Source location of later phases from intermediate-depth earthquakes in the Tohoku area

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1. Introduction

Recently, we have identified remarkable later phases arriving after direct S waves for intermediate-depth earthquakes in the Tohoku district, Japan. Taking characteristics of waveforms, an approaching direction, and travel times into account, the later phases may be S waves that propagate in the slab and are scattered or reflected at lower crust. At JPGU meeting 2008, we reported the location of the later phase source (i.e. a point where the first arrivals of the later phases were generated) for the central part of the Tohoku district. In the present study, we will present the later phase source location about the entire region of the Tohoku district. The data used were waveforms recorded at Hi-net stations and hypocenter parameters determined by JMA.

2. Location of the later phase source

We formed a hypocenter array consisting of 6-8 hypocenters for a station, and estimated the later phase source location from later phase arrival times. Spatial extent of epicenters of an array was about 50km. We collected waveforms with highly attenuated direct S waves and distinct later phases. Therefore stations used were located near active volcanoes, where direct S waves pass through partial melting zones beneath active volcanoes. We picked up later phase on the envelope seismograms, because it was difficult to read arrival times on the original seismograms. Envelope seismograms were drawn for NS component by applying 8-16 Hz band pass filter and calculating root mean square (rms) amplitude of 0.17 s time window. Comparing envelopes between hypocenters, we picked the point where amplitude started abrupt increase, and regarded that point as later phase arrival. Location of later phase source was estimated in the 2D velocity model with the Conrad, the Moho, and a plate boundary. Grid points were distributed at intervals of 0.05 deg in the horizontal direction and 5km in the vertical direction. A travel time was calculated along the path connecting a hypocenter, a grid point and a station. A grid point was searched that gave the travel time close to observations, provided that the later phases were generated at the same position for a hypocenter array.

3. Result

We obtained location of later phase sources for 7 stations, KZNH, ICWH, NRK, NYOH, THTH, ADTH, and INAH situated near active volcanic regions. Later phase sources were located to the east of each station at 20-30km in depth, and seemed to align along the east side of the volcanic front. Later phases arrive at stations other than above mentioned 7 stations. Their travel times indicate that they are generated to the east of the station, at the depth of 20km in the east side of volcanic front. These results suggest that later phases are generated in the lower crust in the east of the volcanic front over the entire region of the Tohoku district.

4. Discussion

In order to determine the later phase source location more precisely, arrival times of the later phase should be picked up more accurately. The wave train of the later phases continues for 5-10 s. In this study, we determined the source location of the first arrivals. The generation of later part of the wave train should be studied. Observation by using station array may be effective for these problems.

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