Copper contamination of lake sediments in the vicinity of Konin (Poland)

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Copper is an element essential to the life of many organisms. However, excessive concentrations of copper can be toxic. Due to the harmful effects of copper to aquatic organisms, its *PEC* level in sediments has been fixed at 149 mg kg-1.

Sediment samples were collected from the 5-cm thick surface layer of the profundal zone of 14 lakes located in the near Konin (central Poland). Determinations of the concentrations of Al, Ag, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Ni, P, Pb, S, Sr, Ti, V and Zn were determined by ICP-AES methods from solutions obtained after digestion in aqua regia. The Hg concentration determinations were made using TMA method and the organic carbon content (TOC) was determined by coulometric titration method.

The concentrations of the some trace elements varied over a wide ranges of content: for Cu - 9-674 mg/kg, Ba 57-409 mg/kg, Hg – 0.058-0.366 mg/kg, Ni - 5-25 mg/kg, Pb - 16-53 mg/kg, Sr - 53–758 mg/kg and Zn - 30-184 mg/kg. It has been found that the sediments of five lakes (Gosławskie, Licheńskie, Pątnowskie, Ślesińskie, and Wąsosko-Mikorzyńskie), whose waters are included in the power plant cooling system, are characterized by much higher contents of Cu, Ba, Hg, Mn, Sr and Zn, as compared to the other lakes. The average concentrations of Cu, Ni, Pb, Hg and Zn in the sediments of the latter lakes are comparable with the concentrations of these elements in sediments of lakes from other regions. The sediments of lakes included in the Konin-Pątnów power plant cooling system are conspicuous by a very high concentration of Cu (avg. - 415 mg/kg), which is 35-times higher than its average concentration in lake sediments (7 mg/kg). The average content of Ba in the sediments of these lakes is three times higher; of Ni, Hg and Zn – twice higher.

The studies of the Konin region lakes sediments have shown that they contain high Cu concentrations that may cause harmful effects on aquatic organisms. However, it is necessary to perform further tests to determine the copper content in fish tissues due to the fact that these lakes are used for recreational and angling purposes on a large scale.

A comparison of Pitzer databases for nuclear waste disposal modelling

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For the modelling of different chemical aspects of a nuclear waste repository in salt rock, the Pitzer formalism is necessary. Therefore, a comprehensive database with the relevant species reaction constants and associated ion-ion interaction parameters including temperature-dependencies is required. A number of different tailored Pitzer databases are available [1]. To judge their capabilities and limitations we performed comparative calculations for well-defined chemical systems (binary or ternary solubility diagrams). To avoid possible deviations due to different speciation codes all databases where transformed into the format specific for Geochemist's Workbench [2]. Additionally, model results are compared to experimental values from the literature.

Most results for the Oceanic Salt Systems (Na^+, K^+, Ca^{2+}, Mg^{2+} / Cl^-, SO_4^{2-} – H_2O) at 25 °C show a good agreement between experiment and model. At higher temperatures, sparse temperature-dependent data causes strong differences in the results.

For the radionuclides (e.g. Nd, Np), the solubility of their amorphous hydroxides in high salinar solutions was calculated as a function of pH. Missing anionic hydroxo-complex species or less reliable data produce inadequate predictions of the increasing solubility of mineral phases (e.g. fresh amorphous $Nd(OH)_3$ or NpO_2OH) in the strongly alkaline medium. This demonstrates the importance of complete chemical speciation data.

Caesium was chosen as example for a fission product. Only minor differences can be found in the calculated solubility diagrams and the occasional absence of solubility data for Cs phases is not significant for real-world scenarios due to the high solubility of these phases in comparison to other salts.

The revealed dsicrepancies illustrate the need for further database work. Joint benchmark activities could help to identify missing or weak data, enhance the quality of all databases and consequently increase the confidence in modelling results.

[1] http://www.thereda.de [2] Bethke, C.M. (2008), *"Geochemical and Biogeochemical Reaction Modeling"* 2nd Ed., Cambridge University Press, 123–134 (see also: http://www.gwb.com).

DOI:10.1180/minmag.2013.077.5.2
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