Heat flow anomalies observed on the seafloor in the vicinity of faults: indication of fluid flow

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Active fluid flow along faults may yield temperature or surface heat flow anomalies because advective heat transport by fluid flow is much more efficient than conductive transport. On land, it is rather difficult to observe such anomalies as temperature profile measurement in deep boreholes is required. On the other hand, we can conduct dense heat flow measurements on seafloor if surface sediment is soft enough to allow penetration of temperature probes. Heat flow and/or temperature anomalies in the vicinity of faults have been reported in some accretionary prisms, e.g., Cascadia and Barbados subduction zones. In this presentation, we show examples of heat flow anomalies associated with faults on the seafloor in the Nankai Trough area.

Accretionary prism developed landward of the Nankai Trough is extensively faulted in a compressional stress field due to subduction of the Philippine Sea plate. At the toe of the prism off Muroto, eastern Shikoku, closely-spaced heat flow measurements were made with a ROV and conspicuous high anomalies were found around the second frontal thrust, indicating that pore fluid flows upward along the fault (Kawada et al., 2014). Off the Kii peninsula, a large thrust fault system termed the megasplay cuts through the entire prism and its branches reach the seafloor. Yamano et al. (2014) conducted heat flow measurements with a surface ship across a branch of the megasplay and observed high heat flow values on the lower part of a fault scarp. Goto et al. (2008) made measurements with a submersible around biological communities along another branch of the megasplay and showed a sharp heat flow variation in a scale of several meters. These observations demonstrate that fluid flow along faults in various spatial scales can be detected by surface heat flow measurements.

The velocity or flux of vertical fluid flow may be estimated through long-term monitoring of temperature distribution in surface sediment. Temporal variation of the bottom water temperature propagates downward through sediment by thermal diffusion. Since this propagation process is affected by vertical fluid flow, analysis of long-term record of temperatures at multiple depths allows us to estimate fluid flow velocity (Goto et al., 2005). This method was applied to temperature records obtained in and around a biological community located a tip of the megasplay branch fault and the result indicates the existence of upward fluid flow (Kawada et al., 2013).

Keywords: heat flow anomaly, fluid flow, fault, heat transport, long-term monitoring

