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Heat flow distribution on the floor of the Nankai Trough: Relation to the temperature structure of the seismogenic zone

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The temperature structure of the subducting oceanic plate, generally determined by the seafloor age, is one of the most important factors controlling the subsurface thermal structure of subduction zone. In the Nankai subduction zone, the age of the subducting Philippine Sea plate (Shikoku Basin) significantly varies along the trough, indicating that the thermal structure of the plate interface and the overriding plate accordingly varies along the trough. Surface heat flow observed on the floor of the Nankai Trough is, however, not consistent with the age of the Shikoku Basin. Off eastern Shikoku (off Muroto), the mean heat flow is about 200 mW/m^2, twice as high as the value estimated from the age considering the effect of sedimentation, while it is nearly normal for the age in the area southeast of the Kii Peninsula (off Kumano), around 100 mW/m^2. It is important to investigate the cause of this contrast for estimation of the thermal structure of the subduction zone. We hence have been conducting heat flow measurements on the trough floor between the off-Muroto and off-Kumano areas to examine the transition from high to normal heat flow.

Our previous works showed that in the area west of 136^{o}E heat flow is scattered and the mean value is comparable to that in the off-Muroto area (Yamano et al., JpGU Meeting 2009). The boundary between the western high heat flow and the eastern normal heat flow was not clear because the data was still sparse. In 2011, we conducted heat flow measurements in the Nankai Trough area south of the Kii Peninsula on the cruises KT-11-15 (R/V Tansei-maru) and NT11-23 (R/V Natsushima) and obtained 23 new heat flow data. The results on the Nankai Trough floor revealed that the heat flow distribution shows a rather sharp and distinct change in the vicinity of 136.0^{o}E. In the area west of 136^{o}E, heat flow is highly variable, ranging from 120 to 250 mW/m^2. In contrast, in the area east of 136^{o}E, heat flow decreases eastward from 200 to 100 mW/m^2 in about 50 km with no appreciable scatter. The sharp change at 136^{o}E and high scatter in the western area strongly suggest that the observed heat flow distribution has a shallow origin, probably in the Shikoku Basin crust. 136^{o}E is close to the rupture segmentation boundary between the 1944 Tonankai and the 1946 Nankai earthquakes, across which seismicity on the landward side of the trough significantly changes. It indicates a relationship between the thermal structure of the subducting plate and the seismic activity.

Spinelli and Wang (2008) proposed a model for the high heat flow anomaly on the Nankai Trough floor off Muroto that vigorous hydrothermal circulation in a permeable layer in the subducting oceanic crust efficiently transfers heat upward along the plate interface. If we apply this model to the heat flow transition between the off-Muroto and off-Kumano areas, the permeability structure of the subducting crust, which controls the vigor of fluid circulation, should significantly change at around 136^{o}E. This change may correspond to the transform boundary between the youngest part of the Shikoku Basin formed by spreading in NE-SW direction and the older part formed by E-W spreading. Upward heat transfer by fluid circulation in the subducting crust cools down the plate interface (seismogenic zone of great subduction thrust earthquakes). Variation in the heat flow distribution on the trough floor might therefore reflect along-arc variation in temperature and physical/chemical properties of the seismogenic zone.

Keywords: Nankai Trough, heat flow, hydrothermal circulation, temperature structure, Shikoku Basin, seismogenic zone