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Evidence for Mesozoic basement in the Izu-Bonin-Mariana arc system

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The ca. 51-52 Ma age of subduction nucleation in the Izu-Bonin-Mariana (IBM) arc system (Ishizuka et al., 2011a) places it before most of the West Philippine Basin (WPB) formed (e.g., Deschamps and Lallemand, 2002). This implies that the potential location of subduction nucleation along the Mesozoic-aged arc crust that is now found along the northern and southern WPB (e.g., Amami Plateau (112-117 Ma): Hickey-Vargas, 2005; Daito Ridge (118 Ma): Ishizuka et al., 2011b; Huatung Basin (119-131 Ma): Deschamps et al., 2000). Recent investigation of Bonin Ridge forearc discovered Jurassic basaltic pillow lavas (159.4+-0.9 Ma: Ishizuka et al., 2011a). This age is consistent with the stratigraphic position of these basalts beneath and trenchward of Eocene gabbro. These Jurassic lavas are MORB-like basalt with Indian Ocean-MORB like isotopic characteristics, which strongly implies that these basalts are in situ and not accreted from the subducting Pacific plate. The presence of Jurassic basalts with an Indian Ocean MORB-type isotopic signature suggests that a sliver of this Mesozoic crust might be found in the Bonin Ridge forearc, and constitute basement of the Izu-Bonin arc. Similarly, Mesozoic sediments have been found from the central Mariana forearc with associated andesitic volcanic clasts at DSDP Sites 460 and 461 (Hussong, Uyeda et al., 1981) and dredge sites (Johnson et al., 1991) suggest that a similar Mesozoic sliver of crust might be present in the Mariana forearc.

Another piece of information about pre-Eocene crust in the IBM arc system was obtained by dredging from southernmost part of the Kyushu-Palau Ridge (KPR). We recovered mafic schists of amphibolite to greenschist facies from a ridge between the Palau trench and the KPR. Age and origin of these rocks are under investigation. These schists may have similar age and origin to those from the Cretaceous Daito Ridge.

These evidences indicate that at least some part of the IBM arc system was built on or adjacent to Mesozoic terranes composed of arcs and ocean basins. Subduction could have begun spontaneously, facilitated by the density contrast between the arc-bearing Mesozoic Asian crust and the old oceanic Pacific crust.

While Mesozoic basement exists beneath part of the IBM arc, other parts might lack pre-Eocene basement. The present geographic relationship between the KPR and the WPB, including the Central Basin Fault (extinct spreading center of the WPB), truncated by the KPR, implies that adjacent parts of the KPR formed on the very young oceanic crust of the WPB, which was still spreading until ~30Ma. The lack of Eocene ages for the central part of the KPR (11-20^{o}N) is consistent with this implication (Ishizuka et al., 2011b).

Petrographic and geochemical variation observed along the KPR may be linked to the variability of the basement crust and lithospheric mantle. For example, high-K andesite only occurs in the northern KPR, especially near the intersection between the KPR and the Daito Ridge, while the KPR south of 20^{o}N is characterized by dominance of basalt and lack of hornblende andesite relative to the northern KPR. However, to test this hypothesis, better tectonic reconstructions of the early Philippine Sea plate history is required, particularly to identify and sample where the various pre-Eocene crustal blocks were relative to each other when subduction began, and where are the segments of IBM and KPR crust where older crust is unlikely to exist, for example at the join between Bonin and Mariana arcs, ~23^{o}N.

Understanding the tectonic setting of subduction initiation is crucial for the understanding of present variability along-arc geochemical variation and seismic velocity structure of the arc crust. Tamura et al. (2010) pointed out the importance of contribution of Oligocene arc crust to silicic magmatism in the Izu-Bonin arc. Mesozoic crust and mantle lithosphere is likely to have significant control on arc crustal structure and composition.