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Heat flow anomaly and cold seep activity in the vicinity of the splay fault off the Kii Peninsula

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We have been conducting heat flow measurements in the area southeast of the Kii Peninsula (off Kumano) for investigation of the thermal structure of the Nankai subduction zone, especially the temperature distribution along the plate interface. The observed heat flow generally decreases landward reflecting the influence of subduction of the Philippine Sea plate, while highly scattered values, 50 to 100 mW/m^2, have been obtained on the accretionary prism slope about 15 to 25 km landward of the deformation front, where the megasplay fault system intersects the sea floor. Possible causes of the scatter are: influence of bottom water temperature variation (BTV), advective heat transfer by fluid flow along active faults, and deformation or movement of surficial sediments such as slumping. The latter two factors may be closely related to the activity of the splay faults.

To study the relation between the scattered heat flow and the splay faults, we conducted closely-spaced heat flow measurements and deployed long-term temperature monitoring systems on the prism slope off Kumano on KH-10-3 cruise of R/V Hakuho-maru in August 2010. We made 11 successful heat flow measurements with an ordinary deep-sea probe at two sites. One site (HF-1) is located in the vicinity of a prominent fault and close to the existing scattered data. The temperature profiles obtained at HF-1, where the water depth is 2600 to 2700 m, are apparently affected by BTV. It indicates that part of the scatter may be attributed to the influence of BTV. At the other site (HF-2), where the water depth is 3000 to 3300 m, no appreciable effect of BTV was found in the temperature profiles. HF-2 is also located around a branch of the splay fault system, along which cold seeps were discovered through submersible surveys. Heat flow measured along the fault is higher than values obtained at stations away from the fault, suggesting that heat flow is locally high along faults due to upward pore fluid flow, though a more intensive survey is necessary for examination of this tendency.

We deployed temperature monitoring instruments using NSS (Navigatable Sampling System) at two stations in the close vicinities of biological communities along branches of the splay fault system. The instruments have 2-m long probes with six or seven sensors and can record temperature profiles in surface sediments for one year or longer. One station is close to the heat flow measurement site HF-2. The other is at about the same location as the station where we conducted temperature profile monitoring with 60 to 70-cm long probes in 2001 to 2002 and in 2003 to 2004. Analysis of the temperature records obtained in the previous experiments shows that heat flow is very high (over 100 mW/m^2) and pore fluid flows upward in bacterial mats. Along the same fault, temperature profile monitoring with shorter (60-cm long) probes has also been conducted about 300 m away from this site since March 2010. Temperature records with these instruments, particularly with longer probes, will allow us to detect slower pore fluid flow and temporal variation of flow, which might be associated with very low frequency earthquakes.

Keywords: Nankai Trough, accretionary prism, splay fault, heat flow, cold seep, long-term monitoring