Different Moho reflections adjacent to Minami-Tori Shima and their petrologic origins

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It is the common knowledge that Moho is the boundary between the crust and mantle, which was discovered by and named after Croatian seismologist Mohorovičić. We have shown that Moho is not the crust-mantle boundary and presented a new hypothesis about the origin of Moho based on seismological and petrological observations (Tamura et al., EGU2018-11069-2; JpGU2018 SMP36-05; AGCC2018 abstract volume590; Tamura et al., in preparation). Direct drilling and sampling of Moho could be the best scenario to examine the hypothesis. However, IODP drillings of basaltic crust could estimate the petrologic origins of the crust-mantle boundary far below the seafloor, which could be useful to examine the hypothesis of formation of Moho.

Kaneda et al. (2010) conducted seismic surveys across the Marcus-Wake seamount chain near Minami-Tori Shima, which is the Japanese easternmost and one and only island on the Pacific Plate. They found contrasting seafloor in the north and south of the seamount chain, which were referred to the northern and southern basins (Figure 1). Average water depths in the northern and southern basins are about 5900 m and 5700 m, respectively. Magnetic anomalies suggest Jurassic ages of M32 (159 Ma) and M42 (167 Ma) for the northern and southern basins, respectively. The southern basin has the clear Moho reflections, which are characteristically sharp, single, flat, and continuous, and of large amplitude, but in the northern basin, Moho reflections are extremely weak or even absent. Interestingly, the crust of the southern basin has a constant thickness of 7.5-8.0 km, but the crust of the northern basin shows a constant thickness of 6 km, 1.5-2 km thinner than that of the northern basin.The correlation between Moho reflections and crustal thicknesses have been generally observed in other seismic profiles (e.g. Ohira et al., 2017).

The boundary between mantle peridotite and layered gabbro from the lower oceanic crust in the Oman ophiolite consists of a dunitic transition zone (DTZ), mostly made of olivine + scattered Cr-spinel. The thickness of DTZ ranges from a few meters to a few hundred meters. When mantle melts under hydrous conditions, the liquidus field of forsterite expands relative to that of enstatite and enstatite melts incongruently to produce dunites and andesitic melts.

We present here a new hypothesis that (1) accidental influx of seawater at the mid-ocean ridges results in hydrous melting of mantle peridotite just beneath the crust and produces thick dunite at the crust-mantle boundaries, (2) the thick dunite represents reflective Moho, and (3) this additional hydrous melting of shallowest mantle increases the thickness of oceanic crust.

Although the andesitic melts, which are the outgrowth of dunites, would be mixed with dominant basaltic melts extracted from the deeper parts of melting column of MORB, there must be systematic and significant differences between crustal materials with Moho and those without Moho. Comparative drillings of oceanic crust in the northern and southern basins for future IODP expeditions will reveal the differences of basalts and examine the models for Moho.

Keywords: Moho, Minami-Tori Shima, dunite, mantle, crust, basalt