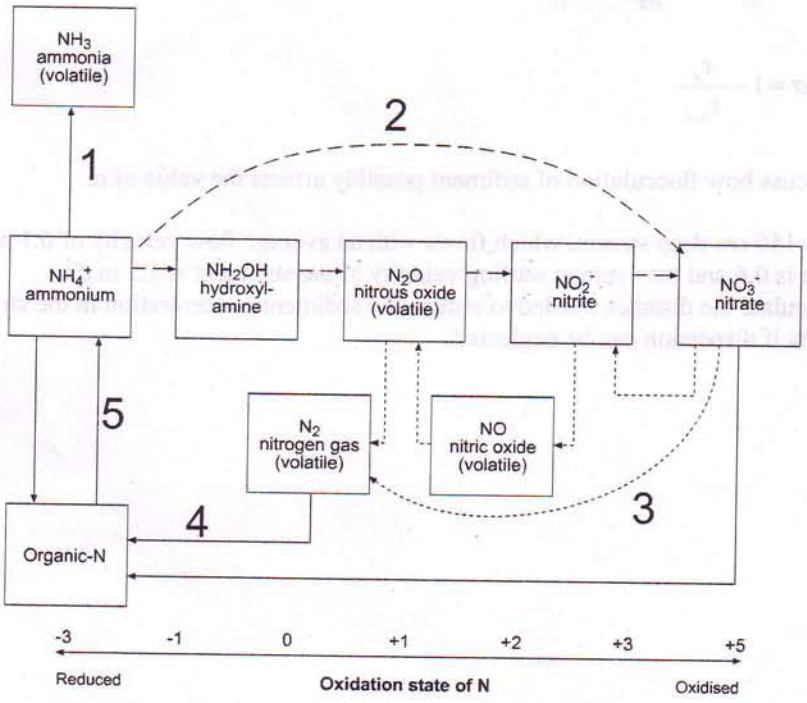
Midterm exam GEO3-4301 Soil and Water Pollution
10 January 2006 9:00 – 11:00 h

General remarks:
- This exam contains five questions.
- Please answer concisely.
- Answers in English or in Dutch are allowed.
- At the end of the examination hand in all your answer sheets.
- Write down your name or student number on all answer sheets.
- Note that after this exam, there will be an introduction to the second assignment, so please be back at 11.00 h.

1. Define the following environmental terms:
   a. 2:1 clay mineral
   b. Bioaccumulation
   c. Alpha radiation
   d. Phosphate fixation
   e. Base saturation
   f. Ligand
   g. Mechanical dispersion
   h. Peclet number
   i. LNAPL
   j. Retardation factor

(20 points)

2. The figure below depicts a schematic overview of the N cycle in ecosystems.



Name the processes 1 - 5 of the N cycle.

(10 points)

3. Discuss the speciation and fate of zinc in river water and river sediments downstream from a mine tailing.

(12 points)

4. A spill of 159 litres of a DNAPL spreads slowly in a shallow aquifer with a porosity of 28 %. The residual concentration of the DNAPL in the aquifer material is 12 %. Calculate the maximum aquifer volume that will be contaminated by the DNAPL.

(8 points)

5. Flocculation is an important process that controls the fate of sediment and sediment-associated pollutants in surface water systems.

   a. Discuss the role of the chemical composition of surface water for flocculation

   The Stokes' equation is used to calculate the settling velocity of sediment. The Stokes' equation reads:

$$w_s = \frac{1}{18} \frac{(\rho_s - \rho_w)\, g\, d^2}{\mu}$$

   b. Name two assumptions that are made for this Stokes' equation.
   c. What parameters in the above Stokes' equation are affected by the process of flocculation and what will be the effect on the settling velocity?

   The general one-dimensional equation for sediment transport and deposition is:

$$\frac{\partial C}{\partial t} = -\bar{u}_x \frac{\partial C}{\partial x} + D_x \frac{\partial^2 C}{\partial x^2} - \frac{\alpha\, w_s}{H} C$$

   Where $\alpha = 1 - \frac{\tau_b}{\tau_{b,d}}$

   d. Discuss how flocculation of sediment possibly affects the value of α.

   e. In a 150 cm deep stream, which flows with an average flow velocity of 0.1 m s^{-1}, the value of α is 0.6 and the average settling velocity of the sediment is 1.2 m d^{-1}.
   Calculate the distance needed to reduce the sediment concentration in the stream water by 30 % if dispersion can be neglected.

(30 points)