Waveform modeling for high velocity anomaly in the uppermost lower mantle in the Sunda subduction zone

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Recent tomographic models show variable behaviors of subducted slabs around the mantle transition zone, i.e., a large-scale subhorizontal high velocity anomaly (HVA) at the bottom of the upper mantle in the northwestern Pacific subduction zones while such a HVA zone penetrates the 660 km discontinuity into lower mantle in the Sunda subduction zone. We focus on the seismic structure associated with the descending slab in the Sunda subduction zone.

We tested two recent tomographic models by Fukao et al. (2001) and Zhao (2001). Both models show no clear HVA images around the 660 km discontinuity and appear to have a wide HVA in the uppermost lower mantle. However, when 3-D images at +1% velocity perturbation are made from these tomographic models, the volume of HVA is different between the models and the distribution of HVA is not continuous.

We examined broadband body wareforms of deep focus events (H greater than 300 km, M greater than 5.4) that occurred near the Sunda arc to evaluate the extent of HVA. We downloaded waveform data for 42 events from the Data Management Center of Incorporated Research Institutions for Seismology (IRIS). We selected stations that are located at a distance between 10 deg and 55 deg from the epicenters. These waveforms sampled the transition zone structure and the uppermost lower mantle strongly.

The downloaded waveform data are first compared with theoretical waveforms computed using a reflectivity code with IASP91, a standard layer velocity model. Some of the waveforms observed at a distance of over 30 deg show complexity in the early parts of P-waves (distance between 29 deg and 52 deg). The bottoming depths of these seismic rays are about 800 to 1500 km. The seismic rays of the complicated waveforms propagated through the HVA region beneath Kalimantan that is found in the recent tomographic models. On the other hand, the waveforms that propagated outside the HVA zone are simple and can be explained with a standard model. A layered structure is limited to model the observed waveforms that propagated in a 3-D structure. However, the complexity in the early parts of P-waves (distance between 43 deg and 48 deg) can be explained with velocity anomalies of +-2% given in the depth range from about 920 to 1300 km.