2-D thermal modeling along a non-volcanic region in southern Kyushu, Japan

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There is a non-volcanic region sandwiched between the Aso and Kirishima volcanic zones in southern Kyushu, Japan. Several characteristic seismic events were identified around there; Postseismic slip was found associated with the two Hyuga-nada earthquakes (M6.6), which were interplate earthquakes that occurred on October 19 and December 3, 1996. Tectonic tremors were observed around the mantle wedge corner beneath the Pacific coast of Miyazaki prefecture. To investigate the cause of these events, we performed 2-D box-type time-dependent thermal modeling in southern Kyushu, and estimated spatial distribution of water content within the oceanic crust, using a phase diagram of MORB. We set a profile to pass through the regions in the plate convergence direction where tectonic tremors and postseismic slips were identified. To constrain calculated temperature structure, we used surface heat flow data. In our model, we considered the subduction history of the Philippine Sea plate, and changed age of an ocean floor and subduction velocity along the profile at each time step. At approximately 4.5 Ma, the profile passed through the Kyushu-Palau ridge where the age of the ocean floor changed discontinuously at the ridge axis. This discontinuity affected calculated thermal structure remarkably. To explain the low observed heat flow above the mantle wedge corner, we introduced a low viscosity layer at the plate boundary. We changed viscosity, thickness, and a down-dip depth of the layer as free parameters, and performed a grid search to fit the calculated heat flows to the observed ones. It became difficult for mantle flow to intrude into the mantle wedge corner, by incorporating the low viscosity layer, and surface heat flow above there became lower than that without it. Among the three parameters, we found that the thickness of the layer affected thermal structure in the mantle wedge most remarkably. On the other hand, viscosity within the layer least affected it. As a result, the temperature range of the upper surface of the subducting PHS plate where postseismic slip associated with the Hyuga-nada earthquake of December 3, 1996 became approximately 300˚C. Interplate temperature where tectonic tremors occurred in Miyazaki prefecture ranges from 400 to 500˚C. We also estimated the dehydration process along the profile and used the phase diagram of hydrous MORB in the oceanic crust. As a result, blueshist transformed into lawsonite blueshist in the postseismic slip region, and lawsonite blueshist transformed into lawsonite eclogite in the active region of tectonic tremors.

