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Monitoring induced denitrification in an artificial aquifer recharge system.

Alba Grau-Martinez (1), Clara Torrentó (1), Albert Folch (2), Cristina Domènech (1), Neus Otero (1), and Albert Soler (1)

(1) Grup de Minerologia Aplicada i Medi Ambient, Barcelona Univeristy, Barcelona, Spain (albagrau@ub.edu), (2) Hydrogeology Group. Dept. of Geotechnical Engineering and Geo-Science, Universitat Politècnica de Catalunya-BarcelonaTech, Barcelona, Spain (folch.hydro@gmail.com)

As demands on groundwater increase, artificial recharge is becoming a common method for enhancing groundwater supply. The Llobregat River is a strategic water supply resource to the Barcelona metropolitan area (Catalonia, NE Spain). Aquifer overexploitation has leaded to both a decrease of groundwater level and seawater intrusion, with the consequent deterioration of water quality. In the middle section of the aquifer, in Sant Vicenç del Horts, decantation and infiltration ponds recharged by water from the Llobregat River (highly affected from wastewater treatment plant effluents), were installed in 2007, in the framework of the ENSAT Life+ project. At the bottom of the infiltration pond, a vegetal compost layer was installed to promote the growth of bacteria, to induce denitrification and to create favourable conditions for contaminant biodegradation. This layer consists on a mixture of compost, aquifer material, clay and iron oxide. Understanding the fate of contaminants, such as nitrate, during artificial aquifer recharge is required to evaluate the impact of artificial recharge in groundwater quality.

In order to distinguish the source of nitrate and to evaluate the capability of the organic reactive layer to induce denitrification, a multi-isotopic approach coupled with hydrogeochemical data was performed. Groundwater samples, as well as river samples, were sampled during artificial and natural recharge periods. The isotopic analysis included: δ15N and δ18O of dissolved nitrate, δ34S and δ18O of dissolved sulphate, δ13C of dissolved inorganic carbon, and δ2H and δ18O of water.

Dissolved nitrate isotopic composition (δ15NNO_3 from +9 to +21 ‰ and δ18ONO_3 from +3 to +16 ‰) demonstrated that heterotrophic denitrification induced by the reactive layer was taking place during the artificial recharge periods. An approximation to the extent of nitrate attenuation was calculated, showing a range between 95 and 99% or between 35 and 45%, by using the extreme literature εN values of -4‰ and -22‰ respectively (Aravena and Robertson, 1998; Pauwels et al., 2000). Ongoing denitrification batch experiments will allow us to determine the specific nitrogen and oxygen isotopic fractionation induced by the organic reactive layer, in order to estimate more precisely the extent of denitrification during artificial aquifer recharge.

These results confirmed that the reactive layer induces denitrification in the recharge ponds area, proving the usefulness of an isotopic approach to characterize water quality improvement occurring during artificial aquifer recharge.

References

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