Crustal and upper mantle structure beneath Taiwan collision zone using natural earthquakes

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1.Introduction

Eurasian plate and Philippine Sea plate are colliding each other beneath Taiwan.This collision causes the mountain building. Based on various surveys and observations, two representative theories were proposed about mountain building mechanism,that is, the thin-skinned model(Suppe,1981) and the lithospheric collision model(Wu et al.1997). These two models are quite different in the point whether the mountain building is explained only by the structure of the upper crust or not.To resolvethis difference and consider the mountain building mechanism,it is very important to clarify the structure of the crust and the upper mantle. In Taiwan an observation of the natural earthquakes was conducted in 2001,and we got the records of local earthquakes and teleseismic ones. In this research,I studied a crustal structure by using local earthquakes,and the deeper structure by teleseismic ones,and discussed the mountain building mechanism.

2.Observation and Data

We deployed a 120-km linear array in central Taiwan from March 2001 to May 2001.The array,which consisted of 55 seismographs (1Hz) spacing at about 2 km,recorded 47 local events that occurred between 23.5N and 24.0N and 11 teleseismic events.To analyze an east-west section I used the events of China and Solomon. Delays of the relative travel time of two teleseismic events from Solomon and China reached 1.3s at the Central Range.

3.Analysis

First I analyzed crustal structure by using local events. I modified the initial model (Yeh et al.1998) to explain the travel times of the 5 events located beneath the array or the extension of the array. And by using this modified model as an initial one, I estimated the structure and thehypocenters by using a three-dimensional tomography.

Next I calculated the relative travel time of the teleseismic events based on the model estimated by the analysis of local events and compared with the observations.

4.Results

The initial model has two characteristics. One is that the shape of the middle crust beneath the Central Range is upward convex. Another is that the place of the deepest part of the Moho is located in the east of the Central Range. I could get the model which could explain the travel times of the first arrival of local events. In this model those characteristics become clearer and a high-speed zone rises to 10 km deep in the east of the Central Range. And the heterogeneity becomes more distinct than that in the initial model in the upper crust shallower than 10 km deep.

On the other hand, relative travel times of teleseismic events could not be explained by this model. Delays in the Central Range reached 2.2 s in China event and 1.8 s in Solomon event.

5.Discussion

The results of a checkerboard resolution test show that the model estimated by the tomography analysis can solve velocity distribution from surface to 30 km depth beneath the array. This model is similar to that of Wu et al.(1997) in the point that the heterogeneity exists in the upper crust and that the high-speed zone rises beneath the Central Range. Moreover, this model represents the delamination and the descent of Philippine Sea plate clearer than Wu's model. Moreover, heterogeneity exists in the upper crust, which implies the possibility that the deformation in the shallow part of the crust considered in the thin-skinned model plays an important role in the mountain building.