Evolution of Island Arc Volcanoes: Ankaramite-Andesite-Basalt (ANANBA) Model

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Nishinoshima, a submarine andesitic volcano in the Ogasawara (Bonin) Arc, ~ 1 000 km south of Tokyo, Japan, suddenly erupted in November 2013, after 40 years of dormancy. Olivine-bearing phenocryst-poor andesites found in older submarine lavas from the flanks of the volcano have been used to develop a model for the genesis of andesitic lavas from Nishinoshima (Tamura et al., 2019). In this model, primary andesite magmas originate directly from the mantle as a result of shallow and hydrous melting of plagioclase peridotites. Andesites erupted from Nishinoshima that were produced in the recent history of the volcano have been generated by olivine fractionation of primary andesitic magmas.
Primary (high Mg#) andesite is produced only when the crust is thin, and consequently only in oceanic arcs. Active examples include boninites erupted in the northern Tonga arc and reararc (Cooper et al., 2010; Resing et al., 2011).
To further examine this hypothesis, we have dived Doyo Seamount by using manned submersible SHINKAI 6500 to sample primitive magmas from the volcano, which is located about 50 km north of Nishinoshima and is underlain by thinner curst (15 km) compared to Nishinoshima. Doyo Seamount is located approximately 900 km south of Tokyo at 27˚41’ N, 140˚48’ E in the Ogasawara Arc. There is a small satellite cone about 11 km east of the summit of Doyo Seamount at the depth of ~3,000 m. A ridge extends on the flank of the volcano from the summit in the ENE direction to the depth of ~2,400 m. Thus, we tried to sample this satellite cone and the deeper part of the ridge. Interestingly, 13 samples out of all 21 samples, which we have recovered during this dive 6K#1519, are olivine-clinopyroxene basalts containing 20-40 % of very coarse clinopyroxene phenocrysts, which could be called ankaramite. Ankaramites are strongly vesiculated and their blocks have rough and rugged surface, which are different from smooth surface of basaltic pillow lavas. Some of ankaramite magmas might have had explosive eruptions at the depth of 2,000~3,000 m, which have resulted in volcaniclastic cones or brecciated lava flows.
Similar primitive and phenocryst-rich ankaramitic basalts were recovered from the old submarine knolls near Nishinoshima (Tamura et al., 2019) and Kibblewhite volcano in the Kermadec arc (Hirai, PhD thesis 2020). We suggested that lithospheric mantle was thicker before the development of Nishinoshima volcano and other oceanic arcs. Primary basaltic magmas could have been generated at depth beneath the thicker lithospheric lid, and these magmas might have interacted with the lithospheric uppermost mantle during their ascent and have resulted in the unique ankaramite magmas. The temperature of the upper part of the mantle wedge increases with frequent passage of magmas through it, and continuous subduction beneath it will drench the whole mantle wedge, thus, the thickness of the lithosphere will decrease and approach the thickness of the curst in mature arcs. Doyo Seamount could represent the early stage of Nishinoshima volcano, and thus, ankaramite magma is deemed to be a precursor of andesitic magmas. We present here the evolution model of oceanic arc volcanoes, which start from ankaramites through andesites to basalts (ANANBA model).

Keywords: andesite, ankaramite, basalt

