Anammox in terrestrial ecosystems: Distribution, diversity and activity

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Introduction

Denitrification and anammox, the anaerobic microbiological conversion of ammonium with nitrite (or nitrate) to N_2, are the only processes closing the global nitrogen cycle. Anammox is increasingly recognized as an important process in wastewater treatment and nitrogen cycling in marine ecosystems [1]. In oxygen minimum zones and surface sediments it may contribute to up to 60% of total N_2 production. Conversely, nothing is known to date about distribution, diversity, and activity of anammox bacteria in terrestrial realm. A variety of soil was tested for the presence of anammox bacteria using a nested PCR approach. The identity and diversity of anammox bacteria was assessed by cloning/sequencing of the 16S rRNA gene, and anoxic soil incubations with ^{15}N-labeled substrates were employed to detect anammox activity along soil profiles.

Results and Conclusions

Anammox bacteria were detected in wetland soils, lake-shores, a contaminated porous aquifer, permafrost soil, marsh sediment, agricultural soil, and in soil samples associated with nitrophilic plants. However, anammox bacteria were not present in all tested soil types or soil fractions, demonstrating their heterogeneous distribution and their specific ecological requirements. Candidate genera 'Brocadia', 'Kuenenia', 'Scalindua', 'Anammoxoglobus', 'Jettenia', and two unidentified clusters were detected, suggesting a higher genus level diversity than in marine environments where mostly 'Scalindua' is found. Low anammox activity was detected at different depths along selected soil profiles. The activity varied with depth and season but denitrification was always the dominant N_2-forming process.

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Geological and geochemical characteristics and exploration potential of the 'continuous' hydrocarbon accumulation in China

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According to whether traps have clear boundaries and hydrocarbon accumulation characteristics, China's hydrocarbon accumulation can be divided into 'non-continuous' type with clear trap and 'continuous' type without clear trap. The former, such as Daqing oil field, Kela-2 gas field, has characteristics of obvious trap, secondary migration, and buoyancy promoting the hydrocarbon accumulation. The latter, such as the Ordos Sulige tight sand gas, Shanxi Qinshui coal-bed methane, Ansai large oil filed and so on, has characteristics of no clear trap, mainly primary migration, and large-scale in-source or near-source distribution, and can not be exploited with conventional technology. The isotope fractionation effect of 'continuous' hydrocarbon accumulation is not obvious, showing in-source or near-source accumulation characteristics[1]. CH_4 accounted for 88 ~ 94% in Sulige tight sand gas, while $\delta^{13}C_1$ is -30‰~-37‰, $\delta^{13}C_2$ is -25‰~-23‰. Comparably, CH_4 of coal-bed methane in south Qinshui Basin accounted for more than 95%, $\delta^{13}C_1$ is -62 ‰ ~ -27 ‰, mainly of -40 ‰ ~ -30%,$\delta^{13}C_2$ is -25 ‰ ~ -12.5%. $\delta^{13}C_1$ values of Sichuan shale gas and southeast Hainan gaseous hydrocarbon hydrates in the South China Sea are mainly of -30 ‰ ~ -50 ‰ and -34 ‰ ~ -29 ‰ respectively, which are due to pyrolysis. In Fuyu reservoir of southern Songliao basin, the crude oil's $\delta^{13}C$ of 'continuous' reservoir in the basin center, slopes and uplift were very close to -30.3 ‰ ~ -31.6 ‰, showing the characteristics of unconspicuous carbon isotope fractionation effect and in-source or near-source hydrocarbon accumulation. In China, the 'continuous' oil and gas resourses are 53.5 billion tons and 3.68 thousand billion cubic meters, respectively. The gas hydrates resource in the Slope and Uplift is about 60-70 billion tons (oil equivalent) within a sea area of one million square kilometers of the South China Sea. And the exploration and development potential of 'continuous' gas in China is great.

[1] Dai (2004) *Organic Geochemistry*, **35**(4): 405-411.