【Grant-in-Aid for Scientific Research (S)】

Broad Section K

Title of Project : Methanogenesis from root organic matters in deep subsurface

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Keyword: deep subsurface, methanogenesis, syntrophic network, high pressure cultivation

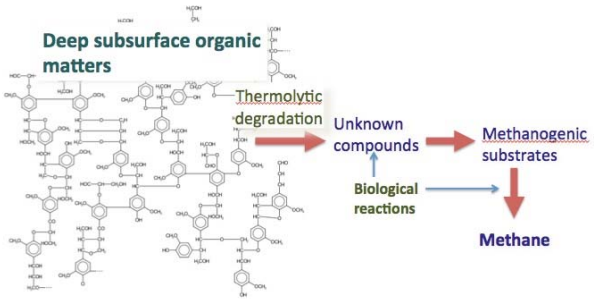
【Purpose and Background of the Research】

Methangenesis occurring in deep subsurface environments involve 1) thermolysis of highly polymeric organic matters present in rocks, coals and oils 2) fermentative degradation of those matters into acetate, methyl compounds, H_2/CO_2, 3) all of which are subsequently converted to methane by methanogenic archaea. However, depending upon *in situ* temperatures and other physico-chemical conditions, the boundary between abiotic and biotic reactions remains largely unknown, thus a whole picture of methanogenesis needs to be clarified to better understand how geochemical and biological process are tightly connected. Questions we raise are 1) what types of chemicals are supplied to microbial communities as a result of thermolytic reactions of organic matters buried in deep subsurface 2) what types of functional microbes including methanogens are associated with bioconversion of organic matters.

【Research Methods】

PI and his collaborators have strong background of geology, geochemistry, microbiology, and genome informatics. In this study, we employ the following approaches. 1) Coals and argillaceous rocks are incubated at high temperatures under high pressure conditions to determine the structures of organic matters released from those rocks by using GC-MS and/or LS-MS. 2) High throughput sequencing technique is applied to comprehensively determine the genomes of microbial communities of deep subsurface biosphere where methanogenesis occurs. RNAseq is also conducted. By combining these methods, we determine what types of fermentative organisms including syntrophs and methanogens are present *in situ* and what functional genes are being expressed under the conditions. Genomes of representative microbes are reconstructed. 3) We cultivate microbes in natural gas-, coal- and oil- associated waters by using a high pressure cultivation apparatus and see what microbes grow and what products are generated using GC-MS and/or LC-MS together with genomic analyses.

【Expected Research Achievements and Scientific Significance】



The hypothesis is that abiotic organic matters and their theymolytic degradation matters sustain the methanogenic biosphere in deep subsurface environments. The hypothesis is already well-known but there have been no direct evidences to support it. Metagenomic research has been focusing solely on community and functional genomics, but has never linked with geochemistry of organic matters buried in deep subsurface. There should be a boundary between abiotic geosphere and biosphere and that boundary may play an important role in transferring organic matters available for microbial community to biosphere. The research outcome would address what types of organic materials are really produced *in situ* and what organisms greatly contribute to methane formation.

【Publications Relevant to the Project】

・Mayumi, D. et al. Methane production from coal by a single methanogen. Science 354: 222-225 (2016).

【Term of Project】

FY2018-2022

【Budget Allocation】

148,800 Thousand Yen

【Homepage Address and Other Contact Information】

https://unit.aist.go.jp/georesenv/geomicrob/member.html
https://unit.aist.go.jp/bpri/bpri-dir/