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Simultaneous Removal of Nitrate and Phosphate in Groundwater Using Calcium-Citrate and Calcium-Lactate Complexes

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Nitrate and phosphate are important groundwater contaminants and they can enter to surface water by base flow, which may result in serious environmental problems such as eutrophication. Thus, it is necessary to remove nitrate and phosphate in groundwater before they reach to surface water. The purpose of this study was to develop a technique to simultaneously remove nitrate and phosphate in groundwater. In this study, calcium-citrate and calcium-lactate complexes were suggested as reactive materials to remove two contaminants, and batch experiments were conducted to evaluate the removal mechanisms. The solution of each set of the experiments were composed of citrate or lactate alone or calcium-citrate or calcium-lactate complexes. Each solution was reacted with the soil, collected from Deokjin pond in Jeonju-si, Korea, with the weight ratio of the soil and solution of 1:20. After the solution was reacted with the soil at 40 ˚C, the reacted solution was sampled every day for the period of 10 days. The experimental results showed that two complexes can remove nitrate and phosphate almost completely within the period of the batch experiments. The removal efficiencies of the two complexes were similar, indicating that both complexes can be used for the treatment. The results suggested that nitrate was removed by denitrification process by denitrifying bacteria which use organic matters as carbon sources, and phosphate was removed by precipitation of a phosphate mineral (e.g., hydroxyapatite). The results thus suggest that the binding of the complexes are broken during the denitrification process, and after which free calcium is combined with phosphate in groundwater forming a phosphate mineral. This study suggests that nitrate and phosphate in groundwater can be simultaneously removed using calcium-citrate and calcium-lactate complexes, and this can be a useful method for removing the two contaminants in groundwater. This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2016R1D1A1A02937479) and by the “R&D Project on Environmental Management of Geologic CO_2 Storage” from the KEITI (Project Number: 2018001810002).