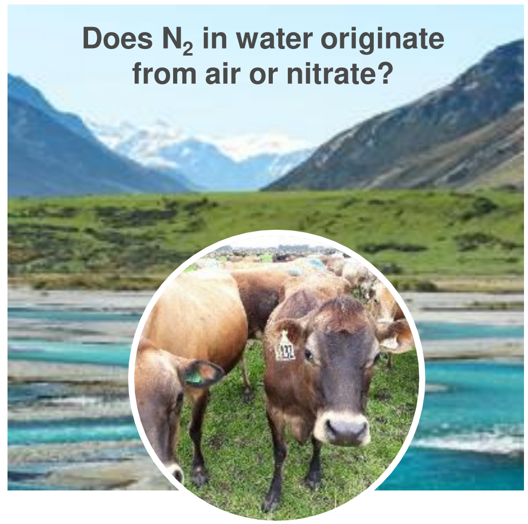
Quantifying Actual Denitrification in Groundwater Systems

Introduction

Nitrate is the most pervasive groundwater contaminant in New Zealand. More than 40% of groundwaters are above natural concentrations.

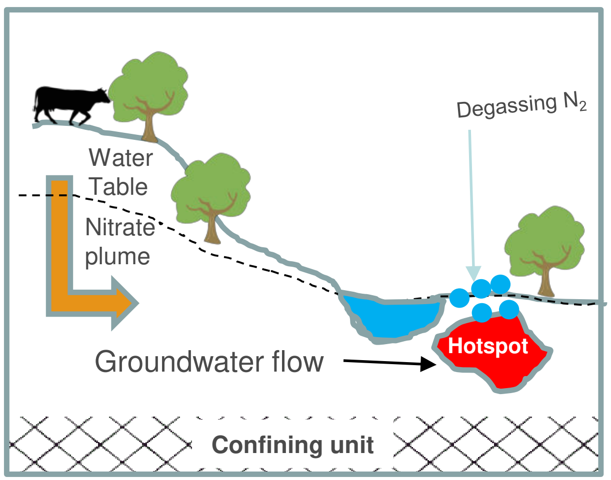
$$NO_3 \rightarrow NO_2 \rightarrow NO_{(g)} \rightarrow N_2O_{(g)} \rightarrow N_{2\,(g)}$$

Denitrification is the best natural process for nitrate remediation. Nitrates are converted to nitrogen gas through a series of oxygen reduction processes.

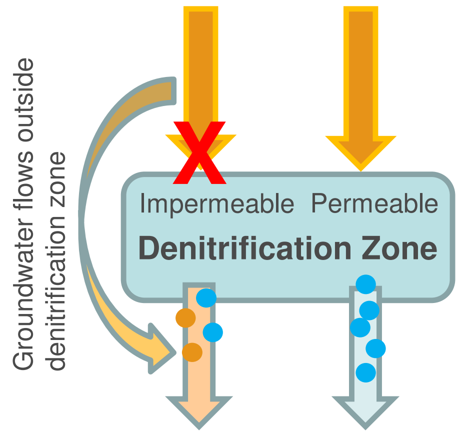


Why measure denitrification?

- High nitrates negatively affect human health
- We quantify the end product (excess N_2) from the denitrification reaction using neon, argon and nitrogen gas analyses.
- Combined with water age tracers, the rate of denitrification can be found.
- From the data we can map denitrification zones and rates of denitrification.
- Improves land management services by identifying denitrification zones for land use planning to improve water quality



We use isotopes to identify nitrate sources but the signal is lost with denitrification. Denitrification hotspots can't be detected using nitrate isotopes. Quantifying excess N_2 gas allows for more accurate determination of denitrification.



GNS Capability

Tracer	Advantages	Disadvantages
Nitrate Isotopes	Distinguishes nitrate contamination sources	Not useful for low level nitrates
Tritium	Dates groundwater and identifies flow pathways	Expensive, hard to define denitrification zones by itself
N_2, Ne, Ar Gas analysis	Identifies denitrification zones and N_2 reduction amount	Need to combine gas analysis with age tracers to obtain denitrification rates

Conclusion

Measurement of neon, argon and $N_{2(g)}$ identifies;

1. Excess $N_{2(g)}$ from denitrification of nitrates
2. In future, $N_{2(g)}$ can be determined using isotopes to analyse N origin (air or nitrates)
3. Combined tracer techniques are complimentary

GNS Science

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