Teleseismic evidence for the deep structure heterogeneities under the Japan Islands

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So far many studies have been made to investigate the 3-D seismic velocity structure under the Japan Islands by using local earthquake data. However, few studies were made by using teleseismic data for the deeper structure under Japan. Teleseismic data are very useful because they contain information on the structure beneath the subducting Pacific slab as well as the depth extension of the subducting Philippine Sea slab, which are still not well known. In this work we have made a detailed analysis of the spatial distribution of teleseismic residuals on the Japan Islands. We used about 34,000 residuals from 333 teleseismic events recorded by the seismic stations of J-array, JMA and Hi-net from 1988 to 2004 (Zhao and Hasegawa, 1994; Abdelwahed and Zhao, 2007). The iasp91 1-D Earth Model was used to calculate theoretical travel times and relative travel-time residuals. The 333 teleseismic events were divided into four quadrants (NE, NW, SW, and SE) for examining the distribution of the teleseismic residuals.

Our results show the following features. (1) In Hokkaido and Tohoku districts, early arrivals appear in the Pacific coast area, while delayed arrivals appear along the volcanic front and Japan Sea coast area, which reflect the low-velocity mantle wedge under the back-arc area in contrast to the average to high velocity under the forearc area. (2) In the Kanto district, very large early-arrivals exist for the rays from teleseismic events in the SW quadrant, which are caused by rays propagating longer within the subducting Pacific slab. (3) Early arrivals appear in the Japan Sea coast area in the Chubu District for rays from the northern direction, suggesting that the Philippine Sea slab may have subducted northward deep in the upper mantle under the Japan Sea. (4) In the Unzen volcanic area and western Kyushu, very large delayed-arrivals appear for rays from the SW quadrant, which may be caused by low-velocity anomalies under the Okinawa Trough.

In this presentation, we will also show a preliminary result of tomographic inversion of both the teleseismic residuals and local-earthquakes arrival times, which provides a 3-D P-wave velocity model of the crust and upper mantle down to about 600 km depth.