Tectonics in Taiwan (2): A scenario of tectonic evolution

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Taiwan is a product of collision between the Luzon arc on the Philippine Sea plate and the East China Sea continental shelf on the Eurasian plate. For understanding the mechanism of active deformation in Taiwan, it is important to reveal the present underground structure and the process of its evolution. Nevertheless both of them are little understood. In this study, we constructed an analog model using plasticine, which reproduced the development of underground structure in and around Taiwan from 15 Ma to the present.

The boundary conditions and initial conditions of the model are derived from many observations compiled by Fukahata et al. (this meeting). We assumed that the plate motion had been constant since 15 Ma based on the compiled paleomagnetic data. The present motion of the Philippine Sea plate relative to the Eurasian plate is about 70 mm/yr in the northwest direction. We take the difference in thickness of the lithosphere in oceanic region, the Luzon arc and the continental shelf into consideration. As the initial (15 Ma) configuration of the plate boundaries, we considered the two trenches (the Ryukyu trench and the Manila trench) connected by a transform fault, which was realized by moving the plates in the reversal direction from the present. We also assumed from the sediment delivery data that the collision between the Luzon arc and the East China Sea continental shelf started at 5 Ma.

Each plate made of plasticine was wrapped by plastic cling film, which enables the plates to move smoothly. To get a clear 3-dimensional view, we put the plates on transparent acrylic tables, and observed the deformation of the plates involved by the plate motion, taking photographs with a digital camera.

Until 5 Ma the plates moved smoothly with no deformation, shortening the length of the transform fault. From 5 Ma to the present, we could see large deformation of the plates, which were classified into the following three basic modes: (1) obduction of the northwestern rim of the Luzon arc onto the East China Sea continental shelf, (2) intrusion of the northernmost part of the Luzon arc into the westernmost part of the Ryukyu arc, (3) shortening of the northern part of the Luzon arc in the east and west direction.

Next, we compare the final state of the analog model corresponding to the present subsurface structure with various observed data compiled by Fukahata et al. (this meeting).

The uplift of the northwestern rim of the Luzon arc due to the obduction in the model corresponds to the heights of topography and Free-air gravity anomaly in Central Range. The negative Bouguer gravity anomaly in Western Foothills can be explained by the subsidence of the East China Sea continental shelf involved by the obduction of the Luzon arc. Our model predicts that horizontal deformation is localized between Western Foothills and Longitudinal Valley, which is consistent with the GPS data. The deep seismic zones observed in the southern and the northeastern parts of Taiwan are ascribed to the subduction of oceanic plates of South China Sea and Philippine Sea, respectively. In our model we cannot see any slab in the middle of Taiwan, which well explains lack of deep earthquakes in this region. Our model concludes that crustal deformation begins at the northernmost part in Taiwan and that the actively deforming region shifts southward gradually. This is also consistent with the sediment delivery data from Central Range.

With this model, we have succeeded in explaining various observed data uniformly. We are confident that our model gives the best framework about the tectonics in Taiwan. It would be very useful, when we interpret various phenomena arisen in the island.