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sP波トモグラフィーによる日本海東縁地域の地殻構造

Crustal structure of the eastern margin of the Japan Sea revealed by sP-wave tomography

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Umino and Hasegawa (1994) and Umino et al. (1995) detected sP depth phase from seismograms of suboceanic crustal earthquakes that occurred beneath the Japan Sea and the Pacific Ocean and demonstrated that the sP depth phase is a very powerful tool to locate accurately the suboceanic events which occur outside of the seismic network in Northeast (NE) Japan. Later studies show that 3-D structure under the NE Japan forearc region under the Pacific Ocean can be determined by using the arrival-time data from the well-located suboceanic events with the sP depth phase (e. g., Mishra et al., 2003; Zhao et al., 2009). Here we call this approach sP-wave tomography for determining 3-D structure outside a seismic network.

In this work we apply the sP-wave tomography to determine the 3-D P-wave velocity structure of the crust and uppermost mantle under the eastern margin of the Japan Sea (EMJS). We used 2,83 3 earthquakes which consist of two groups. The first group includes 145 crustal events which occurred in EMJS during April 1992 to December 1997 and have 442 sP depth phase arrival times collected by following the criteria established by Umino and Hasegawa (1994) and 4,740 P-wave arrival times recorded by the Tohoku University seismic network. The second group consists of 2, 688 events which occurred under the NE Japan land area during January 1992 to April 2003 and have 170,685 P-wave arrival times. Each of the events was recorded by more than 15 seismic stations and their hypocentral locations are accurate to 1-2 km. The total number of 2,833 events in our data set generated 175,425 P-wave arrival times recorded by 330 seismic stations in NE Japan. These seismic stations are permanent and portable stations operated by Tohoku University and other Japanese universities, Japan Meteorological Agency, and Hi-net. The picking accuracy of the P-wave arrival times is estimated to be 0.05-0.15 s.

Our results show that strong velocity variations exist in the crust and uppermost mantle under EMJS, and many large crustal earthquakes occurred in or around low-velocity zones which may represent weak sections of the seismogenic crust. Low-velocity zones in the mantle wedge are found to extend westward under the Japan Sea, rather than just confined under the NE Japan land area. Along the volcanic front and in EMJS, the crustal weakening may be caused by both high-temperature magma and fluids released from the mantle diapirs rising in the mantle wedge associated with the slab dehydration (see a recent review by Hasegawa et al., 2009). These results indicate that the generation of large crustal earthquakes is closely related to the physical and chemical properties of materials in the crust and upper mantle, such as magma, fluids, etc.

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