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## Laboratory Study of Hydraulic Fracturing Behavior in Unconsolidated Sands for Methane Hydrate Production

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### Abstract

If a large surface area such as a hydraulic fracture could be formed artificially in methane hydrates bearing sediments, it should make great progress in achievement of three objectives which are to bring the pressure and temperature conditions around hydrate particles outside the hydrate-stability zone, to sustain the energy required for the endothermic reaction, and finally to provide a means to transfer the products of dissociation to production wells. Thus we carried out laboratory experiments to examine hydraulic fracturing behavior in sand and mud layers. To do this, we used silica sand mixing kaolinite flour as a particulate material to form matrix of specimens, where silica sand and kaolinite flour were mixed in a combination ratio of 10:1. We diffused water uniformly into the mixture as its water weight content to be 10 %. In the same way, we prepared separately wet kaolinite flour with water weight content of 10 % so as to form mud layers of specimens. We layered the wet mixture and the wet kaolinite flour to form a cubical specimen of 200 x 200 x 200 mm<sup>3</sup> with two isolated mud layers. Then we examined phenomena caused by injecting fluid inside of the specimen subjected to triaxial compressive stresses. The results show that the fluid injection induced a fracture-like structure at the interface between sand and mud layers and the fracture-like structure contributed to drive the invasion of fracturing fluid along the interface.

### Introduction

Methane hydrates (MH) is expected to be a huge source of energy. However, in order for commercial gas production from MH reservoir, new technology should be developed to overcome difficulties as follows; (i) MH is present in sediments which are located below seafloor at water depths of about one thousands meters so that it is not easy for us to access, and (ii) in the sediments of natural condition, MH takes a form of not gas nor liquid but ice-like solid so that conventional ways adopted for production of oil and gas cannot be applied directly.

Potential scheme for gas production from MH reservoirs is considered to achieve three objectives. Those are to bring the pressure and temperature conditions around hydrate particles outside the hydrate-stability zone, to sustain the energy required for the endothermic reaction, and finally to provide a means to transfer the products of dissociation to production wells. If a large surface area such as a fracture could be formed artificially in MH-bearing sediments, it should make great progress in achievement of those three objectives (Figure 1).

In petroleum engineering, a technique of hydraulic fracturing exists and it is applied to induce large fractures artificially in strata. The technique is now at so mature stage that it can be applied on various conditions, even if the targeted strata are located below seafloor. However, the technique of hydraulic fracturing has been originally developed assuming cohesive rocks but not incohesive ones such as unconsolidated sediments below seafloor, i.e. MH-bearing sediments. It is unclear whether fracture-like structure is formed or not by high fluid pressure applied to the sediments in hydraulic fracturing procedure.

Regarding this situation, we have started laboratory studies to examine phenomena occurring in incohesive rocks caused by high fluid pressure applied locally through drilled holes. We present here the procedure and results of the laboratory experiments in which we examine hydraulic fracturing behavior in layered formation.