Origin of calc-alkaline felsic magmas in the middle part of northeastern Japan – Petrology of the Takamatsu volcano

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The Takamatsu volcano is composed of medium-K calc-alkaline andesite to dacite, and the products are divided into two units. The Takamatsudake lava, composed of Ol(+-)-Qtz-Opx-Cpx-andesite to dacite (61.6-66.6% in silica content), is covered by the Yamabushidake lava composed of Hbl(+-)-Qtz-Opx-Cpx-dacite (68.8-69.4% in silica content). Mafic inclusions (50.1-55.6% in silica content), which show the quench texture with Ol, Opx(+-), Cpx(+-) and Pl phenocrysts, are found in these lavas. Co-existence of disequilibrium phenocrysts and resorbed textures can be observed in Takamatsudake lavas and Si-richer mafic inclusions but not in Yamabushidake lavas and Si-poorer mafic inclusions. Whole rock compositions from the Takamatsudake, Yamabushidake lavas and mafic inclusions are plotted on the same linear trends in co-variant diagrams. The compositions of Takamatsudake products and Si-richer mafic inclusions are plotted between Yamabushidake products and Si-poorer mafic inclusions. These features suggest that Takamatsudake products and Si-richer mafic inclusions are formed by the mixing of two magmas, which produced Si-poorer mafic inclusions and Yamabushidake products. The temperature of the mafic end-member magma was ca. 1150°C, while that of the felsic end-member magma was ca. 800°C. The trace element composition shows the felsic end-member cannot be derived from the mafic end-member through the fractional crystallization, but from the re-melting of the solidified medium-K basalt leaving Hbl gabbroic residues.

Systematic lateral variation in chemical compositions of Quaternary basaltic rocks from northeast Japan has been well known, such as increasing of incompatible elements from front to back arc. The origin of the variation attributed to across-arc discontinuous dehydration at different depth in the down-dragged hydrous subducting plate and different degrees of partial melting in the mantle wedge. Such zonal variation can be also observed in felsic rocks in the middle part of northeast Japan arc. These felsic rocks generally belong to calc-alkaline series. The trace element composition shows these felsic rocks cannot be derived from their precursory basaltic rocks through the fractional crystallization. Thus the zonal variation supports that these felsic rocks derived from the re-melting of the solidified their precursory basaltic magmas as observed in the Takamatsu volcano.

Life on the rocks: Bioalteration of volcanic glass in the oceanic crust

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Ocean drilling has provided scientsts and the world with a window into the deep biosphere. Early studies of microbial activity previously restricted to shallow sediments have now been extended and complemented by similar investigations of basaltic oceanic crust. Microbial alteration of basaltic glass from *in situ* oceanic crust and ophiolites is perhaps one of the most exciting recent discoveries because of the possibility that significant geochemical fluxes between the oceanic crust and seawater may be biologically mediated.

We discuss the use of petrological, geochemical, and microbiological methods for the detection of microbial alteration in basaltic glass from ODP/DSDP cores and corresponding studies of ophiolites. By using a multi-technique approach we are able to convincingly demonstrate the presence of microbial activity. Petrographic evidence of fossil microbial alteration is observed as two textural types: tubular and granular. Tubular textures are characterized by micron-scale, tubular to vermicular, channel-like features and branching bodies extending into fresh glass (Fig. 1). Granular textures appear as solid bands, semicircles or irregular patches of individual or coalesced spherical bodies (~ 0.2 to 0.6 μm in diameter), that protrude into fresh glass.

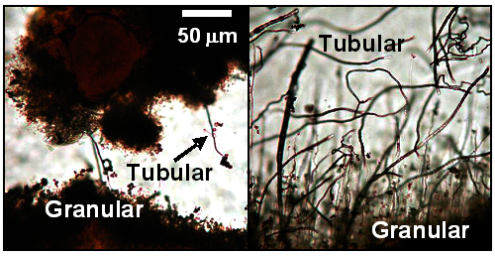

Fig. 1. Granular and tubular microbial textures in glass.

Detailed SEM imaging of these features in thin sections and on grain mounts of freshly exposed surfaces reveal complex channels, delicate filament-like structures, and material resembling desiccated biofilm. X-ray element maps collected by electron microprobe show elevated levels of C, N, P, and K associated with these features. Carbon isotope ratios of carbonates in samples of microbially altered volcanic glass are commonly depleted by as much as -20‰, which is interpreted to result from biologic fractionation. We have applied commonly accepted nucleic acid staining techniques to these samples and imaged them with laser scanning confocal microscopy. This has produced exceptional images that provide high resolution spatial information on the presence of DNA/RNA associated with areas of suspected microbial alteration.