# Evaluation of nitrogen and oxygen isotopes as indicators of nitrate contamination sources in the Monforte- Alter do Chão Aquifer

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One of the main goals of environmental protection is to prevent deterioration of water quality through early recognition of contamination sources. The wide variety of sources of contamination makes the task difficult. The use of both inorganic N fertilizers and various animal waste fertilizers in regions where animal farming is a widespread practice complicates the assessment of various N fertilizer application types as nitrate contaminants.

Stable isotopes of nitrogen are good indicators of the origin or source of pollution. The composition of the natural environment in $\delta^{15}N$ varies between -20 and +30 ‰. The main natural source of nitrogen is the atmosphere, with $\delta^{15}N$ ranging from -10 to +8 ‰. Many plants also fix nitrogen and microorganisms incorporate it into the ground. Other sources of nitrogen to water resources including fertilizer, from -5 to 5 ‰ of $\delta^{15}N$, livestock $\delta^{15}N$ between +10 to +25 ‰ and septic wastes with $\delta^{15}N$ from +10 to + 20 ‰. The two most important sources of nitrate in rural areas, fertilizers and livestock, have distinct isotopic signatures in $\delta^{15}N$. However, the nitrate produced naturally in soil and from fertilizers has similar results in $\delta^{15}N$. According to Kendall and McDonnell (1998) [1] the joint analysis of isotopes $\delta^{18}O$ and $\delta^{15}N$ of nitrates dissolved in water is a valid process to identify the sources of nitrate pollution.

The use of nitrogen and oxygen stable isotopes from nitrates, to identify contaminant sources, was examined in waters from the Alter do Chão - Monforte aquifer system, where fertilization with mineral N and manure is a common practice. This aquifer system is affected by various sources of contamination, both in isolated spots and widespread.

The hydrochemical and isotopic study was carried out in two sampling campaigns, between Set/2010 and May/2011, to assess spatial and temporal variability of nitrate contents in the aquifer due fertilization and rainfall episodes. So 14 groundwater samples were collected from wells and springs for chemical and isotopic analysis ($\delta^{15}N$ and $\delta^{18}O$ - $NO_3$). A large range of nitrate concentration values was obtained with maximum values of 96 mg/L and 46 mg/L, in the first and second campaign, respectively, showing

strong rainfall influence in the contaminant dilution.

The results allowed identifying different nitrate sources: septic waste, manure, natural N soil and inorganic N fertilizers. There is good evidence to indicate that the $\delta^{15}N$ and $\delta^{18}O$ values of the nitrate contamination in groundwater may be very useful for identifying and distinguishing between different potential sources of the nitrate and delimit contaminant areas.

**References**

[1] Kendall, C., Caldwell, E.A. (1998). Fundamentals of Isotope Geochemistry. In Isotope Tracers in Catchment Hydrology , C. Kendall and J. J. McDonnell (Eds.) Elsevier Science B.V., Amsterdam. pp. 51-86.

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