Andesite magmas from NW Rota-1 volcano, Mariana arc

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NW Rota-1 volcano is an active submarine volcano in the Southern Seamount Province of the Mariana arc. NW Rota-1 is conical and about 16 km in diameter at its base at 2700 mbsl. The summit is about 520 mbsl. Using JAMSTEC’s ROV, a total of 42 rock samples were collected from the summit region (531-1080 mbsl) and near the base (1474-2260 mbsl) of the volcano. These lavas are medium-K basalts and andesites with 51.5-58.2 wt% SiO$_2$. We note, that lavas ranging from 54-57 wt% SiO$_2$ are conspicuously absent and that most lavas tend to cluster at 52 and 57 wt% SiO$_2$. In contrast, melt inclusions trapped within olivine grains from the same lavas span a much wider range (48.7 to 56.9 wt% SiO$_2$) and show a continuous range (i.e., no gaps). Major element compositions of melt inclusions are based on volatile-free compositions, normalized to 100% with total iron calculated as FeO. Water contents of melt inclusions range from 1.1 up to 5.8 wt% H$_2$O and we suggest that compositions could represent primary melts. We reject the possibility that melt inclusions are simply recording differentiation processes since the range in SiO$_2$ is found over a relatively narrow range of MgO contents. Interestingly, hydrous melt inclusions (5-6 wt. % H$_2$O) are magnesian andesites, having Mg# ($100\text{Mg}/(\text{Mg}+\text{Fe}) > 65$ and $53-57$ wt % SiO$_2$. There are two trends in olivine compositions from NW Rota-1 on Fo-NiO diagram. One trend is magnesian at the same NiO contents and extends to $\text{Fo}92$, having ~0.4 wt. % NiO. Another trend is less magnesian. Hydrous magnesian andesitic melt inclusions are trapped within olivine grains, which forms the former magnesian and thus depleted trend. Estimated primary magmas of these melt inclusions range from basalt to magnesian andesite (48-55 wt% SiO$_2$) and, interestingly, these compositions are similar to compositions of melts formed by partial melting of peridotite under hydrous conditions.

If melt inclusions are recording a wide range of primary melts composition, why do complementary lavas record such a restricted range of compositions? Here we explore why this difference is observed and evaluate whether melt inclusions record primary andesite melt compositions. One possible explanation is that lavas have experienced late stage differentiation processes such as reheating and remobilization, obscuring primary source compositions. Pyroxenites found in lavas show compositional zoning and based on thermometry estimates, suggest cool core temperatures 800-900°C, as compared to their rims (1000-1100°C). We suggest that low temperature, water-rich magnesian andesite magmas stalled at depth, but were later reheated and remobilized by partial melting within the crust. Thus, hydrous magnesian andesite melts just couldn’t erupt on the surface, but may be ubiquitous within the arc middle crust.

Key words: Izu-Bonin-Mariana arc, island arc, subduction zone, magma, andesite

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