Environmental isotope studies on the origin and transformation of nitrate and sulfate in alluvial groundwater

최병열 · 윤성택 · 권창훈 · 김경호

고려대학교 지구환경과학과 및 전기지원환경연구실(styun@korea.ac.kr)

The sources and transformation of nitrate and sulfate and their effects on groundwater quality were studied using environmental isotopes (δ^{15}N and δ^{18}O of nitrate, and δ^{34}S of sulfate) for groundwater samples from a largely two-layered alluvial aquifer. Each layer has the different groundwater recharge sources and redox condition with depth. The δ^{15}N_{nitrate} and δ^{18}O_{nitrate} values clearly show that the sources of nitrate in oxic groundwater at near surface are the mixture of ammonia or urea-containing fertilizer and manure. In addition, the decrease of nitrate concentrations with depth is caused by denitrification. The estimated enrichment factor for δ^{15}N_{nitrate} is -5.8‰. About 40-50% of nitrate is attenuated by denitrification. In oxic groundwater, δ^{34}S_{sulfate} values range from -14.4 to 2.4‰, which indicate that sulfate may be originated from pyrite oxidation, fertilizers and soil S. However, a simple mass calculation for sulfate indicates that pyrite oxidation by denitrificaton considerably generates sulfate in oxic groundwater, leading to a decrease in nitrate concentration. This illustrates that the recharge of nitrate-contaminated water may cause a secondary water quality problem such as increased sulfate and hydrogen ions. On the other hand, in sub-oxic groundwater the increased δ^{34}S_{sulfate} values (up to 64.1‰) evidently indicate that sulfate is removed by microbial-mediated sulfate reduction.