Depth of the vadose zone controls aquifer biogeochemical conditions and extent of anthropogenic nitrogen removal through denitrification

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We investigated biogeochemical conditions and watershed features controlling the extent of denitrification within different portions of the surficial glacial aquifer located on the north and south shores of Long Island, NY, USA. The extent of denitrification differs within portions of the aquifer, with greatest denitrification observed at the south shore of Long Island where the vadose zone is thinnest, while limited denitrification occurred under the thick vadose zones on the north shore. In areas with a shallow water table and thin vadose zone, low oxygen concentrations and sufficient DOC concentrations are conducive to denitrification. Results support the hypothesis that in aquifers without a significant supply of sediment-bound reducing potential, vadose zone thickness exerts an important control of the extent of denitrification. Since quantification of excess N_2 relies on knowledge of equilibrium N_2 concentration at recharge, calculated based on temperature at recharge, we further identify several features, such as land use and cover, seasonality of recharge, and climate change that should be considered to refine estimation of recharge temperature, its deviation from mean annual air temperature, and resulting deviation from expected equilibrium gas concentrations.