

What does the multi-isotope approach bring to the knowledge of sources and processes affecting the NO₃ budget in groundwater ?

David Widory[1]

[1] BRGM

Nitrate is one of the major pollutants of drinking water resources worldwide. Recent European directives reduced inputs from intensive agriculture, but in most places NO₃ levels are approaching the potable limit of

50 mg.l⁻¹ in groundwater. Determining the source(s) of contamination in groundwater is an important first step for improving its quality by emission control. It is with this aim that we review here the benefit of using a multi-isotope approach (d15N, d18O, d11B), in addition to conventional hydrogeological analysis, to both constrain the watersheds hydrology and trace the origin of their NO₃ pollution. Watersheds presented here include both fractured bedrock and alluvial (subsurface and deep) hydrogeological contexts.

The characterisation of the different usual nitrate sources of pollution in groundwater (mineral fertilisers, wastewater and animals manure) shows that they can clearly be discriminated using isotopes.

Since the pioneer work of Thomas Hoering (1957), the isotopic composition of the dissolved nitrogen species has been used extensively to better constrain the sources and fate of nitrate in groundwater. The possibility of quantifying both origin and secondary processes affecting N concentrations by means of a single tracer appears more limited however. Nitrogen cannot be considered conservative because it is biologically modified through nitrification and denitrification reactions, both during infiltration of the water and in the groundwater body, causing isotopic fractionation that modifies the d15N signatures of the dissolved N species. Discriminating multiple NO₃ sources by their N isotopic composition alone becomes impossible whenever heterogenic or autogenic denitrification occurs, thus arising the need for establishing co-migrating discriminators of NO₃ sources: addition of d18O from NO₃ at first (e.g. Kohl et al., 1971) and of d11B recently (Widory et al., 2005).

The use of this multi-isotope approach, in most if not all of the studied contexts, clearly deciphers the origin of NO₃ in groundwater and allows a semi-quantification of the contributions of the respective pollution sources.