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## Development and experiments of hole-bottom freezing drilling tool for gas-hydrate-bearing sediments sampling

Wang, Y.<sup>1,2</sup>, Sun, Y.H.<sup>1,2</sup>, Guo, W.<sup>1,2</sup>, Jia, R.<sup>1,2</sup>

<sup>1</sup>College of Construction Engineering, Jilin University, Changchun 130061, China, waruo229@yahoo.com.

<sup>2</sup>Key Lab of Drilling and Exploitation Technology in Complex Conditions, Ministry of Land and Resource, Changchun, 130061, China.

World-wide natural gas hydrate (NGH) is a kind of notably large potential energy resource. Its reserves was estimated at over  $15 \times 10^{12}$  tons of oil equivalent. In fact, when the utilization rate of this resource just reached 17%-20%, the world's energy requirements for 200 years would be satisfied [1]. NGHs are stable at low temperatures and high pressures and are usually located in permafrost regions, deepwater seas, and lake sediments [2,3].

The analysis of core samples is an essential component in the exploration-exploitation of natural gas hydrates (NGH). The condition precedent for investigations of NGH drilling core is a special sampling technique that prevents its volatilization in the sampling process. In this paper, we propose a hole-bottom freezing method for NGH sampling that uses the mixture of alcohol and dry ice as a cold source to decrease the temperature of the NGH drilling core. The low temperature reduces NGH's critical breakdown pressure and promotes the self-preservation of NGH. For example, gas hydrates were putted

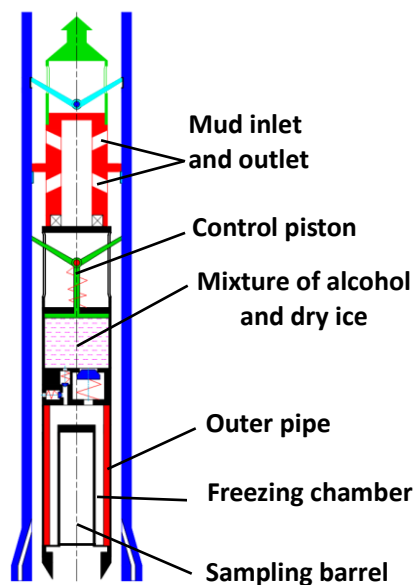


Figure 1: Schematic of the NGH hole-bottom freezing drilling tool

into the vessel that its temperature is  $-5^{\circ}\text{C}$ ,  $-10^{\circ}\text{C}$  and  $-18^{\circ}\text{C}$ , the gas hydrates almost didn't decompose in the time of ten days. When the temperature of vessel is  $-18^{\circ}\text{C}$ , the decompose amount is only 0.85%[4].

We introduce the hole-bottom freezing drilling tool that allow for the recovery of gas-hydrate-bearing sediments, A schematic of the NGH hole-bottom freezing drilling tool is shown in Figure. 1. The hole-bottom freezing technique utilizes a sampling barrel and an outer pipe. The mixture of alcohol and dry ice is injected into the annular space between the sampling barrel and the outer pipe to reduce the NGH core to subzero temperatures during the sampling process. Then, functional tests using several different experiments such as hole-bottom storage experiment of cold source, freezing experiment of simulative NGH-core and application of the drilling tool. Laboratory tests and the application show that the hole-bottom freezing method are feasible for NGH sediments sampling.

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