Spatial and temporal variability of magmatism at the northern end of the Mariana Trough back-arc basin

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The southern end of the Izu-Bonin arc and northernmost part of Mariana arc are characterized by occurrence of highly alkaline shoshonitic lavas, referred to as the alkalic volcano province(AVP) (e.g., Bloomer et al., 1989; Sun and Stern, 2001; Ishizuka et al., 2007). This area lies north of the northern termination of Mariana Trough. Back-arc and intra-arc rifting is propagating northward through this area, while back-arc spreading and creation of oceanic crust has not begun. Large variations in magma chemistry and age, coupled with recent efforts to obtain seismic velocity structure by JAMSTEC make this area a suitable target to study the effects of rifting on arc magmatism and its impact on arc crustal growth.

We conducted dredge sampling on the western side of the northern tip of Mariana Trough (NT0608 cruise). The sampling was mainly focused on small, possibly monogenetic volcanoes widely distributed in this area, hoping to trace northward propagation of the tip of Mariana Trough and associated spatial and temporal variability of magmatism. West Mariana Ridge was also investigated during this expedition and Japanese continental shelf survey project.

Recovered samples are mainly vesiculated basalt with ol and cpx phenocrysts. They are classified as medium K to shoshonitic and are exclusively basaltic, which is a remarkable contrast to adjacent volcanic front where andesitic lavas are common. These basalts have significantly higher alkali contents than Mariana Trough basalts, and show clear arc-like signatures such as depletion in HFSE and enrichment in LILE. On the other hand, samples from the western margin of the Mariana Trough are low K basalt, distinct from the monogenetic volcanoes. However, alkaline (high-K) basalt was obtained from a volcano on the West Mariana Ridge.

Age of shoshonitic lavas systematically becomes younger toward north. The age of c. 6Ma was obtained at 21.5^{o}N, c. 3 Ma at 23-23.5^{o}N, and zero-age shoshonites occur on Ioto Island at 24.4^{o}N. This implies that shoshonitic magmatism represents the leading edge of rifting and is propagating northward with time.

High-precision Pb isotopic analyses reveal that the monogenetic volcanoes form a single trend on Pb-Pb isotopic plots between 2 components, one with lower ^{206}Pb/^{204}Pb and high delta7/4, and another with high ^{206}Pb/^{204}Pb as well as low delta7/4 and 8/4 (HIMU-like). These components could correspond respectively to subducted pelagic sediment and subducted HIMU seamounts. Isotopic trends of northern Mariana Trough basalts crosscut that of the monogenetic volcanoes, and isotopic ranges do not overlap.

These results seem to indicate that volcanism associated with propagating back-arc rifting is strongly arc-like, but more primitive than AVP frontal arc volcanism. This could be because the magma erupts without fractionating in a shallow crustal magma chamber under extensional stress regime. As rifting evolved, the relative contributions of the subducted endmembers might have changed. In this contribution, we will also present high-precision Pb isotopic data from AVP frontal arc volcanoes, and discuss effect of rifting on arc front as well as across-arc chemical variation.