Anaerobic ammonium oxidation in the oxygen-deficient waters off northern Chile

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ABSTRACT: We investigated the pathways of N_2 production in the oxygen-deficient water column of the eastern tropical South Pacific off Iquique, Chile, at 20° S, through short anoxic incubations with 15N-labelled nitrogen compounds. The location was characterized by steep chemical gradients, with oxygen decreasing to below detection at ~50-m depth, while nitrite reached 6 µmol L^{-1} and ammonium was less than 50 nmol L^{-1}. Ammonium was oxidized to N_2 with no lag phase during the incubations, and when only NH_4^+ was ^{15}N-labeled, ^{15}N appeared in the form of $^{14}N^{15}N$, whereas $^{15}N^{15}N$ was not detected. Likewise, nitrite was reduced to N_2 at rates similar to the rates of ammonium oxidation, and when only NO_2^- was ^{15}N-labeled, ^{15}N appeared mainly as $^{14}N^{15}N$, whereas $^{15}N^{15}N$ appeared in only one incubation. These observations indicate that ammonium was oxidized and nitrite was reduced through the anammox reaction, whereas denitrification was generally not detected and, therefore, was a minor sink for nitrite. Anammox rates were highest, up to 0.7 nmol N_2 L^{-1} h^{-1}, just below the oxycline, whereas rates were undetectable, <0.2 nmol N_2 L^{-1} h^{-1}, deeper in the oxygen-deficient zone. Instead of complete denitrification to N_2, oxidation of organic matter during the incubations may have been coupled to reduction of nitrate to nitrite. This process was evident from strong increases in nitrite concentrations toward the end of the incubations. The results point to anammox as an active process in the major open-ocean oxygen-deficient zones, which are generally recognized as important sites of denitrification. Still, denitrification remains the simplest explanation for most of the nitrogen deficiency in these zones.

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