}$ and from 22 to 120 $\mu\text{g N kg}^{-1}\text{d}^{-1}$, respectively. The relationships between denitrification rates and the parameters of the reduced compounds will be discussed.

References:

Konrad, C. (2008): Methoden zur Bestimmung des Umsatzes von Stickstoff, dargestellt für drei pleistozäne Grundwasserleiter Norddeutschlands, PhD thesis, Dresden Univ. of Techn., Germany, 157 pp.