

4.62.22

Transport and reduction of nitrate in clayey till underneath forest and arable land

P.R. JØRGENSEN¹, J. URUP², T. HELSTRUP²,
M.B. JENSEN³, F. EILAND⁴ AND F.P. VINTHER⁴

¹Hedeselskabet, Ringstedvej 20, DK-4000 Roskilde, Denmark
(pej@hedeselskabet.dk)

²Geological Institute, University of Copenhagen, Øster
Voldgade 10, 1350 Copenhagen K, Denmark

³Royal Danish Veterinary and Agricultural University,
Thorvaldsensvej 28, DK-2000 Copenhagen F, Denmark

⁴Danish Institute of Agricultural Research, Research Centre
Foulum, DK-8830 Tjele, Denmark

This study relates variable flow rates with nitrate fluxes and reduction of nitrate in typically macroporous clayey till. The experiments were carried out using saturated, large diameter (0.5 m), undisturbed soil columns (LUC), from a forest and nearby agricultural sites. Transport of nitrate was controlled by flow along the macropores (fractures and biopores) in the columns.

Nitrate reduction (denitrification) determined under active flow mainly followed first order reactions with half-lives ($t_{1/2}$) decreasing with depth (1.5 to 3.5 m) from 7 – 35 days at the forest site and 1 - 7 hours at the agricultural site. Nitrate reduction was likely due to microbial degradation of accumulated organic matter coupled with successive consumption of O_2 and NO_3^- in the macropore water followed by reductive dissolution of Fe and Mn from minerals along the macropores.

Concentrations of total organic carbon measured in soil samples were near identical at the two study sites and consequently not useful as indicator for the observed differences in nitrate reduction. Instead the high reduction rates at the agricultural site were positively correlated with elevated concentration of water-soluble organic carbon and nitrate-removing bacteria relative to the forest site.

After high concentrations of dissolved organic carbon in the columns from the agricultural site were leached they lost their elevated reduction rates, which, however, was successfully re-established by infiltration of new reactive organics represented by pesticides. Simulations using a calibrated discrete fracture matrix diffusion (DFMD) model could reasonably reproduce the denitrification and resulting flux of nitrate observed during variable flow rate from the columns.

4.62.23

Natural attenuation of cyanides in an aquifer of a former MGP site

N. KUNZE AND M. ISENBECK-SCHRÖTER

Institute of Environmental Geochemistry, Im Neuenheimer
Feld 236, D-69120 Heidelberg, Germany
(nkunze@ugc.uni-heidelberg.de;
mischroe@ugc.uni-heidelberg.de)

The natural attenuation of different cyanide species in groundwater of a former manufactured gas plant (MGP) site has been investigated in field studies and batch experiments.

Cyanide contents in groundwater have been studied for a period of about 1½ years. Non-toxic and highly toxic cyanide species were distinguished by quantifying the operational parameters strong acid dissociable cyanide (SAD) and weak acid dissociable cyanide (WAD) according to German standard method DIN 38405. SAD concentrations reached up to 4.5 mg/l, whereas WAD concentrations were not higher than 35 µg/l. Within the aquifer an extended cyanide plume (71 000 m²) was observed, which behaved non-progressive during the entire period of investigations. The extend of the plume depends on interacting physical and geochemical processes such as cyanide input by leachate, dilution due to mixing with uncontaminated groundwater as well as sorption and degradation processes during the transport of cyanides in the aquifer.

Cyanide species distributions were calculated using PHREEQC [1]. The calculated results on the basis of thermodynamic equilibria differed significantly from the species distributions measured in the samples. In batch experiments conducted with sediment and groundwater from the test site degradation of WAD was demonstrated. It is a first order kinetic process with a rate constant of $k=0.02 [h^{-1}]$ and is probably mediated by microorganisms. Due to this degradation of WAD the species distribution shifts to a higher content of the hexacyanoferrate fraction. The batch experiments also provided evidence that adsorption and hence retardation of the dominating cyanide species take place within the aquifer. The hexacyanoferrates form weak surfacecomplexes either at iron oxide/-hydroxide-, kaolinite- or chlorite-surfaces. These minerals could be detected in the fine fraction of the aquifer material. From the results of the study it can be deduced that the risk potential concerning cyanides in groundwater of the investigated site is low because the non-progressive cyanide plume is restricted to a distinct area within the former MGP site and because the toxic WAD-fraction of total cyanide is below risk level due to degradation processes.

Reference

- [1] Parkhurst, D.L. and Appelo, C.A.J. (1999) U.S. Geological Survey Water-Resources Investigations Report 99-4259