

Link between eruption place and magma ascent condition-example from 1977 and 2000 eruptions of Usu volcano-

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Rate and stagnation in syneruptive magma ascent can determine eruption place (summit or flank). Along with height of summit, density of magma beneath summit can control eruption place (lower density is preferable for flank eruption)(Ida, 2000). The density changes with depth and time, due to vesiculation and gas phase escape from the system. In general, faster magma ascent prohibits the gas escape, resulting in lower density. Using volcanic ejecta, we can discuss whether or not ascent conditions control eruption place in certain volcano.

We thus compared syneruptive magma ascent in latest two eruptions in Usu volcano. Four plinian eruptions occurred at summit in 1977, while one phreatomagmatic event occurred at flank (West Nishiyama) in 2000. Suzuki and Nakada (2001, 2002) revealed that all dacitic magma issued in the phreatomagmatic event ascended in similar timescale and style. As target of comparison, we selected pumices issued in the first eruption (Big-1) of 1977 activity. Magma ascending prior to the Big-1 event probably determined eruption place through 1977 activity, by forming a new conduit. Magmas in two activities resemble each other, in compositions of phenocryst and groundmass glass (e.g. Tomiya and Miyagi, 2002), indicating temperature and depth of reservoir also resembled.

In 2000, magma ascended beneath summit at first, and then moved toward West Nishiyama without significant change in depth (2km). This implies ascent to 2km depth may determine eruption place. To focus on such stage, we use groundmass microlite (especially plagioclase whose compositional and textural changes with decompression condition are well known) because this enables us to extract ascent condition of specific timing. In case of explosive felsic magma eruption, crystallization does not record ascent condition at depth shallower than fragmentation level (because increased melt viscosity and magma acceleration act synergistically). For example, syneruptive crystallization of 2000 magma was completed before acceleration beneath West Nishiyama (Suzuki and Nakada, 2001). Furthermore, pressures of nucleation start can be compared using core compositions of relatively large microlites (Suzuki et al., 2005).

Plagioclase microlites in 2000 ejecta are skeletal and lack compositional zoning (An₄₅₋₅₀). In decompression experiments to simulate magma ascending from reservoir (125MPa) to 2km depth (50MPa) (Suzuki et al., in review), the skeletal form was reproduced when decompression was completed in less than 1.5 hour and sample was additionally held at the final pressure. An content of experimental plagioclase microlite decreased with increasing decompression rate and approached that in ejecta when decompression is as short as 1.5 hour, being in accordance with constraint from the form. Irrespective of pumice color (white, bright gray, dark gray; Nakamura et al., 2005), plagioclase microlites in 1977 ejecta resemble those in 2000 ejecta in form and composition. This means magma erupted in 1977 activity was held at a constant depth after fast ascent, as in 2000. The stagnation is highly possible, because the ascent before eruption initiation should have take place along with conduit formation. Also, composition data implies similar depth of stagnation, as An content of plagioclase microlite can be dependent on final pressure in fast decompression.

As far as 2000 and 1977 activities are considered, magma ascent condition does not change with eruption place. However, efficiency of gas escape in the stagnation stage may have been different. For example, permeability of host rock (a factor controlling the efficiency) was probably higher in 2000 than in 1977. Erupted magma began to ascend from reservoir after two days precursory seismicity in 2000 (Suzuki et al., in review), while after shorter time in 1977 (e.g. Yokoyama et al., 1981), letting us speculate that destruction of host rock advanced more in 2000.