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Vertical Variation of Biotite and Fe-Ti Oxides in Takanoobane Rhyolite Lava in Aso Caldera

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The rhyolite lavas have been effused everywhere in the world through geologic time. The internal structures are divided into three parts: (1) Alternation of the pumiceous layers and the obsidian layers (the upper part), (2) the crystalline rhyolite layer with flow structure composed of assemblage of minute cavities (the central part), and (3) the obsidian layer (the lower part) (Furukawa and Kamata, 2005). These are almost formed as a result of cooling and degassing process during flowage and emplacement. The textures observed in microscopic scale also reflect the variation of physical properties of the lava. Especially, the occurrences of biotite and Fe-Ti oxides reflect cooling rate and redox state of the lava, respectively. Therefore, it is important to study the textures to understand the behavior of the rhyolite lava. In this study, we deal with the two drilling cores obtained from the Takanoobane rhyolite lava in Aso caldera.

Biotite was divided into three based on the colors: (1) Green indicating fresh, (2) red indicating dehydrogenized, and (3) black indicating dehydrated. The distribution shows a symmetrical pattern in a perpendicular direction in both AVL1 and AVL2. Biotite in black is distributed in only the central crystalline rhyolite layer. Biotite in red is distributed from the central crystalline rhyolite layer to outer obsidian and pumiceous layers. Biotite in green is distributed in outer obsidian and pumiceous layers. This result means that the cooling rate was relatively slow in internal part and relatively fast in the outer part. It shows that the Takanoobane lava cooled from both the top and bottom part toward the central part.

Fe-Ti oxides were divided into three types based on the occurrence and minerals: (A) homogeneous titanomagnetite, (B) titanomagnetite containing ilmenite lamellae, and (C) a completely pseudomorphed titanomagnetite consisting of titanohematite with pseudobrookite lamellae. Type C is the most advanced stage of oxidation of original titanomagnetites. We showed the distribution of the type of Fe-Ti oxides. The distribution shows no systematic change corresponding to the depth of the lava unlike the distribution of biotite. Instead, it seems to be related to the distribution of the flow structure. The highly oxidized Fe-Ti oxides such as types B and C are distributed around the flow structure. On the other hand, Fe-Ti oxides distributed in the part showing no flow structure do not show significant oxidation. Most Fe-Ti oxides are a magnetic mineral and show individual magnetic property. Hence, the change of the above type of Fe-Ti oxides causes the change of the magnetic property of the rock. We obtained rock magnetic data from the Takanoobane lava in order to confirm the relation between the flow structure and the oxidation state. The results also showed that oxidation is progressed in the flow structural part. Oxidation generally occurs by either addition of oxygen or release of hydrogen. In the thick lava, it is difficult to add oxygen to the central part of the lava. Therefore, it is considered that the oxidation is caused by release of hydrogen from internal part of the lava. The plausible process is as follows.

Hydrogen is saturated with the cooling of the lava. The hydrogen gas does not be released easily in the high viscosity rhyolite lava. However, in around the flow structure composed of the minute cavities, the hydrogen gas is released to the minute cavities due to the relatively low pressure. Therefore, oxygen fugacity increases around the flow structure, and hematite suggesting high oxidation state is formed there.