# Hydrous felsic magma generated by unmixing of slab-derived supercritical liquid: evidence from Rishiri Volcano, Kuril Arc

*Hajime Taniuchi[1], Takeshi Kuritani[2,3], Tetsuya Yokoyama[4,3], Eizo Nakamura[3], Mitsuhiro Nakagawa[2]

1. Department of Natural History Science, Graduate School of Science, Hokkaido University, 2. Department of Earth and Planetary Science, Faculty of Science, Hokkaido University, 3. Institute for Planetary Materials, Okayama University, 4. Department of Earth and Planetary Sciences, Tokyo Institute of Technology

## Introduction

Water-rich components released from the subducting slab play important roles in the generation of subduction-zone magmas in the mantle wedge (e.g. Elliott, 2003). With increasing fluid releasing depths, the slab-derived water-rich materials would become supercritical liquid (e.g. Bureau and Keppler, 1999).Experimental studies have suggested that slab-derived supercritical liquid is separated into hydrous silicate melt and aqueous fluid during the ascent in the mantle wedge (e.g. Kawamoto et al., 2012). However, the occurrence of magmas corresponding to this hydrous melt has not been reported so far. In this context, we have carried out a detailed petrological, geochemical, and chronological study on calc-alkaline andesite and dacite at Rishiri Volcano.

## Results

Rishiri Volcano is a Quaternary stratovolcano in southern Kuril arc, and is 300 km above the Wadati-Benioff Zone. The volcanic activity started at ~0.2 Ma, which is characterized by coexistence of alkali basalt, tholeiitic andesite to dacite, and calc-alkaline andesite to dacite. The calc-alkaline andesitic products and the following dacitic lavas, investigated in this study, comprise Middle stage of the volcanic activity (Ishizuka, 1999). Our new $^{40}Ar/^{39}Ar$ age data for the dacitic and andesitic lavas are 35.5 ±1.4 ka and 34.6 ±3.0 ka, respectively.

The phenocryst assemblage of the dacitic lavas is Cpx + Opx + Pl, and that of the andesitic lavas is Ol + Cpx + Opx + Pl. All phenocrysts in the dacite have homogeneous compositions or show normal zonation with limited variations. In contrast, those in the andesite occasionally show reverse zonation. Some olivine and plagioclase phenocrysts have core compositions with up to Mg#89 and An#88, respectively. The dacitic lavas are characterized by high Sr/Y and La/Yb ratios (adakitic signature), no Eu anomaly, homogeneous Sr, Nd, and Pb isotopic ratios, and $^{230}Th$-excesses. On the other hand, the andesitic lavas are heterogeneous in whole-rock major, trace, and isotopic compositions.

## Discussion

The petrological and geochemical features of the andesitic products suggest that they were produced by mixing between felsic magma and primitive mafic magma. On the other hand, the dacitic lavas do not show any evidence of magma mixing. The absence of Eu anomaly negates a primary role of fractional crystallization in the magma genesis. In addition, the adakitic signature cannot be produced by crustal melting, because the underlying crust is too thin (Niu et al., 2016) for garnet to be stable (e.g. Rapp and Watson, 1995). Therefore, it is suggested that the dacitic magma was derived from the upper mantle, most plausibly, from the subducting slab. The slab origin of the magma is consistent with the $^{230}Th$-excess

 

signature and the Pb isotopic compositions, which can be explained by mixing of a sediment component and an altered oceanic crust component of the slab.

One possible origin of the dacitic magma would be direct partial melting of the subducted slab (e.g. Defant and Drummont, 1990). However, extremely high temperatures with >1300ºC (Mibe et al., 2011) is required to melt the slab at ~300 km depth, which is highly unlikely. The andesitic and dacitic lavas erupted almost contemporaneously (~35 ka), with the former preceding the latter. The primitive mafic magma, involved in the generation of the andesitic magma, is considered to have been generated through fluid-fluxed melting of the mantle. These observations suggest that slab-derived aqueous fluid and slab-derived hydrous melt, corresponding to the dacitic magma, were almost simultaneously present in the upper mantle beneath the Rishiri Volcano at ~35 ka. Therefore, it is suggested that the dacitic magma may represent hydrous melt, which was separated from the ascending slab-derived supercritical liquid at the depth corresponding to the critical end point, leaving behind aqueous fluid (e.g. Kawamoto et al., 2012) that induced the generation of the primitive basaltic magma.

Keywords: Supercritical liquid, Unmixing, Subduction zone magmatism

 