Nitrite oxidation and nitrite-oxidisers in the OMZs: Significance and twists

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Nitrite oxidation is a key process in the marine nitrogen cycle, as it is the only source of nitrate in modern oxic ocean; with nitrate being by far the most abundant form (~88%) of bioavailable inorganic nitrogen. Despite the deficiency of oxygen in oxygen minimum zones (OMZs), activity of nitrite oxidation has now been detected across various OMZs, including the ETNP, ETSP and Namibian OMZs, as well as has been modeled in the Arabian Sea OMZ. Apart from its occurrence in the oxycline, nitrite oxidation also directly co-occurs with nitrogen-loss processes, anammox and denitrification, in the OMZ core at comparable or often much greater rates. Rates superseding nitrate reduction have also been observed, up to almost 1000 nM per day. Here we evaluate nitrite oxidation rates measured across different OMZs, and confirm the crucial role nitrite oxidation plays in the OMZ-nitrogen cycling – it generally recycles >50% of reduced nitrate, thereby retaining nitrate in the system and potentially curbing further N-loss.

Additional corroboration for nitrite oxidation in the OMZs comes from the parallel detection of nitrite-oxidizing bacteria (NOB), especially *Nitrospina* and *Nitrococcus*, via culture-independent methods. These two NOB genera appear to have distinct physiological adaptations to OMZ conditions: *Nitrospina* seems to have kept its microaerophilic trait from ancestry while maintaining a chemolithoautotrophic lifestyle. *Nitrococcus*, on the other hand, can live chemoorgano-heterotrophically under anoxic conditions: it switches to the use of dissolved organic matter as sources of electrons and carbon, whilst reducing nitrate to nitrite and nitrous oxide. Genomic and experimental evidence further show its ability to autotrophically oxidize sulfide, thus having a role in OMZ S-cycling as well. In fact, these *Nitrococcus* S-oxidation functional genes have quite a worldwide distribution according to environmental metagenome datasets.