

Monitoring nutrients cycles at catchment scale

T.P. VAN TOL¹ AND B. VAN DER GRIFT^{2*}

¹Alterra, Wageningen University and Research Centre, P.O. Box 47, NL-6700 AA Wageningen, The Netherlands (dorothee.vantol-leenders@wur.nl)

²Deltares, P.O. Box 85467, NL-3508 TA Utrecht, The Netherlands
(*correspondence: bas.vandergrift@deltares.nl)

In The Netherlands, the high concentration of nitrogen and phosphorus has an adverse affect on the quality of our surface water. The abundant growth of algae, water plants and reed is a recurring problem in Summer. Furthermore, the discharge of nutrient-rich water into the sea is a real threat to the marine ecosystem. Unfortunately, the origin and fate of all these nutrients often remains unclear.

The total nutrient concentration in surface water is determined by a range of sources, transport routes and chemical or biological processes. Nutrient cycles at a watershed scale are therefore very complex. To come up with solutions to improve the water quality it is very important to gain insight into the origin of the sources, their transportation time and what happens en route. In four typical watersheds in the Nederland's we studied the biogeochemical cycling of nitrogen en phosphorus at regional scale. The main goal of the project is to understand the relationship between long term changes in nutrient surplus and the quality of the surface water. The four watersheds are: a sandy with high loads of nutrients due to intensive cattle breeding, a more natural sandy area, a clay polder and a polder with peat soil. Each area has its own characteristics regarding the sources and transport route for nutrients. For this study we analysed soil, groundwater, sediment and surface water quality on several locations. The surface water quality and quantities were monitored continuously in the period 2004-2010. Combined with data collected on nutrient loads this resulted in an extensive dataset to study biogeochemical cycling of nitrogen and phosphorus in the soil-groundwater-surface water system at regional scale. A combined soil-groundwater-surface water model is used to predict the effectiveness of different source or transport route oriented measures to improve the quality of the surface water.

One of the major findings is the importance of sediments in the binding and release of phosphorus when transported from groundwater to surface water and the role of sulfate in this process.

Uranyl coordination chemistry on magnesite and brucite surfaces: Polarisation dependent EXAFS

A. VAN VEELLEN^{1*}, G.T.W. LAW¹, A.J. SMITH¹, J.R. BARGAR², J. ROGERS² AND R.A. WOGELIUS¹

¹University of Manchester, School of Earth, Atmospheric and Environmental Sciences, Oxford Road, Manchester, M13 9PL, United Kingdom (*correspondence: arjen.vanveelen@postgrad.manchester.ac.uk)

²Stanford Synchrotron Radiation Laboratory, PO Box 4349, Stanford, CA 94309, USA

Previous studies have examined uranium uptake by calcium carbonate minerals (calcite and aragonite) under conditions pertinent to both natural and anthropogenically perturbed systems. However, research on uranyl uptake by magnesium-rich minerals such as magnesite [MgCO₃], brucite [Mg(OH)₂], nesquehonite [MgCO₃·3H₂O] and hydromagnesite [Mg₅(CO₃)₄(OH)₂·4H₂O] has not, to the best of our knowledge, been previously conducted. Such experiments will improve our understanding of the mobility of uranium and other actinides in natural lithologies such as dolomitic limestones or mafic igneous emplacements, as well as provide key information applicable to nuclear waste repository strategies involving Mg-rich phases. Thus, experiments with mineral powders were used to determine the partition coefficients and coordination of UO₂²⁺ during adsorption and coprecipitation with magnesite, brucite nesquehonite and hydromagnesite. A second set of experiments used single crystal magnesite (10.4) cleavage surfaces and MgO(111) surfaces engineered and hydroxylated to be equivalent to the Mg(OH)₂(00.1). Here EXAFS measurements were made at $\chi = 0^\circ$ and $\chi = 90^\circ$ in order to use the polarisation of the incident beam to unequivocally determine adsorbate and coprecipitate structures. The selected minerals were reacted with uranyl chloride at three different concentrations (500, 50 and 5 ppm) above and below solubility boundaries of schoepite (UO₂(OH)₂·H₂O) at pH 8 and PCO₂ = 10^{-3.5} atm. K_d values for Mg carbonate phases were comparable to or exceeded those published for calcium carbonates. EXAFS results showed clear polarisation dependence of surface uranyl. The spectra demonstrated consistently that the uranyl molecule is preferentially oriented with the axial oxygens perpendicular to the mineral surface. This implies the creation of local rutherfordine-like regions which may polymerise at high uranyl activities into a thin film.