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New Model of Enhanced In Situ Biodenitrification for Groundwater

The presence of nitrate in groundwater, due to intensive farming and agricultural activities which include high levels of fertilizer application and animal waste disposal, is a worldwide problem and could increase the incidence of some diseases. Enhanced *in situ* biodenitrification is a method for removing nitrates with microorganisms which use these compounds for their metabolism. This thesis proposes a new model that will facilitate the implementation of this method.

Author: iStockphoto/toktak_kondesign.

The presence of nitrate in groundwater is a worldwide problem. Intensive farming and agricultural activities that include high levels of fertilizer application and animal waste disposal are the major causes of such pollution in rural areas. Excessive nitrates and nitrites consumed with drinking water increase the risk of methemoglobinemia and stomach cancer. Consequently, a maximum drinking water nitrate concentration has been set up within the European Union of 50 mg/l. In Catalonia, 30% of the territory is polluted by nitrates, and approximately 12% of the groundwater is affected. High nitrate concentrations have decreased the availability of water for domestic uses, and many water supply wells have been abandoned as a consequence. Due to its minimal cost, the most common solution to nitrate pollution has been to mix polluted and clean groundwater. Nevertheless, this solution is highly limited by water scarcity in Mediterranean and/or (semi-)arid countries, and conditions are expected to worsen due to climate change. In this context, it is necessary to implement other solutions to improve groundwater quality.

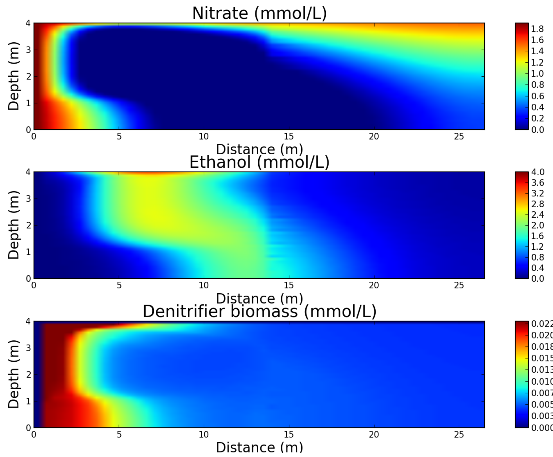

Figure 1: Enhance in situ biodenitrification model in an aquifer cross-section.

Enhanced *in situ* biodenitrification (EIB) is a feasible technology for remediation of nitrate-polluted groundwater. The EIB process creates optimized conditions via the addition of an organic carbon source and by controlling/monitoring other environmental parameters (e.g., oxidant concentrations, pH, micro-nutrients). Similar to all *in situ* technologies, EIB interacts with other hydrogeochemical processes in the aquifer. In this way, precipitation or dissolution of carbonates can be induced leading to porosity changes. Moreover, the inclusion of stable isotopes can improve monitoring of EIB. In this context, a reactive transport model that integrates all these processes offers a useful tool for planning, managing, monitoring, and optimizing this technology.

In this thesis, an integrated reactive transport model has therefore been developed that takes into account microbiology, geochemistry, and isotope geochemistry. Overall, the elaboration of this thesis has contributed to the knowledge of all processes involved in Enhanced *in situ* Biodenitrification and their quantification using numerical models. The developed model can allow improvement in the design, planning, monitoring and optimization of this technology at the field scale.

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References

“Modeling of enhanced in situ biodenitrification at diferent scales: Integration of microbiological, hydrogeochemical, and isotope biogeochemical processes”, Paula Rodríguez Escales doctoral thesi, supervised by doctor Albert Folch Sancho and read at the Institute of Environmental Sciences and Technologies (ICTA).

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