Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

MIS26-07 会場:202 時間:5 月 22 日 10:30-10:45

映像観察と音響解析によるメタンの海中上昇に伴う相変化に関する研究
The phase transformation of methane caused by pressure change during its rising from seepage

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Recent studies found that, in the Sea of Japan, methane hydrate exists in crystal form on the surface of the seabed or in the shallow layer of about 100m from the seabed. To study the methane hydrate that exists at depth in the sediment, the Bottom Simulating Reflector (BSR) can be used as an indicator. On the other hand, methane hydrate near the sediment surface (surface-type) is scattered in crystal form, and thus the BSR cannot be used as an indicator.

The surface-type methane hydrate often exists with methane plumes. The methane plumes are the visualized image of the acoustic differences of the physical properties among solid phase, gas phase, and liquid phase that emerge when the methane hydrate or bubbles gush from the seabed. By sending ultrasonic waves from the transducer of a fish detector or sonar in the water and measuring the echo of the scattered ultrasonic waves that come back after they hit the methane hydrate or bubbles, we can see the visualized image of the methane plumes on the screen of the fish detector or sonar.

When piston coring is conducted at the root of the methane plumes, the collection of surface-type methane samples can be carried out efficiently. Furthermore, it is possible to guide an unmanned submersible to the gushing point or sampling site of the methane hydrate based on the location of the methane plumes. Thus, the methane plume is a good indicator for exploring the surface-type methane hydrate.

Quantification of the methane plumes is extremely important for the global environment as part of the carbon cycle.The authors have already conducted the rising experiments of methane hydrate in the nearby ocean area using a fish detector and computed the rising speed. The authors also measured and analyzed the bubble echo of the rising methane hydrate and estimated the quantity of the rising methane hydrate per bubble unit in the area. At that time, the gas phase of the methane hydrate bubble was computed for gas and solid substance, separately.The results of the above study were provisional. Thus, we enhanced the precision for this study.

For this study, in order to quantify the methane plumes, we observed the image of methane plumes using a submersible vessel (hyper dolphin, property of Japan Agency of Marine-Earth Science and Technology (JAMSTEC)) as well as collected the methane bubble using a funnel.

The observation was carried out at Umitaka Kaikyaku in the Sea of Japan. In this area, the authors had been observing the methane plumes every year since 2004, and every year, the authors could observe the methane plumes in the same ocean area in a similar way. Thus, it was chosen as the observation site.

The experiment in the ocean revealed the followings. The methane hydrate particles that are gushing out from seabed are solid substances just above the seabed.In the studied ocean area, the volume of methane hydrate bubbles is gushing out every second per unit area.

キーワード: メタンプルーム, メタンハイドレート, 湧出量, 相
Keywords: methane plume, methane hydrate, volume of seepage, phase