Generation of primary andesitic magma in oceanic arcs: Evidence from Kibblewhite Volcano, Kermadec Arc

*平井 康裕[1,2]、田村 芳彦[2]、Kaj Hoernle[3]、Christian Timm[4]、Folkmar Hauff[3]、Reinhard Werner[3]、Bogdan Vaglarov[2]、常 青[2]、宮崎 隆[2]、木村 純一[2]
*Yasuhiro Hirai[1,2], Yoshihiko Tamura[2], Kaj Hoernle[3], Christian Timm[4], Folkmar Hauff[3], Reinhard Werner[3], Bogdan Vaglarov[2], Qing Chang[2], Takashi Miyazaki[2], Jun-Ichi Kimura[2]

1. 金沢大学大学院 自然科学研究科、2. 海洋研究開発機構、3. ゲオマール海洋研究所、4. GNSサイエンス
1. Graduate School of Natural Science and Technology, Kanazawa University, Japan, 2. Japan Agency for Marine-Earth Science and Technology (JAMSTEC), Yokosuka, Kanagawa, Japan, 3. GEOMAR Helmholtz Centre for Ocean Research, Kiel, Germany, 4. GNS Science, Lower Hutt, New Zealand

Melting of hydrous subarc mantle at low pressure (<1 GPa) may produce primary andesitic melts, suggesting that primary andesitic lavas can be expected in oceanic arcs where the crust is thin (Tamura et al., 2016). Beneath thick crust, melting of hydrous mantle at higher pressures will occur at higher pressures below the thick crust, generating basaltic primary melts. Recently, Tamura et al. (2018) discovered olivine-bearing andesites derived from primary andesitic melts at the Nishinoshima volcano in the Ogasawara Arc, Japan, where the crustal thickness is 21 km. Here, we will present another example for generation of primary andesitic melts in the southern Kermadec arc.

During R/V SONNE expedition in 2017 (SO-255), phenocryst-poor andesites (57.5–57.6 wt.% SiO_2) were recovered from Kibblewhite volcanic complex, southern Kermadec Arc. These andesites contain skeletal olivine and clinopyroxene microphenocrysts with similar and restricted Mg-numbers (Mg/[Mg+Fe] = 0.84–0.85) and a few euhedral olivine xenocrysts with a magnesian cores (Mg/[Mg+Fe] = ~0.92). The magnesian andesites (5.5–5.6 wt.% MgO; Mg# = 56.8–57.3) have relatively high Ni (~50 ppm) and Cr (~180 ppm) contents. These lavas have depleted high-field strength element and enriched large-ion lithophile element compositions (e.g., Nb/Yb = 0.75–0.80; Ba/Nb = 148–175), similar to the coeval Kibblewhite basalts and typical for other southern Kermadec Arc lavas. Sr-Nd-Hf-Pb isotope compositions for the andesites and basalts of the Kibblewhite Volcano also cannot be distinguished from each other and are consistent with the range of published data for the southern Kermadec Arc (Todd et al., 2011; Timm et al., 2014).

Calculation of equilibrium olivine compositions and olivine fractionation trends (Tamura et al., 2000) indicate that olivine microphenocrysts in the andesites are in equilibrium with host rocks and that the andesites have experienced 10% olivine fractionation from mantle-derived primary melts. Primary melt compositions for the andesites (estimated by addition of 10 wt.% equilibrium olivines) are still andesitic (55.9–56.0 wt.% SiO_2; 9.58–9.68 wt.% MgO) in composition and similar to the estimated primary andesite melt of the Nishinoshima volcano. According to thermo-barometric modelling of Lee et al. (2009) the primary melts for the andesites are segregated from mantle peridotite at temperatures of 1190–1220℃ and pressures of 0.45–0.55 GPa assuming primary H_2O contents to be 1.0–3.0 wt.%. The low primary magma segregation pressures, corresponding to 15–18 km depths, are consistent with thin (9–12 km; Bassett et al., 2016) crust beneath the southern Kermadec Arc.

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