Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SIT04-03 Room:414 Time:April 28 09:40-10:05

Thermal modeling associated with subduction of the Philippine Sea plate in southwest Japan

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By constructing a parallelepiped three-dimensional thermal convection model, we investigated temperature, mantle flow and heat flow distributions associated with subduction of the Philippine Sea (PHS) plate in southwest Japan. We proposed new, realistic, and high-resolution temperature field on the plate interface, and attempted to clarify its relationships with the occurrences of megathrust earthquakes, long-term slow slip events (SSE), and low frequency tremors (LFEs). For this purpose, we newly developed a numerical model to deal with subduction of an oceanic plate with 3D arbitrary geometry. We modeled subduction of the PHS plate by using the up-to-date three-dimensional slab geometry, referring to high resolution P-wave seismic tomography and seismic reflection studies. We also used large number of heat flow data such as BSRs, borehole, heat probe, and Hi-net to constrain calculated temperature field, and took account of complicated subduction history in southwest Japan. The results showed that the interplate temperature was lower by approximately 100^{o}C in western Shikoku where a larger true subduction angle exists than eastern Shikoku. Temperature change due to erosion and sedimentation affected surface heat flow with short wavelength. We also found that the obtained interplate temperature in the Nankai seismogenic zone was wider than that in the Tonankai seismogenic zone. The LFEs occurred near the plate interface with temperatures ranging from 350^{o}C to 450^{o}C at depths of 30 to 40 km. The existence of large temperature gradients from the surface to the inside of the PHS plate was considered to be related to the occurrence of long-term slow slip events beneath the Bungo Channel.