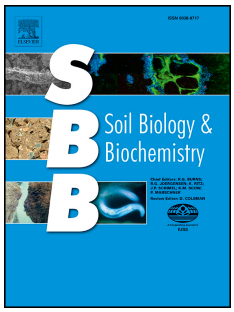
Accepted Manuscript



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PII: S0038-0717(18)30340-7

DOI: 10.1016/j.soilbio.2018.09.029

Reference: SBB 7296

To appear in: *Soil Biology and Biochemistry*

Received Date: 29 June 2018

Revised Date: 26 September 2018

Accepted Date: 27 September 2018

Please cite this article as: Yu, Z., Elliott, E.M., Probing soil nitrification and nitrate consumption using $\Delta^{17}O$ of soil nitrate, *Soil Biology and Biochemistry* (2018), doi: https://doi.org/10.1016/j.soilbio.2018.09.029.

Probing soil nitrification and nitrate consumption using $\Delta^{17}O$ of soil nitrate

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0. Abstract

Recent analytical and conceptual advances related to the nitrate (NO_3^-) ^{17}O anomaly ($\Delta^{17}O$) have opened the door to a new method that probes soil nitrification and NO_3^- consumption using $\Delta^{17}O$ of soil NO_3^-. Because biological NO_3^- production and consumption processes in soil obey the mass-dependent fractionation law, $\Delta^{17}O$ of soil NO_3^-, an index of excess ^{17}O over that expected from ^{18}O, can be used to trace gross nitrification and NO_3^- consumption in a way analogous to the $^{15}NO_3^-$ tracer typically employed in studies of soil NO_3^- cycling. Moreover, coupling $\Delta^{17}O$ with the dual NO_3^- isotopes ($\delta^{15}N$ and $\delta^{18}O$) at natural abundances offers additional valuable insights into mechanisms that underlie soil NO_3^- dynamics. In this study, we conducted both laboratory and field experiments to assess the use of $\Delta^{17}O$-NO_3^- for tracing soil nitrification and NO_3^- consumption. Soil samples spanning a wide range of physical and chemical properties were sampled from four sites for batch incubations and amendments with a $\Delta^{17}O$-enriched NO_3^- fertilizer. After amendments, the triple isotopes ($\delta^{15}N$, $\delta^{18}O$, and $\Delta^{17}O$) of soil NO_3^- were measured periodically and used in a developed $\Delta^{17}O$-based numerical model to simultaneously derive gross rates and isotope effects of soil nitrification and NO_3^- consumption. The measured $\Delta^{17}O$-NO_3^- was also used in the classical isotope dilution model to estimate gross NO_3^- turnover rates. *In situ* field soil sampling was conducted in a temperate upland meadow following snowmelt input of $\Delta^{17}O$-enriched atmospheric NO_3^- to assess the robustness of $\Delta^{17}O$-NO_3^- as a natural tracer. The results show that the temporal dynamics of $\Delta^{17}O$-NO_3^- can provide quantitative information on soil nitrification and NO_3^- consumption. In the laboratory incubations, a wide range of gross nitrification and NO_3^- consumption rates were estimated for the four soils using the $\Delta^{17}O$-based models. The estimated rates are well within