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Vertical interval dynamics of greenhouse gases in groundwater (Hesbaye chalk aquifer, Belgium)

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Increase in the concentration of greenhouse gases (GHGs) in the atmosphere threatens the existence of many ecosystems and their inhabitants. Agricultural activities contribute up to 70 % of total anthropogenic emission of nitrous oxide (N_2O), one of the GHGs, which is characterized with the highest global warming potential and contributes to stratospheric ozone depletion. Our study presents the results obtained from the recent field and lab activities carried out in order to obtain better insight into the factors that define the presence of N_2O in groundwater. Previous large scale investigations, performed in the Hesbaye chalk aquifer in Eastern Belgium, suggested that the concentration of N_2O in the aquifer depends on different, possibly overlapping biochemical processes such as nitrification, denitrification and/or nitrifier-denitrification. This study explored the occurrence of biochemical stratification in the same aquifer and its impact on N_2O production and consumption mechanisms. For this purpose low flow sampling technique was applied at different depth intervals to obtain better insight into the extent of oxic and anoxic zones and variability of concentrations of GHGs along the vertical profile. Collected groundwater samples were analyzed for the range of hydrochemical parameters as well as NO_3^-, N_2O, H_2O and B isotopes signatures and N_2O isotopomers. Afterwards, rates of nitrification and denitrification processes were estimated based on short-term incubations of collected groundwater amended with NO_3^- and NH_4^+ compounds labeled with heavy ^{15}N isotope. In addition, in order to characterize the dynamics of ongoing biogeochemical processes, polymerase chain reaction (PCR) tests for detection of the activity-specific enzymes in the aquifer were performed. Such studies help to clarify which conditions are more prone to the accumulation of high concentrations of GHGs in aquifers and better constrain models which estimate local and regional GHGs budgets.

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