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Precise hypocenter structure of the upper-plane seismic belt of the double seismic zone in the Pacific slab

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1. Introduction

Dehydration embrittlement or CO^2-{_}bearing devolatization embrittlement hypothesis has been proposed as a possible cause of intraslab earthquakes [e.g., Peacock, 2001; Kirby et al., 1996]. Precise location of intraslab seismicity is needed to discuss the cause of intraslab earthquakes.

We have relocated mamy earthquakes in the Pacific slab benearth Tohoku and Hokkaido by the double-difference hypocenter location methods using the data of JMA earthquakes catalog. We found the existence of upper-plane seismic belt parallel to the iso-depth contours of the plate interface beneath the forearc area at depths of 70-100 km, and that the location of the deeper limit of this belt appears to correspond to one of the possible facies boundaries (e.g., from jadeite lawsonite blueschist to lawsonite amphibole eclogite; Hacker et al., 2003) [Kita et al., 2006].

In this study, we relocated intraslab seismicity using the travel time difference calculated by the waveform cross-spectrum analysis in order to detect a more detailed characteristic distribution of the upper-plane seismic belt seismicity within the Pacific slab beneath NE Japan.

2. Data and method

We relocated events at depths of 50-300 km for the period from March 2003 to November 2006 from the JMA earthquake catalog. We applied the double-difference hypocenter location method (DDLM) by Waldhauser and Ellsworth (2000) to the arrival time data of the events. We adopted a P- and S-wave velocity structure model used in the routine procedure of hypocenter locations in Tohoku University [Hasegawa et al., 1978a]. We use relative earthquake arrival times determined by both of the waveform cross-spectrum analysis and the catalog-picking data. In waveform cross-spectrum analysis, we selected event pairs with an epicentral separation of less than 20km and picked the arrival time difference of pairs, whose waveforms coherence average value are larger than 0.8.

3. Results and discussion

1) Seismicity is more active in the topmost part of the upper plane of the double seismic zone. In some area, the upper plane seems to be consist of two separated hypocenter distributions parallel to the plate interface at depths of 70-100 km. The separation distance between the two is about 2-4km.

2) In the lower hypocenter distribution within the upper seismic plane,hypocenters are distributed sparsely and the number of the events is relatively small. This distribution is found at depths from shallower than 70km to 120km. In the other hand, events in the upper of the two are distributed relatively densely and this is found only at depths of 70-100km, where the upper-plane seismic belt is found. In other words, the upper one is relatively active and located at the upper part of the upper-plane seismic belt.

The existence of two distributions in the upper-plane seismic belt is possibly related with the layered structures of the topmost part of the subducted oceanic plate, where many faults with hydrated minerals are formed by the hydrothermal activities and/or the bending of the plate at the outer-rise region before its subduction could exist. The high seismicity of the upper part of the seismic belt may be due to the dehydration embrittlement of these hydrated faults in the topmost part of the oceanic plate.