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Characterization of the nitrate source in a karstic spring (southwest of France): use of isotopic biogeochemistry

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Because of fast transit times and the absence of water filtration within the aquifers, karstic water resources are particularly vulnerable to contaminations in relation with surface activities. When contaminated, it is necessary to determine the contamination source in order to well manage the water quality for present time as well as for the future. The measurement of the isotopic composition of nitrate (δ^{15}N-NO_3^- and δ^{18}O-NO_3^-) is a powerful tool because it allows identifying the main water end-members usually involved in nitrate contamination (agriculture, animals, domestic water).

Our case study is the Marseillon spring, located in the southwest of France, on the top of an anticline of cretaceous limestones. It is the resurgence of a karstic aquifer considered as a strategic resource for the future. The spring water is tapped for drinking water production. If water quality is good in general; the nitrate concentrations have increased for the last decades and have recently reached 25 mg.L^{-1}. Moreover, the spring regularly shows fecal bacteria contamination and turbid events.

The spring catchment area is rural, the potential sources of NO_3^- are N-fertilizers used for the maize culture, livestock wastes and individual septic system effluent. Our study is based on different space and time scales (hourly to bimensal sampling on surface and subsurface water) using the specific isotopic composition of δ^{15}N- NO_3^- and δ^{18}O- NO_3^- of these different potential sources to characterized the NO_3^- contamination of the spring.

A specific sampling campaign has been conducted in February 2011 at five different depths of a 100 meters well settled in the cretaceous aquifer at 20 meters from the Marseillon spring. NO_3^- concentration gradually decreases with depth from 25 mg.$L^{-1}$to 19 mg.L^{-1}. The isotopic data composition of δ^{15}N-NO_3^- and δ^{18}O-NO_3^-, respectively around 9 ‰ and 3,8 ‰ suggest an organic source of nitrates such as animal and domestic wastes. Nitrates derived from urea are enriched in ^{15}N due to the ammonia volatilization occurring during the nitrification process whereas derived fertilizers nitrates carry N_2 atmosphere isotopic composition (δ^{15}N $\approx$ 0‰). Furthermore, additional sampling for microbiology analyses showed animal marker on the fecal microorganism contaminating the well water.

Up to now, available isotopic datasuggest that the nitrate source is organic and microbiology provides proof of an animal contamination of Marseillon spring water. Other samples for boron isotopes and chemical contents have been also realized and will help to decipher the best strategy for resource and catchment protection.