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Natural denitrification in the Kakamigahara groundwater basin, Gifu prefecture, central Japan

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Abstract

Although nitrate is recognized as the most common groundwater contaminant due to growing anthropogenic sources, such as agriculture in particular, its adverse effects on human and animal health are debatable. The current issue, however, is to control and reduce nitrate contamination with regards to the long residence time of groundwater within aquifers. Denitrification has recently been recognized for its ability to reduce high nitrate concentrations in groundwater. The Kakamigahara groundwater basin, Gifu prefecture, Japan, witnessed rising levels of nitrate (>12 mg/l NO^3–N) originating from agricultural sources. Chemical analyses for the determination of major constituents of groundwater and $\delta^{15}N$ of residual nitrate were performed on representative groundwater samples in order to fulfill two main objectives. One is to investigate the current situation of nitrate groundwater pollution. The second objective is to determine whether the denitrification is a potential natural mechanism, which eliminates nitrate pollution in the Kakamigahara aquifer. Agricultural nitrate contamination of groundwater was obvious from characteristically high concentrations of Ca^{2+}, Mg^{2+}, NO_3^- and SO_4^{2-}. High nitrate concentrations were found on the eastern side of the basin in association with vegetable cultivation fields, and decreased gradually towards the west of the basin along the direction of groundwater flow. The decrease of nitrate concentration was conveniently coupled with increase of HCO_3^- (the heterotrophic denitrification product), pH and $\delta^{15}N$ of residual nitrate (due to isotopic fractionation) from east to west. Therefore, denitrification in situ is continuously removing nitrate from the Kakamigahara groundwater system.

Keywords: Japan; Kakamigahara; Fertilizers; Groundwater contamination; Nitrate; Denitrification; $\delta^{15}N$

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