^{15}N Characterization of Landfill Nitrogen and its Application to Fingerprint Landfill-Leachate in Contaminated Groundwater and Surface water

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Abstract – A study was carried out to study the fate of ammonium in landfill-leachate contaminated groundwater and surface water. A characterization of the concentration and isotopic signature of ammonium in landfills was firstly done, and secondly a plume of contamination rich in ammonium was investigated to evaluate both the fate of the landfill ammonium concentration and its $^{15}NH_4$ signature along the groundwater flow system and along the course of a creek, both impacted by the landfill leachate. The study showed that the isotopic signature of the landfill ammonium was conserved along the groundwater flowpath despite attenuation of ammonium along the flowpath, and therefore it can be used as a tool for fingerprinting landfill leachate contamination.

Keywords – landfill, leachate, ammonium.

INTRODUCTION

Contamination of groundwaters and surface waters by ammonium can pose a serious threat and associated problems to animal and vegetal life (e.g. Hecnar, 1996). Landfills are common point sources of ammonium and concentrations of ammonium up to 3,500mg/L are commonly found (Wang et al., 2003). Then, there is potential strong

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ammonium source in landfills that can impact aquifers through downwards percolation of landfill leachate, with a potential impact in surface water. Where potential multi-sources of contamination, for example in agriculture settings, exist, detecting and tracing the source of contamination can prove very difficult. The main objective of the study was to evaluate the ^{15}N fingerprint of landfill ammonium and the processes that could modify this fingerprint along the groundwater flow system.

ISOTOPIC SIGNATURE OF LANDFILL LEACHATE

An isotopic characterization of landfill ammonium was carried out in several landfills. Results gave a range of $\delta^{15}N\text{-}NH_4$ values varying between –3‰ and +8‰ in leachate of several municipal landfills and one industrial landfill. The $\delta^{15}N\text{-}NH_4$ values for domestic landfills were more enriched than industrial fertilizers and overlap the lower limit for NH_4 of sewage and manure origin (Figure 1). This pattern allowed the potential application of $^{15}N\text{-}NH_4$ for fingerprinting sources of ammonium in a landscape where these potential sources of ammonium can co-exist.

USE OF $\delta^{15}N\text{-}NH_4$ TO FINGERPRINT LANDFILL LEACHATE CONTAMINATION

In the second part of the study, an ammonium plume was investigated to evaluate the fate of the landfill ammonium along the groundwater flow system and along the course of a creek, both impacted by the landfill leachate. A significant decrease in NH_4 concentration from about 58mg/L in groundwater located nearby the landfill to less than 1mg/L was observed along the groundwater flow system in the confined aquifer (Figure 2). No evidences of direct impact of the landfill leachate were observed in the unconfined aquifer in the areas near the landfill. This aquifer was impacted

downgradient of the landfill by groundwater discharge from the contaminated confined aquifer.

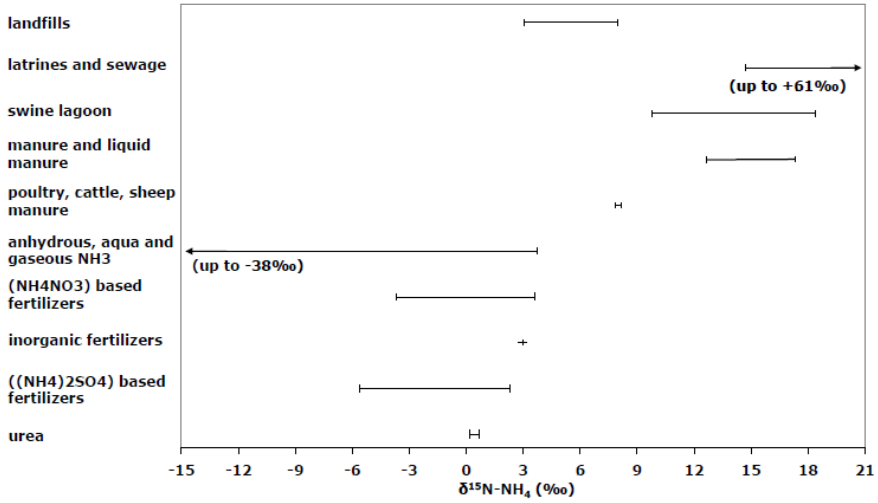

Figure 1: Range of $^{15}N\text{-}NH_4$ of different sources of NH_4 (Modified from Urrutia Bustos (2006)).

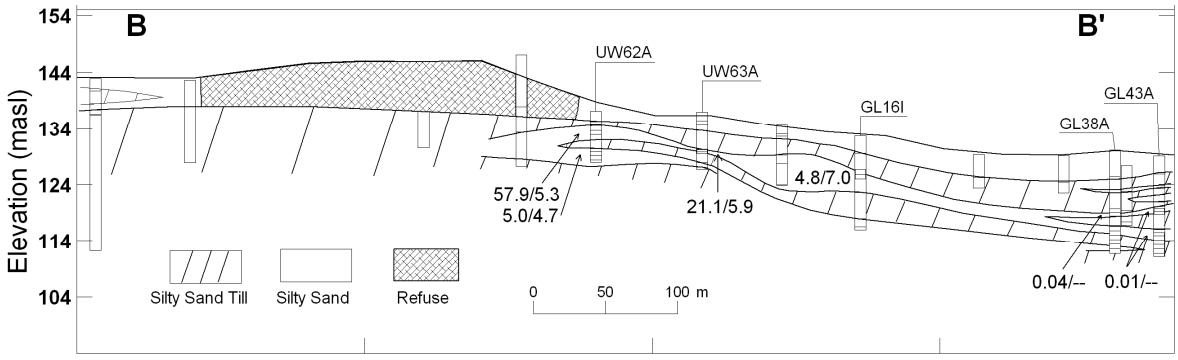

Figure 2: Distribution of NH_4 and $\delta^{15}N\text{-}NH_4$ along groundwater path ($NH_4\text{-}N$ / $\delta^{15}N\text{-}NH_4$).

This study showed that dilution, groundwater discharge into the creek and cation exchange are the main processes responsible for the attenuation of ammonium along the groundwater flow system.

The groundwater characterized by high NH_4 concentration near the landfill present ^{15}N-NH_4 values in the same range as the leachate and no significant changes were observed in the ^{15}N-NH_4 fingerprint in the groundwater characterized by low ammonium concentration in the plume downgradient of the landfill. The most significant changes in the ^{15}N fingerprint of landfill NH_4 were observed in surface water. The increase in nitrate concentration associated to decrease in NH_4 concentration and an enrichment observed in the ^{15}N-NH_4 content indicated that nitrification is partially responsible for the decrease of ammonium along the course of the creek.

CONCLUSIONS

This study showed that NH_4 in landfill leachate has a characteristic ^{15}N signature which can be used to fingerprint landfill leachate among sources of NH_4 contamination in groundwater and surface water in agriculture landscape.

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