

A CO₂ injection-experiment with subseafloor coal measures under in-situ pressure and temperature condition

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The release of one-carbon compounds (i.e., CO₂ and CH₄) into the atmosphere due to human activities has been recognized as a major factor causing dramatic climatic change on the Earth. In recent years, the increasing concentrations of greenhouse gases are expected to cause warmer surface temperatures at an accelerating rate and subsequent alternation of ecosystems and biogeochemical cycles. Consequently, a variety of CO₂ disposal options are discussed, including CO₂ Capture and Storage (CCS) followed by injection of CO₂ into deep subseafloor hydrocarbon reservoirs such as coal formations. However, geophysical and geochemical behaviors of high concentration of CO₂ within subseafloor environments, as well as ecological consequence and biogeochemical carbon cycle, remain largely unknown. In this study, we performed a CO₂ injection-experiment using subseafloor bituminous coal samples (Kushiro Coal Mine, Co. Ltd.) under high pressure and temperature condition.

The reaction experiment was performed using a newly developed flow-through geobio-reactor system at the Kochi Institute for Core Sample research, Japan Agency for Marine-Earth Science and Technology (JAMSTEC). The reaction column was prepared from the coal chips (from 1 to 3 cm in diameter) and powdered sandstone, which were packed in a heat-shrinkable tube under anaerobic condition. Anaerobic artificial seawater (ASW) and CO₂ were continuously supplemented into the column for 56 days under the following condition: flow rate of ASW; 0.002 ml/min, flow rate of CO₂; 0.00001 ml/min, pore pressure; 40 MPa, confined pressure; 41 MPa, temperature: 40 degrees C. After the reaction, XRD analysis showed no or very little changes on mineral assemblages of the sandstone, whereas minor carbonate generation was observed by SEM-EDS analysis. The sandstone contained ~10⁴ microbial cells/cm³ after experiments, which was similar to the biomass prior to the experiment. Molecular analysis of the extracted 16S rRNA genes revealed the predominance of spore-forming bacteria (e.g., *Lysinibacillus* and *Bacillus*) in the coal samples, which members were also found in the reaction column after the CO₂-injection experiment. During the reactor operation, we observed increase of dissolved CH₄ concentration up to 186 micro M, whereas total dissolved inorganic carbon in the medium passed through the column decreases compared to the injected amount (e.g., total dissolved inorganic carbon in the medium: 125.6 mM, the injected total dissolved inorganic carbon: 138.38 mM at 56 days). Based on the carbon isotopic composition of DIC, it is most likely that no or very little microbial methanogenesis occurred and the absorbed CH₄ was released from the coal samples during the CO₂-injection experiment.

Keywords: Bio-CCS, Coal, CO₂