Initial rifting structure at the northernmost of Mariana Trough

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Mariana Trough is a typical back-arc basin locating at the eastern edge of the Philippine Sea Plate, with a crescent shape between the Mariana Arc at the eastern side and the West Mariana Ridge at the western side. Mariana Trough is pinched around the 24N converging the Mariana Arc and the West Mariana Ridge, connecting to the Bonin Arc. The opening of the Mariana Trough is varied from the rifting stage between 22N and 24N to back-arc spreading stage south of 22N, which was initiated about 6 Ma confirmed at the middle of Mariana Trough around 18N. Izu-Bonin and Mariana Arcs (IBM) are oceanic arcs evolved by arc activity associated with the Pacific Plate subduction and back-arc openings, which is thought to be one of important candidate to form felsic continental crust from mafic oceanic environment because of the discovery of intermediate middle crust with P-wave velocity (Vp) of 6 km/s. However, the influence of rifting activity to arc evolution has not been well understood. In this study, we will present the crustal and uppermost mantle structures at the northernmost Mariana Trough and discuss the influences and development of rifting in the arc region.

The seismic lines in this study are two transects called Lines IBr13 and IBr14 where lengths are 536 km and 506 km, respectively. Line IBr13 is a NE-SW line from forearc region to Minami-ioujima spur crossing the Mariana Arc around 23.6N. Line IBr14 have an azimuth of ENE-WSW from forearc of Mariana to Parece Vela Basin across the Mariana Trough intersecting the Mariana Arc about 23N. The southern end of Line IBr14 was located on Line IBr13. The distance between the two seismic lines on Mariana Arc is about 100 km. On both lines, 100 ocean bottom seismographs (OBS) were deployed with 5-km spacing. Airgun shooting intervals of both lines were 200-m. Recording conditions were almost good enough to detect the airgun signals around 200-km offset distances in several stations.

Data analyses for both lines are two steps of first arrival tomography and travel time mapping of later phases. Structural characteristics of arc region in Line IBr13 are as follows: Crustal thickness of the Mariana Arc is 22 km including the three regions with Vp of 6-6.5 km/s, 6.5-6.8 km/s and 6.8-7.2 km/s where thicknesses are 5 km, 7 km and 5 km/s, respectively. The thickest part of the crust in Line IBr13 is not at the Mariana Arc but the portion from the Mariana Trough to the West Mariana Ridge whose crustal thickness is about 25 km with three regions with Vp of 6-6.5 km/s, 6.5-6.8 km/s and 6.8-7.2 km/s having thicknesses of 5 km, 7 km and 5 km/s, respectively. The region with Vp of 7.4 km/s underlie the portion from the Mariana Trough to the West Mariana Ridge On the other hand in Line IBr14, crustal thickness of the Mariana Arc, the West Mariana Ridge and Mariana Trough are respectively 15 km, 17 km and 10 km. The arc crust in Line IBr13 is meaningfully thicker than those in Line IBr14 and in the middle of Mariana region, implying that the crustal formation is vigorous around the northernmost of Mariana Trough. Moreover, the fact that the crustal thickness of the portion from the Mariana Trough to the West Mariana Ridge is thicker than that of the Mariana Trough suggests that crustal accretion of the rifting seems to be stronger than that of arc activity