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Microbial methanogenesis in coal seams and diatomaceous formations: Topics and application prospects

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1. Introduction

Microbial methanogenesis occurs in diverse subsurface environments. For example, biogenic methane has been detected from all representative ecosystems of the world and has been reviewed[1)]. However, the process of methanogenesis in those subsurface environments has yet to be revealed. Understanding the methanogenesis process is necessary for discerning the global-scale carbon-cycle and for a more effective utilization of biological methane as an energy resource from subsurface environments.

2. Methanogenic archaea from coal-beds and diatomaceous rock

Research topics on biogenic methanogenesis in the Ishikari (bituminous coal)[2)] and Tenpoku (brown coal) basin and the diatomaceous formations[3,4,5)] of northernmost Japan will be introduced in this presentation. We were successful in isolating and culturing methanogens from these habitats. In particular, the dominant methanogens isolated from diatomaceous shale formation[4,5)] will help in understanding some of the processes of methanogenesis in subsurface environments.

3. Biological methanogenic potential of coal-beds and diatomaceous rock formations as geobioreactors

The bottleneck of methanogenesis in subsurface environments is the production of suitable substrates for methanogens from persistent geomacromolecules. One of our approaches for eliminating the bottleneck is a geobioreactor for methanogenesis using hydrogen peroxide. Oxidation of low-rank coal using hydrogen peroxide produces a high yield of small-molecule substrates for methanogenic microorganisms (e.g., methanol, acetate, formate)[6)]. Substrate production from diatomaceous rock is considerably less than that from low-rank coal. However, the stratum thickness of diatomaceous rock (1 km or more) is much more than that of coal seams (several meters). Therefore, although the methanogenic potential of diatomaceous rock is low, by quantity, it constitutes an abundant resource. Furthermore, we have had success in microbial methanogenesis from small molecules produced from brown coal using hydrogen peroxide.

References)

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Keywords: Methane, Coal, diatomaceous rock, subsurface microorganisms, methanogenesis, Geo-bioreactor