Ammonia Oxidation by Bacteria Collected from a Karst-Bedrock Well

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Abstract

Elevated ammonia concentrations in groundwater pose health and environmental problems. In karst systems where water can enter directly through sinkholes or disappearing streams without any filtration, ammonia contamination can be exacerbated. The rate of ammonia oxidation by nitrifying bacteria in karst systems is not known. The objective of this study was to characterize the aerobic and anaerobic rate of NH_3 oxidation using bacteria indigenous to a karst aquifer in Middle Tennessee. Static batch reactors using indigenous karst bacteria collected from a spring established a first-order rate of NH_3-oxidation (k) = 0.0209 per day. Because this rate appeared to be slow, in a follow-up experiment, the effect of supplements and surface area were investigated. It was found that, in a flow-through karst system, a 500% increase in surface area to volume (SA/V) ratio increased the k value 54%. Addition of 1 g of lactate/L further increased the k value almost 10-fold. Because NH_3-oxidizing bacteria are autotrophs (CO_2 fixing), it is hypothesized the lactate stimulated the growth of symbiotic bacteria that significantly enhanced the activity of NH_3-oxidizing bacteria. Anaerobic NH_3 oxidation was also investigated using data collected in 2002 from an anaerobic karst site in northern Tennessee with high levels of NH_3. The tracer and ammonia data were entered into the RTDB model and yielded a calculated ammonia oxidation k of 0.0168/day. The observation of ammonia biotransformation at an anaerobic site is circumstantial evidence that the anaerobic ammonia oxidation pathway called anammox was active. Additional research, however, is needed to confirm if the anammox pathway was responsible for the observed anaerobic removal of NH_3.