Long-term temperature monitoring at the top of a mud volcano, Kumano Basin

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Mud volcano is a surface expression of mud diapir, unconsolidated sediment which has intruded into the overlying sediment column. There are many mud volcanoes in subduction zones over the world. Mud diapir is important in material transport in subduction zones. Mud volcano provides information on the process of material transport and physical and chemical conditions in a deeper part without a deep drilling.

Recently, seven mud volcanoes were found by side-scan sonar survey and deep-tow survey in the Kumano Basin east of Kii peninsula [Kuramoto et al., 1998; Ashi et al., 2003]. In the summit area of several mud volcanoes, chemosynthetic biological communities were discovered in the dives of Shinkai-6500 [Kuramoto et al., 2001].

Dai-yon Kumano Knoll is one of the mud volcanoes in the Kumano Basin. The diameter and height above the basin floor are 800 m and 100 m, respectively. The summit area has bumpy surface with pits whose diameter are several meters. There are living and dead clam colonies in the area. In order to survey thermal and hydrological characteristics of Dai-yon Kumano Knoll, we deployed a long-term temperature monitoring system (LTMS) at the top of the mud volcano by ROV Kaiko on August 9, 2002. This system is composed of a stainless frame, a titanium pressure case containing a data-logger and battery, and two probes (760 mm in length and 13.8 mm in diameter). Each probe contains six thermistors at intervals of 10 cm. One probe (Probe-2) was penetrated into sediment within a pit with a dead clam colony that suggests the existence of cold seepage in the past. The other (Probe-1) was installed in the outside of the pit where there was no expression of cold seepage. LTMS was recovered by ROV Kaiko on May 28, 2003.

Measured bottom-water temperature shows long-period variation with short-period variation. The predominant periods are 48.5 days, 9.4 days, 29.7 hours and 12.3 hours. Measured sub-bottom temperatures show similar variation to the bottom-water temperature variation but its amplitudes decay and the phases delay with increasing sub-bottom depth. For sub-bottom temperatures measured in the outside of the pit, we could explain that the effects of bottom-water temperature variation propagated into sediment by conduction only. By eliminating the effects from the sub-bottom temperatures by the method of Goto et al. [1999], we estimated heat flow value as 14 mW/m^2. On the other hand, sub-bottom temperatures measured within the pit could be better explained by a model with upward water flow at a rate of 10^-7 m/s order, than by conduction only. Heat flow combined conduction and this upward water flow was estimated as 60 mW/m^2, about four times the heat flow values in the outside of the pit. Our results indicate that there was cold seepage activity in the Dai-yon Kumano Knoll.

During the dive of ROV Kaiko on May 28, 2003, we conducted 11 heat flow measurements with two small heat flow probes 60 cm in length (SAHF). Using bottom-water temperature data measured with LTMS, we removed the effects of bottom-water temperature variation from temperature profiles measured with SAHF. The heat flow values are higher in the summit area and east slope than in the western slope.

In our presentation, we will report those results and will discuss thermal and hydrological characteristics of the Dai-yon Kumano Knoll.