Removal of nitrate and phosphate in groundwater using sequential passive treatment systems

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Discharge of groundwater constituents to surface water bodies consists of an important part of nutrient cycles. In this regard, reduction of nutrients in groundwater, such as nitrate and phosphate, may alleviate possible outbreaks of algal blooms in surface waters. This study assessed a possibility of sequential treatment of nitrate and phosphate in groundwater through laboratory column experiments. The experiments consisted of two separate periods: one period evaluating individual processes to treat each of nitrate and phosphate and another period assessing sequential treatment of nitrate and phosphate. The columns were composed of organic carbon materials (i.e., woodchips) and basic oxygen furnace (BOF) slag to treat nitrate and phosphate, respectively. Analyses of aqueous chemistry and dual isotopic composition of nitrate, bacterial sequencing, and geochemical modeling have been conducted to evaluate reaction mechanisms responsible for removal of nitrate and phosphate. The results suggest that nitrate is removed via bacterial denitrification and phosphate is removed by precipitation of a phosphate mineral (e.g., hydroxyapatite). Additional removal of phosphate was observed in the column targeted for nitrate removal during the period of sequential treatment, probably due to sorption of phosphate onto the organic carbon materials. This study shows that passive treatment systems, such as permeable reactive barriers (PRBs) [1], can be used to remove nitrate and phosphate in groundwater and thus can contribute to the reduction of nutrient load to surface waters. Alternatively, above ground reactors [2] may be used to treat contaminated waters in the first place before the nutrients enter to groundwater and/or surface waters.

[1] Robertson *et al.* (2008) *Ground Water Monit. R.* **28**, 65-72. [2] Hussain *et al.* (2015) *Environ. Eng. Sci.* **32**, 340-352.