Temperature distribution on the upper surface of the Philippine Sea plate in southwest Japan, deduced from 3D subduction model

Koji Murakami[1]; Shoichi Yoshioka[2]

[1] Earth and Planetary Sci., Kyushu Univ; [2] Dept. of Earth and Planetary Sci., Kyushu Univ.

The Nankai trough is a convergent plate boundary where the oceanic Philippine Sea plate is subducting beneath the continental Amuria plate, which forms southwest Japan. Large megathrust earthquakes have occurred repeatedly along the Nankai trough with a recurrence time of about 90 to 150 years (e.g., Ando, 1975; Kanamori, 1981).

In the Nankai trough, Hyndman et al.(1995) estimated temperature distribution on the upper surface of the subducting Philippine Sea plate, and regarded the region whose temperature ranges from 100-150 degree C to 350-450 degree C as a seismogenic zone. The temperature distribution is based on preferred model, which was calculated by Wang et al.(1995). However, almost 9 years have passed since these papers were published, and many data have been accumulated and new findings have been obtained by following vigorous researches since then. To put it concretely, detailed configuration of the upper surface of the subducting Philippine Sea plate has been revealed by rigorous seismic explorations and compilation of hypocentral data which used to belong to different research organizations. The continental plate is not the Eurasia plate, but is newly proposed to be the Amuria plate from analysis of GPS data (e.g., Miyazaki and Heki, 2001), indicating that temperature boundary condition in the oceanic side should be modified accordingly. In addition, the number of BSR data off Shikoku increased. Hyndman et al.(1995) discussed the seismogenic zone of megathrust earthquakes based on temperature distribution on the upper surface of the subducting Philippine Sea plate, by interpolating two investigated sections passing through Shikoku and Kii Peninsula. In addition, since Hyndman et al.(1995) did not consider the effect of the flow in the mantle wedge in estimating temperature distribution of the subducting plate, the estimated heat flow value monotonously decreases with increasing distance from the trough axis, and can not necessarily explain the data of inland region. In addition, since preferred model only considers the subduction of a fossil ridge (former ridge center whose spreading has ceased) perpendicular to the trough axis, the age of plate increases simply at the elapsed time of the calculation. However, considering the direction of the subduction of the Philippine Sea plate, it is necessary to construct a model, taking account of the distance from the fossil ridge and oblique subduction of the Philippine Sea plate.

In this study, we realized 3D parallelepiped numerical simulation of temperature and flow, by improving stag3d(Tackley, 1993), taking account of flow in the mantle wedge induced by the subducting plate and the subduction of the fossil ridge. We attempted to estimate temperature of the upper surface of the Philippine Sea plate which is subducting along the Nankai trough off Shikoku and the seismogenic zone, by solving equations of that mass conservation, momentum conservation, and energy conservation with unelastic approximation, by using finite difference method and finite volume method.

The seismogenic zone estimated from this study is consistent with coseismic slip region(Satake,1993) associated with the 1944 Tonankai and the 1946 Nankai earthquakes. Comparing our result with that of Hyndman et al.(1995), influence of distance from the fossil ridge on the temperature and heat flow distributions appears clearly. The seismogenic zone tends to be determined by the Moho depth in the western part of Shikoku and Tokai district, while by temperature distribution in the eastern part of Shikoku and Kii Peninsula.

Acknowledgement

We thank J.Ashi and A.Tanaka for providing heat flow data, and T.Nakagawa for his kind advice through calculation.