# $^{17}$O-rich nitrate as a tracer for constraining nitrogen transformations in coastal sediments

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Coastal sediments are often replete in organic matter and exhibit sharp gradient in redox conditions. In addition, the oxic-anoxic interfaces are often around a few centimeters if not less below the sediment surface. This make this environment poised to harbor both oxidative and reductive nitrogen transformations. As such, the use of a single or a couple of isotope-labeling tracers to determine the rates of these many processes might suffer from the systems being underconstrained. In this work, we demonstrate how naturally-occurring, $^{17}$O-rich nitrate can aid in the studying these complex systems through the ability to follow the transformations of added nitrate ($NO_3^-$) into other different pools of N-species and closely investigate the triple isotopic compositions ($\delta^{15}$N, $\delta^{18}$O, and $\Delta^{17}$O). While we followed five different pools of N-species namely $NO_3^-$, $NO_2^-$, $N_2O$, $NH_4^+$, and total reduced N ($NH_4^+$ plus DON), we chose to focus this work on the intermediate nitrite, $NO_2^-$. For all intact flow-through core incubations done on the sediments collected from Sylt Island, Germany, sediments acted as sources for $NO_2^-$ in all experimental manipulations including sediment type, dissolved oxygen level, and $NO_3^-$ loading. Unlike in the environments that are solely driven by reductive processes where the changes in $\delta^{15}$N and $\delta^{18}$O are coupled, the co-occurrence of both oxic and anoxic in the sediments such as ones from this study cause the $\delta^{15}$N and $\delta^{18}$O to decouple primarily because O is often subject to more processes than N. By using three isotope systems along with the change in concentrations, we demonstrate how we can use a natural abundance appraoch and rely on a series of mathematical equations to solve for different N transformation rates.

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