Reexamination for the subsurface structure beneath the southern part of the Hidaka Collision Zone, Hokkaido, Japan by using a numerical test of wave propagation

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Hidaka Collision Zone (HCZ) is located in the central and southern part of Hokkaido where the Kuril forearc dragged by oblique subduction of the Pacific plate collided with the northeastern Japan arc. The Kuril arc’ s middle crust and its shallower part have been thrusted up along the Hidaka Main Thrust (HMT) and are exposed to the surface. Various seismic reflection surveys have been conducted for the purpose of investigating the subsurface structure of this region.
At the southernmost part of the HCZ, researchers of Hokkaido university, university of Tokyo and Chiba university conducted three seismic reflection surveys whose lines were settled across the HCZ in 1994, 1996, and 1997, respectively. From obtained time section, Tsumura et al. (1999) showed that the lower crust of the Kuril arc is divided into a northeast-dipping ascending layer and a southwest-dipping descending layer at a depth of 23km and interpreted it as delamination structure. Seismic profiles which were obtained by integrating three survey lines [Ito et al.,2000] and by applying new analysis technique of CRS / MDRS method [Ito et al.,2013] also supported the delamination structure.
Meanwhile, Kita et al. (2012) estimated the three-dimensional P wave velocity structure in the same region by travel time tomography. They suggested that a shallower part than 23km indicates the similar structure to that of Ito et al. (2000), but at deeper than 23 km, crustal material of the northeastern Japan arc reaches the plate boundary of the Pacific plate.
If delamination has occurred beneath the HCZ, it is expected that the length of southwest-dipping descending layer corresponds to the one of ascending layer having northeast inclination. Although two parallel reflectors can be recognized at the depth from 23 km to 38 km, deeper extension more than 38km cannot be found in the depth cross section of Ito et al. (2013). Then, in this study, we conducted a numerical test to know what kind of reflected waves can be observed when shots are performed with the same specification of actual surveys using analysis software Madagascar.
For the numerical test, we prepared two kind of subsurface structure models: One is a “Delami” model in which delamination occurs and lower part of the lower crust are descending into the depths deeper than 38km; and the other one is a “Non-Delami” model based on the interpretation of Kita et al. (2012). Both of the models consist of upper crust, lower crust, mantle and oceanic plate, and the average density of each material was set as density. Velocity of each layer was given referring to the result of Kita et al. (2012).
For the “Delami” model, only the reflected waves from the tip of wedge like structure of the subducting layer reached within the survey lines, whereas reflected waves from the deeper part reached the southwestern outside of the survey line. For the “Non-Delami” model, no reflected waves were seen around the arrival times which correspond to those of reflected waves from the depths at 23 km to 38 km.

Keywords: Collision zone, Hidaka, Subsurface structure, Reflection survey

