Geophysical investigation of the Mado Megamullion Oceanic Core Complex: Implication for the end of back-arc spreading

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Detachment faulting is a major style of seafloor spreading at slow to intermediate mid-ocean ridges, whereas we have limited insight into the role in back-arc basin formation. We surveyed a part of the remnant back-arc spreading center of the Shikoku Basin in the Philippine Sea, where oceanic core complexes (OCCs) develop. We reveal the detailed feature and formation process of the Mado Megamullion OCC in the context of back-arc evolution, based on the shipborne bathymetry, magnetics, and gravity with radiometric age dating of collected rock samples. The Mado Megamullion shows a typical OCC morphology with the prominent corrugated surface on the domed massif. The termination side continues to the axial rift valley, suggesting that the OCC was formed at the end of back-arc basin opening. Eroded scarp by mass wasting and minor faults on the OCC indicate the deformation after the denudation of deep materials. The positive mantle Bouguer gravity anomaly also supports the thinner crust and/or dense materials in the shallow subsurface, suggesting the decrease of melt supply rate as much as 50%. The identification of lineated magnetic anomalies constrained by Zircon U-Pb dating of gabbroic rocks shows that the half spreading rate decreased from 23 mm/yr. to 11 mm/yr. at the final stage of magmatic spreading, and then the asymmetric tectonic spreading along a detachment fault formed the OCC. Many OCCs and other morphological features indicating the detachments are widely distributed along the remnant spreading axis in the Philippine Sea. This indicates that detachment faulting is a general, dominant style of seafloor formation when back-arc basins cease to open. The extension likely continues and the spreading occurs slowly and asymmetrically after the waning of melt generation in the final stage of back-arc basin formation.

Keywords: back-arc basin, oceanic core complex, geophysical mapping, Philippine Sea, detachment fault

