R224-P025 **Room: Poster Session Hall** **Time: May 28**

Experimental study on mechanism of hydraulic fracturing in sand and mud layers

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In order to obtain data for understanding the occurrence of MH and estimating resource potential in Japan, a drilling campaign was conducted from January to May 2004, where 32 wells were drilled in the eastern Nankai Trough, offshore southeast Japan. By this exploration, it was found that, with concentration sufficient for commercial gas production, MH was born in pores of unconsolidated sand layers which were derived from turbidite deposits, and the sand layers were imbedded between mud layers. Such MH bearing sand layers are named 'MH concentrated zones (MHCZ)'.

There are three essential methods to bring the pressure and temperature conditions around hydrate particles outside the hydrate-stability zone, which are by depressurization of MH, heating of MH, and usage of MH inhibitors. It is important to provide stable gas passages in MHCZ in addition.

If a large surface area such as a fracture could be formed artificially in MHCZ, it should make great progress for the dissociated methane gas production, because a methane gas production rate from MHCZ depends absolutely upon the effectiveness of expansion of MH's dissociation surface area in MHCZ. 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. MHCZ. 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 conducted laboratory experiments to clarify the fracture initiation and propagation mechanism in sand and mud layers.

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. The permeability is about 25 md. 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. Then we layered the wet mixture and the wet kaolinite flour to form a cubical specimen of 200 x 200 x 200 mm^3 with two isolated mud layers as shown in Fig. 1. The specimen is set in the loading frame, and the compressive stresses, S_H, S_h and S_v produced by three hydraulic jacks(Fig. 1). A casing pipe has been set in the specimen at the stage of specimen preparation. The casing pipe has a slit of 0.5 mm in width and 40 mm in length. Azimuthal orientation of the slit was set to be aligned with the orientation of maximum horizontal stress, S_H. Fracturing fluid driven by a hydraulic pump flows into the casing pipe, and then it flows out inside the specimen passing through the slit of the casing pipe. The pressure is measured by an electric transducer.

We conducted laboratory experiments under loading conditions of S_H = 1.5 (MPa), S_h = 0.5 (MPa) and S_v = 1.5 (MPa). Machine oil with dynamic viscosity of 80 cSt (= 8x10^{-3} m^2 s^{-1}) was used as fracturing fluid. The oil was injected into the specimen by a constant flow rate of 10^{-4} m^3/min (= 100 cm^3/min). After the injection test, we excavated the specimen bit by bit and observed how the fracturing fluid invaded into the specimen. The result suggests that fracturing fluid firstly invaded along the interface between sand and mud layers, and it subsequently spread downward from the interface to the middle sand layer. Furthermore it seems that, by fluid injection, a fracture was induced and propagated at the interface between sand and mud layers, and it contributed to drive the invasion of fracturing fluid along the interface.

This research work was carried out as a part of the MH21 Research Consortium.

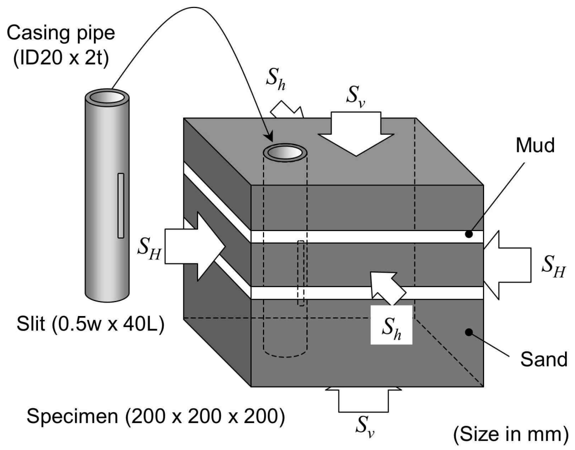

Fig. 1

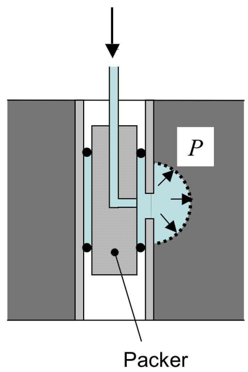

Fig. 2