

ISOTECH[®]

ISOTECH LABORATORIES INC



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Isotopic analysis of $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of Nitrates in Groundwater

Where does nitrate come from?

Nitrate, (NO_3^-) is highly soluble and non-volatile, migrating easily in groundwater. Nitrate in groundwater typically comes from:

- Naturally occurring nitrate in precipitation and soil horizons.
- Fertilizer in the form of potassium nitrate or ammonium nitrate.
- Municipal and industrial wastewater, septic tank effluent, feed lot discharges, animal wastes (including birds and fish).

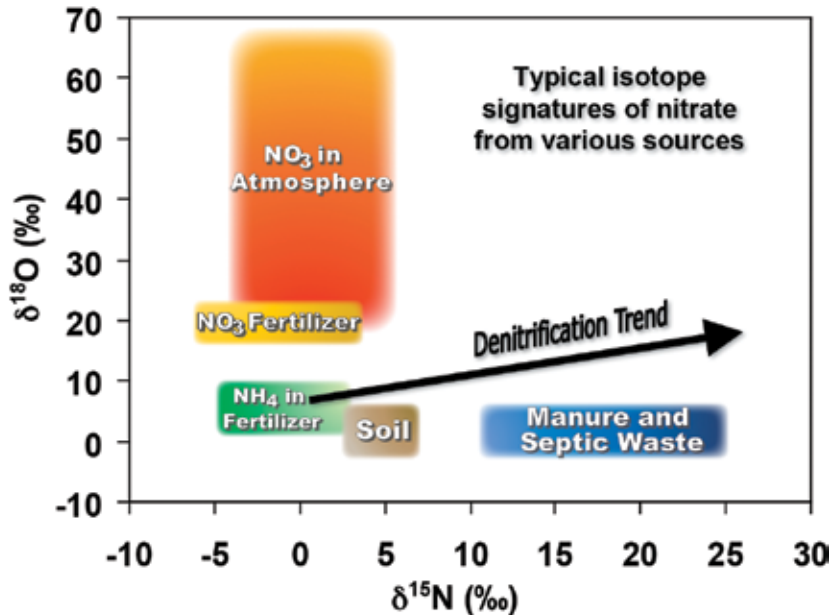
How does nitrate affect the environment?

- It poses a serious health risk, particularly to children, where high nitrate concentrations in drinking water interfere with the red blood cell's oxygen carrying capacity (Blue Baby Disease).
- High nitrate levels can cause eutrophication of rivers, lakes, and shallow sea waters, making the water uninhabitable for fish, animal, and plant life due to oxygen depletion.
- Saturation of nitrates can lead to acidification in surface waters.
- US EPA nitrate Maximum Contaminant Level (MCL) = 10ppm.



How can nitrate isotopes be used?

Nitrates from different sources carry distinctly different N and O isotopic compositions. Therefore, $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ can be used for source identification.



Determination of $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ allows *differentiating between various potential sources* of nitrate in groundwater. It can also be used as a key to understanding chemical processes that affect drinking water quality in aquifers. For example, de-nitrification, a reduction process commonly observed in groundwater, is considered an aquifer friendly process because of its ability to convert nitrate to harmless N₂ gas. This process also fractionates $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ of the remaining nitrate exponentially, thus creating a pair of isotopic signatures. Analysis of $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ for the remaining nitrate can provide information regarding the *extent and the rate of de-nitrification*, serving as a useful tool in aquifer management planning.

How does Isotech analyze nitrate?

Nitrate is extracted from groundwater samples and converted into AgNO₃ using ion exchange techniques. The purified AgNO₃ is then broken down into N₂ and CO for $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ determination. The equipment used by Isotech Laboratories, Inc. for this analysis is a ThermoQuest Thermal Conversion Elemental Analyzer (TCEA) connected to a state-of-the-art Delta V isotope ratio mass spectrometer. TCEA analysis has advantages over the widely used sealed quartz tube combustion technique by eliminating the risk of ¹⁸O exchange between quartz tubes and nitrate, a factor which could substantially alter the $\delta^{18}\text{O}$ value of the nitrate sample.

Turnaround time for analysis

¹⁵N/¹⁴N ($\delta^{15}\text{N}$) and ¹⁸O/¹⁶O ($\delta^{18}\text{O}$) analysis

Standard	15 business days
Priority	10 business days
RUSH*	5 business days

*Advance arrangements required for RUSH SERVICE

Sample size requirements: 500ml of water, 1000 ml preferred (minimum sample size is nitrate concentration dependent).



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