Nitrification in a Young Ridge Flank Hydrothermal System

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Every day ~100 billion cubic meters of seawater are circulated through the permeable upper oceanic crust with fundamental consequences for the Earth system. Beside facilitaing massive heat loss and alteration of the oceans geochemical composition, the circulating fluids allow for a vast microbial community to exist. This crustal biosphere is likely to be the least explored ecosystem on Earth and fundamental ecological questions regarding its contribution to biogeochemical processes, cell recruitment, and community succession remain unanswered.

Here, we present a study on microbial nitrification in the sediment-buried basalts at a young ridge flank hydrothermal system. Through modeling we find that nitrification is not only thermodynamically favorable but also an ongoing process. We estimate that nitrification account for 6 - 7% of oxygen consumption in the crustal fluids, similar to what is observed in marine oxic sediments. Our modeling is supported by molecular evidence for the presence of ammonia oxidizers and we show that the ammonium oxidizing community is composed primarily of the archaeal group Nitrosopumilaceae. Further, our phylogenetic analysis reveals Nitrosopumilales assemblages in the deeply buried oceanic crust that are distinct from the above water masses, but similar to those in the basal part of the overlying sediment column, indicating either similar environmental selective pressure or the dispersal of microbes across the sediment-basement interface. This study identify ammonium oxidation as an potential important metabolism in the crustal biosphere with ecological implications on the biogeochemical cycling of nitrogen and microbial succession strategies in the crustal subsurface.