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High-precision measurements of nitrogen gas tracers in an anthropogenically-impacted groundwater system

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Industrial wastewater facilities often aim to remove excess nitrate from waters before release through stimulating denitrification in a controlled environment. Many also release solid waste into settling ponds, creating diverse nitrogen environments near these facilities. The surrounding groundwater systems can have nitrate or ammonia concentrations much greater than those found in nature, depending on the composition of the source waters. It can be difficult to characterize nitrogen cycling occurring in these systems from nutrient sampling alone; measuring species from the reactant and product pools can give much deeper insight into the processes present. At the site of an industrial facility in central Texas, we measured high-precision ^{15}N-N_2, N_2/Ar, Kr/N_2, and N_2O concentrations/isotopes in 17 groundwater monitoring wells with varying degrees of anthropogenic impacts. Some wells had extremely elevated ^{15}N-N_2 and N_2/Ar, likely due to a combination of quantitative denitrification and degassing in the groundwater. The large range of ^{15}N-N_2 values measured in the wells indicates a complicated subterranean system with differences in the isotopic signal between relatively close wells. This heterogeneity is relatively unsurprising due to the unconfined alluvial aquifer setting of the study. These pilot study results highlight the potential for paired N_2 isotope and noble gas measurements to constrain the cycling and fate of nitrate in groundwater systems.