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THE CARBON ISOTOPE COMPOSITION OF HERBICIDES IN GROUNDWATER: THE EXAMPLE OF GLYPHOSATE AND ITS DEGRADATION BYPRODUCT AMPA

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1. Introduction

Glyphosate is the principal active substance of a weed-killer used worldwide. Its use and migration towards groundwater is of real concern. Both glyphosate and the aminomethyl phosphonic acid (AMPA), one of its degradation product, are among the 10-most observed pesticides or metabolites in France (SOeS, 2009), usually leading to the classification of the corresponding groundwater as having a bad quality status (in regard to the Water Framework Directive).
Moreover, the glyphosate and AMPA can have multiple origins. Glyphosate is used as pesticide in agricultural or non-agricultural contexts, and can be synthesized by different manufacturers. AMPA is either a glyphosate metabolite or is formed by the abiotic degradation of certain phosphonates (present in particular in detergents; Jaworska *et al.*, 2002; Nowack, 2003).

Our project aims at showing that the carbon isotope composition ($\delta^{13}C$) of these two molecules could be of great help for identifying their respective sources, and to assess and characterize potential biodegradation processes that would link AMPA to either its parent pesticide glyphosate or phosphonate molecules.

2. Methodology-Results

The first step is to understand the carbon isotopes behavior and potential isotope fractionation during infiltration and degradation of glyphosate during its transfer in the unsaturated zone of aquifers. With that aim, we designed a lab experiment, in which degradation of glyphosate is tested and isotopically monitored (over a period of 100 days) in various types of soils (covering both biotic and abiotic degradation pathways).

After quantification of glyphosate and AMPA concentrations in the studied soils, corresponding $\delta^{13}C$ of both glyphosate and AMPA are measured by LC-CFIRMS.

In parallel samples of commercial herbicide formulations containing glyphosate (from various manufacturers), as well as sewage effluents (representing potential sources of phosphonates from which AMPA could be produced by degradation) are isotopically characterized.

We will discuss results from these two parallel approaches, and assess the possibility to use carbon isotopes as a tool to track sources and processes controlling the budget of Glyphosate and AMPA in groundwater.

3. References

Jaworska J., Van Genderen-Takken H., Hantstveit A., van de Plassche E., Feijtel T., 2002. Environmental risk assessment of phosphonates, used in domestic laundry and cleaning agents in the Netherlands. *Chemosphere*, **47**, 655-665.

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SOeS, 2010. Les pesticides dans les milieux aquatiques. Données 2007. Etudes et documents n°26. ISSN : 2102-4723, ISBN : 978-2-11-098770-9