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Magmatism at spreading ridge-arc collision in the Philippine Sea – its spatial and temporal variation

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We investigated the intersection of a spreading center with an island arc within the Philippine Sea Plate using a combination of submersible sampling and shipboard geophysics. We used geochemistry and Ar-Ar dating to constrain the structure, age and origin of magmatism as spreading interacted with the arc.

The West Philippine Basin (WPB) occupies the western half of the modern Philippine Sea Plate in the Western Pacific. However, its origin, spreading history and tectonic relationship to the adjacent Izu-Bonin-Mariana arc remains poorly understood (e.g., Deschamps and Lallemand, 2002).

An extinct spreading center of the WPB (CBF Rift) intersects the Kyushu-Palau Ridge (KPR), which is the Oligocene remnant of the Izu-Bonin-Mariana arc (Ishizuka et al., 2011). But it was not clear when and how this tectonic arrangement commenced.

Between 33-31 Ma, the western CBF Rift magmatism had mantle-like Ce/Pb and Th/Ce indicating a lack of slab flux. Radiogenic isotopes form a trajectory towards low $^{143}Nd/^{144}Nd$ and high $^{20x}Pb/^{204}Pb$, but extend to delta$^{208}Pb/^{204}Pb$ >85 which corresponds to an EM-2-like mantle component rather than pelagic sediment input from the slab, i.e., characteristics of E-MORB magmatism.

While spreading along the CBF Rift continued, interaction between a volcanic arc and a spreading center seems to have caused excess magmatism in the back-arc on both sides of the spreading center, resulting in the CBF Rise. Its geochemical characteristics are similar to the KPR arc and reflect a slab flux derived from altered ocean crust and pelagic sediment.

The final stage of spreading-related activity occurred between 31-28.5 Ma when the spreading axis rotated and propagated into the arc. During the final stage magmatism La/Sm, Nb/Zr increased while Pb and Sr isotopes became progressively more radiogenic, demonstrating a progressive decrease in the degree of partial melting and preferential tapping of the EM-2 component. This change in melt generation and composition appears a common process at the end of spreading.