# New advances of seismic tomography

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Recently there have been several remarkable advances in the methodology of local and regional scale seismic tomography. These new approaches can be used to improve the seismic imaging of the crust and upper mantle structure of the Japan islands which are covered by the dense seismic networks such as F-net and Hi-net.

The first advance is to determine the detailed 3-D structure of the oceanic regions close to the Japan Islands. So far fine tomographic images are determined only under the land areas of Japan, while the structure under the surrounding oceanic areas could not be determined reliably using the natural earthquake data because the hypocenters, in particular, focal depths, could not be determined accurately due to the lack of seismic stations offshore. Umino et al. (1995) detected an sP depth phase for the earthquakes under the Pacific Ocean and used the depth phases to relocate the events in the NE Japan forearc region from the Japan trench to the Pacific coast. Zhao et al. (2002) and Mishra et al. (2003) determined 3-D P and S wave velocity structure of the NE Japan forearc using P and S arrival times recorded by the seismic network on the land area with the hypocenters relocated with the sP phase. They imaged, for the first time, 3-D lateral velocity variations along the upper boundary of the subducting Pacific slab in the forearc region and revealed a remarkable correlation between the velocity heterogeneity and distribution of the large interplate earthquakes. This approach can also be applied to the offshore areas under the Japan Sea and any seismic areas in the vicinity of a seismic network.

The second advance is to improve the spatial resolution of tomographic images under a seismic network. For the conventional tomography using first P or S wave arrival times, the spatial resolution of tomographic images is generally controlled by the spacing between stations. Zhao et al. (2003) tried to add multiple reflected waves in the crust (SmS, sSmS) in the tomographic inversion. In their example for Southern California, they found that the tomography resolution can be improved by 3-5 times after adding a number of SmS and sSmS data which were identified by comparing synthetic seismograms with the observed ones.

The third advance is to conduct teleseismic tomographic inversions by using the Banana-Doughnut theory (Dahlen et al., 2000) rather than the traditional ray theory (Montelli et al., 2004; Hung et al., 2004). It is found that such an approach can retrieve not only the pattern but also the amplitude of velocity anomalies. Thus the distribution of Poisson's ratio and dlnVp/dlnVs can be determined more accurately from the Vp and Vs tomography, which would enable better interpretations of the tomographic results in terms of magma, fluids, temperature and compositional variations.