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Two primary basalt magmatypes from Northwest Rota-1 volcano, Mariana arc

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Primitive NW Rota-1 basalts provide a unique example of near-primitive basaltic magmas in the Mariana arc. Northwest Rota-1 is a submarine volcano that is located about 100 km north of Guam in the Southern Seamount Province (SSP) of the Mariana arc. A single continuous submarine eruption was witnessed during ROV visits in 2004, 2005, 2006, 2008 and 2009 near the summit at 520 m depth. We visited NW Rota-1 in 2005 (NT05-17) and 2009 (NT09-02), using remotely operated vehicle (ROV) Hyper-Dolphin and RV Natsushima. Rocks were collected from the summit areas at 520-1000 m depth (dives HPD480, HPD481 and HPD952), from the eastern slope of the volcano (HPD 488; 1500-2300 mbsl), and from an andesite knoll about 13 km east of the NW Rota-1 summit (HPD951; 2000-2300 mbsl). Volcanic samples from these dives range from basalt to andesite (51-58 wt % SiO2). Samples from HPD480 (summit) and HPD488 (eastern slope) include 17 magnesian basalts (51-52 wt % SiO2) having 7.5-9.5 wt % MgO and Mg# of 61-67, indicating little fractionation. These magnesian basalts are classified on a basis of petrography into three groups: 1) olivine-clinopyroxene (Ol-Cpx) basalts; 2) olivine-plagioclase (Ol-Pl) basalts; and 3) porphyritic basalts. Ol-Cpx basalts (8 samples from deeper part of HPD488) contain phenocrysts of olivine (1.1-4.6%) and clinopyroxene (0-2.4%) sometimes with rare (<0.2 %) plagioclase. Ol-Pl basalts (6 samples from shallower part of HPD488) have olivine (0.8-3.8 %) and plagioclase (rare-1.9 %) phenocrysts with 0-0.3 % clinopyroxene. Porphyritic basalts (3 samples from HPD480) contain up to 9 % olivine, 20 % plagioclase, and 2 % clinopyroxene; these basalts are not discussed here because of high phenocryst contents. Ol-Pl basalts have higher Mg# (63-6 7) than Ol-Cpx basalts (61-65 Mg#) at the same silica contents, but these two groups differ in incompatible trace element ratios at the same silica contents. Zr/Y and Nb/Yb are higher in Ol-Pl basalts (3.1-3.2 and 1.2-1.5, respectively) than in Ol-Cpx basalts (Zr/ Y = 2.8-3.0 and Nb/Yb = 0.7 -0.9), suggesting that Ol-Pl basalts formed from lower degree of melting of its mantle source, or that the Ol-Cpx mantle source was more depleted. On the other hand, Ol-Cpx basalts have Ba/Nb = 70-80, Ba/Ta = 700-1300, Th/Nb = 0.4-0.5; and Th/Ta = 4-8, which are higher than trace element ratios for Ol-Pl basalts (30-35, 300-500, 0.1-0.2 and 1-3, respectively), suggesting that Ol -Cpx basalts have a greater subduction component than Ol-Pl basalts. Some olivine phenocrysts in Ol-Cpx basalts are Fo93 and 0.4 wt % NiO, which indicates equilibrium with mantle olivines. Most olivines of both basalt groups are more iron-rich (Fo80-90), thus differentiated, but Ol-Cpx basalts have more magnesian olivine at the same NiO contents, which further suggests a more magnesian, thus more depleted mantle source of the Ol-Cpx basalts and confirming higher degrees of melting. Olivine chemistry is consistent with the previous trace element ratios. We (Tamura et al., 2005 and 2007) also found two basalt magmas in Sumisu and Torishima volcanoes in the Izu-Bonin arc, originating from either wet or dry parental basaltic magmas. The two NW Rota-1 basalt series have an interesting contrast, which can be derived not only from the different water contents, but also from the different subduction melt components coupled with the water contents.

References

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