Modeling natural attenuation of petroleum contaminants in aquifers: conceptional model and simulations

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Introduction

Natural attenuation of petroleum contaminants is often observed through biologically mediated transformation reactions using different electron acceptors. This leads to changes in geochemical conditions and induces mineral precipitation/dissolution reactions in groundwater environment. Reactive transport modeling, thus requires a coupling of biodegradation, geochemical reactions and transport. We have applied the one-dimensional transport in PHREEQC with user-specified kinetic formulation of dual Monod kinetics.

Conceptional model

We have adopted the dual Monod kinetics to describe growth and metabolism of microorganisms as a function of substrate, electron acceptors and nutrients. The Monod expression is conservative and rely on a minimum number of model parameters. We assumed a diverse microbial population able to degrade under various TEAPs, and adopted the Monod parameters from Essaid et al. (1995).

Simulations

Simulations of several laboratory (batch and column) biodegradation experiments and one field case (Zheng, 2001; Hunkeler et al., 1998) have been performed. The initial biomass showed an expected scale dependency, while the Monod parameters were kept constant except for minor adjustments. For Hunkeler's experiments all the major C-t-x observations were well simulated in addition to quantification of corresponding mineral dissolution and precipitation reactions.

Conclusions

PHREEQC reactive flow simulations with dual Monod kinetics included, represent an attractive approach to evaluate the degradation potential for contaminated aquifers.

References

Essaid H.I., Bekins B.A., Godsy E.M. and Warren E. (1995) *Water Resour. Res.* **31.** 3309-3327
Hunkeler D, Jorger D., Haberli K., Hohener P. and Zeyer J. (1998) *J. Contam. Hydrol.* **32**. 41-61
Zheng Z. (2001) *Ph.D. thesis, University of Oslo*, 137p

A mixed proto-atmosphere during the runaway accretion

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The surface environment of the Earth during its formation is reconstructed in accordance with a recent planetary formation theory. The recent planetary formation theory suggests two stages of planetary formation; the stage of runaway growth (e.g., Kokubo and Ida, 1998) followed by the stage of giant impacts (e.g., Chambers and Wetherill, 1998).

A Mars-sized planet forms in 10^6 years at the stage of the runaway growth. Since the solar nebula likely exists at this stage, the proto-Earth should have a distended solar-composition (H_2–He) atmosphere (e.g., Hayashi et al, 1978) through gravitational attraction of the nebula gas. Also, impact degassing from Earth-forming planetesimals forms an atmosphere, which sometimes called as 'a steam atmosphere' (e.g., Abe and Matsui, 1986). Thus, a mixed proto-atmosphere composed of solar and degassed components would have formed. Though the structure of the mixed atmosphere embedded in the nebula gas is not well understood yet, it would be similar to that of the degassed atmosphere with an extended upper atmosphere. The proto-atmosphere would show a strong thermal blanketing effect, and a surface magma ocean is formed because of relatively frequent planetesimals impacts. Chemical interactions between the proto-atmosphere and the Earth's proto-mantle and core-materials proceed through the magma ocean. The formation of the mixed atmosphere and its chemical interaction during accretion has important effects on the budget of volatile components, in particular for the noble gas budget.

Though the solar nebula has likely been lost by the stage of giant impacts, the mixed proto-atmosphere would have survived the nebula dissipation, because the atmosphere is tightly bounded by the Earth's gravity field. This atmosphere should survive the stage of giant impacts with some modification (Genda and Abe, 2002).

References

Abe, Y. and T. Matsui, 1986. *J. Geophys. Res.*, **91**, **suppl.**, E291-E302.
Chambers, J. E., and G. W. Wetherill 1998. *Icarus* **136,** 304-327.
Hayashi, C., K. Nakazawa and H. Mizuno, 1979, *Earth Planet. Sci. Lett.*, **43**, 22-28.
Genda, h. and Y. Abe, in this volume.
Kokubo, E., and S. Ida 1998. *Icarus* **131,** 171-178.