Three-dimensional velocity structure in and around the 2001 Geiyo earthquake, revealed by double-difference tomography method

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Geiyo earthquake (M6.7) occurred beneath the Inland Sea of Japan at about 50km depth on March 24, 2001. The hypocenter of this event is located within the Philippine Sea plate, which is subducting north-westward from the Nankai-trough beneath southwestern Japan. In this study, we obtained the detailed seismic velocity structure in and around the source region of the Geiyo earthquake within the Philippine Sea plate by using the double-difference tomography method (Zhang and Thurber, 2003), and discussed its relation with the occurrence of the 2001 Geiyo earthquake.

In the conventional tomography method, the seismic velocity structure (particularly for the region where seismic ray paths are distributed) is determined by using only the absolute travel times. In comparison, the double-difference seismic tomography method has the ability to determine the detailed velocity structure around the source region by using both the absolute data and the differential travel times from pairs of earthquakes.

Our findings are summarized as follows: (1) The Philippine Sea slab subducting northward beneath Shikoku to Chugoku district is imaged as a high velocity anomaly zone. (2) Aftershocks of the 2001 Geiyo earthquake are located not only within the low velocity region just beneath the upper boundary of the slab but also within the high velocity region below it. Our results support that the thickness of the crust of the Philippine Sea slab is 5-7 km, as suggested in previous studies, and the coseismic rupture zone by the 2001 Geiyo earthquake may be extended to both the crust and mantle of the slab. The maximum coseismic slip region of the 2001 Geiyo earthquake (Yagi and Kikuchi, 2002) is distributed within the low velocity zone associated with the oceanic crust of the Philippine Sea slab. (3) Low frequency seismic tremors (Obara, 2002) likely occur around the low velocity region at 30-35km depth (western Shikoku), which may be caused by fluids generated from various dehydration reactions inside the slab.