

## **Nitrous oxide production from reactive nitrification intermediates: a concerted action of biological and chemical processes**

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This contribution tries to open up a new perspective on biogeochemical  $N_2O$  production processes, taking the term bio–geo–chemistry literally. What if a major part of  $N_2O$  is produced from reactive intermediates of microbiological N turnover processes (“bio...”) leaking out of the involved microorganisms into the soil (“...geo...”) and then reacting chemically (“...chemistry”) with the surrounding matrix? There are at least two major reactive N intermediates that might play a significant role in these coupled biological–chemical reactions, i.e. hydroxylamine ( $NH_2OH$ ) and nitrite ( $NO_2^-$ ), both of which are produced during nitrification under oxic conditions, while  $NO_2^-$  is also produced during denitrification under anoxic conditions. Furthermore,  $NH_2OH$  is assumed to be also a potential intermediate of DNRA and/or anammox.

First, this contribution will summarize information about several chemical reactions involving  $NH_2OH$  and  $NO_2^-$  leading to the formation of  $N_2O$ . These abiotic reactions are: reactions of  $NO_2^-$  with reduced metal cations, nitrosation reactions of  $NO_2^-$  and soil organic matter (SOM), the reaction between  $NO_2^-$  and  $NH_2OH$ , and the oxidation of  $NH_2OH$  by oxidized metal ions. While these reactions can occur over a broad range of soil characteristics, they are ignored in most current N trace gas studies in favor of biological processes only. Disentangling microbiological from purely chemical  $N_2O$  production is further complicated by the fact that the chemically formed  $N_2O$  is either undiscernible from  $N_2O$  produced during nitrification, or shows an intermediate  $^{15}N$  site preference between that of  $N_2O$  from nitrification and denitrification, respectively. Results from experiments with live and sterilized soil samples, with artificial soil mixtures and with phenolic lignin decomposition model compounds will be presented that demonstrate the potential contribution of these abiotic processes to soil N trace gas emissions, given a substantial leakage rate of these reactive intermediates into the soil matrix. It will be shown that the magnitude of these chemically produced  $N_2O$  fluxes is not only governed by soil nitrogen availability and soil water content, but also by organic matter content and composition, pH, redox conditions and redox-active metal ion content.

The presented data reveal that the interplay between biological and chemical processes is relevant for soil  $N_2O$  emissions. The integration of these processes and their additional controlling variables in soil N trace gas emission models would very likely have a great potential for reducing the uncertainty in emission model results and for facilitating the design of appropriate, site-specific  $N_2O$  mitigation strategies.