The magma ascent process of Usu 1977 Plinian eruption: Constraints from the microlite texture and chemical composition

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The magma ascent and degassing processes can control the nature of eruption style (e.g. Eichelberger et al., 1986). Recently, a lot of magma decompression experiments, which imitate the magma ascent process, have been done to solve how it is. Burgisser and Gardner (2005), for example, suggests the ascent rate when magma starts to ascent from the magma chamber is one of the most influence parameters to control the nature of eruption style. Suzuki et al. (in review) basically believes the microlite in the groundmass of pumice records the magma ascent rate, and conducted the decompression experiment to solve the magma ascent process of the phreatomagmatic eruption of Usu Volcano in March 31, 2000. As a result, it reveals the magma ascent process in detail by comparing the microlite textures and chemical compositions between natural pumice and products of the experiment. Usu 1977 Plinian eruption resembles Usu 2000 phreatomagmatic eruption in the chemical composition of groundmass glass (Tomiya and Miyagi, 2002). Thus, we can apply the result of Suzuki et al. (in review) to Usu 1977 Plinian eruption. So we investigate the microlite texture and chemical composition of the pumice, which was produced by Usu 1977 Plinian eruption, and infer the magma ascent process.

Usu 1977 eruptive activity is characterized by 4 Sub-Plinian eruptions (Suzuki et al., 1982). The first Plinian eruption started at 9:10 August 7th (Katsui et al., 1978), which was preceded by the earthquake swarms for about 32 hours (Yokoyama et al., 1981). The all eruptive activity finished in 2 days. Nakamura et al. (2005) reveals the pumice produced by them has heterogeneity in its color, vesicularity, and bubble number density, and the vesicularity and bubble number density are systematically changed by the color.

Almost all of the plagioclase microlites are skeletal and have no chemical compositional zoning. The anorthite content of them is about 45-50, and doesn't depend on the color, vesicularity, and bubble number density. By the way, the result of Suzuki et al. (in review) (initial and final pressure is 125 and 50 MPa, respectively) shows the skeletal plagioclase microlites appear when the sample is rapidly decompressed (about 0.67 MPa/s), and then kept at final pressure. It also shows more rapidly decompressed, lower anorthite content. Therefore, we suppose all types of pumice were produced by the magma which was rapidly decompressed and stagnated. The variations of the color, vesicularity, and bubble number density were produced by the difference of magma degassing process when and after it stagnated. We propose two mechanisms to make the difference. First, the difference of magma stagnation time may cause the difference of degree of magma degassing. Second, the variable shear stress of magma across the conduit wall after the magma restarted from stagnation point may cause it.