学位論文の要旨

Abstract of Thesis

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学位論文題目 Title of Thesis（学位論文題目が英語の場合は和訳を付記）

Geochemical studies of inorganic nitrogen source for chemosynthesis-based animals
（化学合成依存動物の無機窒素栄養源に関する地球化学的研究）

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Hydrothermal activities and methane seeps can affect global elemental cycles in Earth surface system. Because emitting fluids in sediment-hosted hydrothermal areas and some methane seep areas contain milli molar level of ammonium, the ammonium may play an important role as inorganic nitrogen nutrient source for chemosynthesis-based animals inhabiting the areas. Therefore, purpose of this study is to confirm importance of ammonium as a nitrogen nutrient source for the animals harboring chemolithoautotrophic symbionts. To accomplish this purpose, I performed three types of experiments as follows:

Experiment 1: Incubation of vestimentiferan tube-worm, *Lamellibrachia satsuma*, in each experimental tank which were added ^{15}N-enriched nitrate and/or ammonium were performed. As a result, high δ^{15}N values of the tube-worms and drastic decrease of ammonium concentrations together with higher growth rate were observed in the tank which only ^{15}N-enriched ammonium was added, while the low growth rate of the tube-worms and slow decrease of nitrate concentrations was observed in the tank which only ^{15}N-enriched nitrate was added. Those results suggest that the ammonium was preferentially incorporated and assimilated by the tube-worms. Thus, the tube-worms actively incorporate the ammonium rather than nitrate when ammonium is available for the tube-worms.

Experiment 2: extremely organic rich and anoxic condition was prevailed below the whale carcass, then, where abundant ammonium was yielding during mineralization of the huge biomass. So, I examined the nitrogen isotope ratio of ammonium as well as whale biomass and pore water chemistry of the sediment below the carcass. In early diagenesis, increasing of ammonium concentrations and decreasing of sulfate concentrations in below the carcass

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were negatively correlate. Their relationship can be explained by a stoichiometry (atomic ratio of N to S = 0.3) of anaerobic decomposition of proteinaceous matter using sulfate. The $\delta^{15}N$ values of ammonium in pore water (+13‰). Therefore, there are insignificant isotope effect during organic matter mineralization in anoxic environment.

Experiment 3: In serpentinization-associated systems, abiotic generation of ammonium is expected because there are rich in hydrogen. So, I performed geochemical analyses of some geological and biological samples obtained from Shinkai Seep Field, a serpentinization-associated system. However, ammonium concentrations in the pore water beneath *Calyptogena* clam colony were very low. Therefore, abiotic ammonium generation is not plausible in this area, and the contribution of ammonium as nitrogen nutrient for the animals is limited.

In addition to those experiments, I compiled the published $\delta^{15}N$ values of representative animals with chemosynthetic and/or methanotrophic symbionts, such as *Calyptogena* clams, *Bathymodiolus* mussels, and vestimentiferan tube-worms, to the geochemical environments of their habitats, ammonium-rich and -limited environments. Wide variations of $\delta^{15}N$ values of the mussels suggest a variable source of nitrogen nutrient. However, the $\delta^{15}N$ values of mussels inhabiting close to hydrothermal vents or methane-rich fluid seeps are strongly affected by the emitting fluids, whereas the mussels in shallow water could mainly rely on DOM and POM from marine surface as a nitrogen nutrient source. On the other hand, the $\delta^{15}N$ values of the clams and the tubeworms inhabiting ammonium-rich areas can be explained by assimilation of the ammonium. These findings suggest that the ammonium in venting or seeping fluid in the ammonium-rich environments plays an important role as nitrogen nutrient source although each animal has different nitrogen acquisition strategies. This insight can be important component of understanding behavior and fate of ammonium in nitrogen cycle in deep-sea hydrothermal and methane seep communities.