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Numerical simulations of temperature field associated with subduction of two oceanic plates beneath Kanto district

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1. Introduction

The Philippine Sea plate is subducting beneath the North American plate in the NNW direction, and the Pacific plate is subducting below the Philippine Sea plate in the WNW direction beneath the Kanto district. In this region, it is considered that complicated temperature and flow fields associated with subduction of the two oceanic plates are formed. Since the contact zone between the Philippine Sea and the Pacific plates exists beneath the Kanto district, low temperature field is considered to be realized. In fact, observed heat flow data which represent the underground temperature field is low in the Kanto district, which is remarkable in the Japanese islands.

In this study, we performed numerical simulations of temperature distribution associated with subduction of the plates along profiles parallel to the convergence direction of the Pacific or the Philippine Sea plates. By comparing heat flow estimated from thus obtained temperature distribution with the observed one, we focused on what kinds of features are brought by subduction of the two plates.

2. Models and Methods

In this study, using a 2-D box-type thermal convection model developed by Torii and Yoshioka (2007), we constructed a model in which the Philippine Sea plate subducts from 15Ma into the model region where the Pacific plate has already been subducting. We gave subduction velocity, referring to Sella et al. (2002). For the Pacific plate, we changed the age of the subducting plate according to Sdrolias et al. (2006). In addition, based on Nakajima et al. (2007, 2009) and Hirose et al. (2008), we gave the shape of the upper surface of the two oceanic plates and fixed it in the model as indicator of guides for the two subducting plates. We set a profile passing through the Kujukuri-hama for the direction of the Pacific plate subduction. On the plate boundary between the Philippine Sea and the North American plates, the 1923 Kanto earthquake (M7.9) occurred. Moreover, aseismic slow slip events off the east coast of the Boso Peninsula have been reported (Ozawa et al., 2003). So, to estimate the temperature field at the plate boundary is important. Then, we took three profiles passing through the areas of east and west asperities of the 1923 Kanto earthquake and the region of the aseismic slow slip events in the convergence direction of the Philippine Sea plate. For these four profiles, we calculated the temperature fields and heat flow, and compared the latter with the observed heat flow in each of these profiles. We used heat flow data of bore holes & heat probe (Tanaka et al., 2004; Yamano, 2004), BSR (Ashi et al., 1999, 2002), and Hi-net on the wells (Matsumoto, 2007).

3. Results

In our model, when the Philippine Sea plate subducts, where hot material associated with subduction of the Pacific plate is flowing into a mantle wedge, temperature decreases there. Furthermore, since the Philippine Sea plate plays a role as an obstacle, flow with high temperature yields near the upper surface of the Pacific plate at the down dip of the contact zone of the two oceanic plates, and the temperature rises there. Heat flow gradually decreases over time in association with subduction of the Philippine Sea plate, which fits the spatial distribution of the observed heat flow data well. In this presentation, we will also discuss the difference between the temperature fields in the areas of the two asperities of the 1923 Kanto earthquake and aseismic slow slip events on the plate boundary.

Keywords: subduction, temperature distribution, flow field, heat flow, Kanto earthquake, aseismic slow slip event