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古フィリピン海プレートの起源と北部伊豆小笠原弧で発見された中生代基盤岩類
Origin of the proto-Philippine Sea Plate and the discovery of Mesozoic basement beneath the northern Izu-Bonin Arc

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The Izu-Bonin Arc is widely regarded to be a typical intra-oceanic arc, with the oceanic Pacific Plate subducting beneath the Philippine Sea Plate, an evolving complex of active and inactive arcs and back-arc basins. It is dominated by oceanic crust forming three large back-arc basins; Shikoku, Parece Vela, and West Philippine Basins, making the present Philippine Sea Plate look like an ”oceanic” plate. However, all of these back-arc basins were formed after subduction at Izu-Bonin Arc had begun, at ˜52 Ma (Ishizuka et al. 2011, EPSL). Little is known about the proto-Philippine Sea Plate, which existed along with the Pacific Plate at the time of subduction initiation and before the formation of back-arc basins.

To investigate the crustal structures of the proto-Philippine Sea Plate, we conducted manned-submersible SHINKAI6500 and Deep-Tow camera surveys during cruise YK10-04 of the R/V YOKOSUKA in April 2010 at the Daito Ridges. The Daito Ridges comprise the northwestern Philippine Sea Plate along with what are regarded as remnants of the proto-Philippine Sea Plate. Submersible observations and rock sampling revealed that the Daito Ridges expose deep crustal sections of gabbroic, granitic, and metamorphic rocks, along with volcanic rocks ranging from basalt to andesite. Jurassic to Cretaceous magmatic zircon U-Pb ages have been obtained from the plutonic rocks, and whole-rock geochemistry of the igneous rocks indicates arc origins. Furthermore, mafic schist collected from the Daito Ridge has experienced amphibolite facies metamorphism, with phase assemblages suggesting that the crust was thicker than 20 km at the time. These finds show that the Daito Ridges represent developed crustal sections of the Mesozoic arc that comprises part of the proto-Philippine Sea Plate, and, together with the tectonic reconstruction of the proto-Philippine Sea Plate (Deschamps and Lallemand 2002, JGR), they suggest that subduction of the Izu-Bonin Arc initiated at the continental margin of the Southeast Asia, possibly correlating with the Mesozoic island-arc and ophiolite complexes exposed in the southwest Pacific margins, such as those in the Philippine Islands. Only later did it acquire an ”intra-oceanic”-like setting through the formation of the backarc basins.

Furthermore, detrital zircon ages from volcaniclastic sandstones collected from northern Izu-Bonin forearc, counterpart of the Daito Ridges, yield Mesozoic to Paleozoic ages, indicating that similar Mesozoic basement may even exist beneath the present Izu-Bonin Arc. To confirm this hypothesis, we have conducted a SHINKAI6500 survey on the landward slope of the northern Izu-Bonin Trench during cruise YK11-07 of the R/V YOKOSUKA in September 2011. The collected samples are dominantly andesite with two diorite samples, and preliminary zircon U-Pb dating of the diorite sample yielded Cretaceous (˜100 Ma) magmatic age as well as abundant Paleozoic to Proterozoic detrital zircons. Preliminary whole-rock geochemistry of the andesite and diorite samples show clear arc-signatures, confirming that a preexisting basement composed of Mesozoic arc crust underlies at least part of the present northern Izu-Bonin Arc.

These new insights on the crustal structure of the proto-Philippine Sea Plate and the discovery of preexisting Mesozoic arc basement beneath the Izu-Bonin Arc raise serious doubts about the intra-oceanic nature of the Izu-Bonin Arc system. Previous petrologenetic and geochemical models, used to interpret the seismic crustal structures of the present Izu-Bonin Arc, have assumed oceanic crust as a preexisting basement, and on the basis of these new results such models now need to be reconsidered.