Factors affecting the sequence of the Plinian eruption inferred from rock texture and physical properties - an example of the 1783 eruption, Asama volcano, Japan

*Tatsuki Mizuno[1], Fukashi Maeno[1], ATSUSHI YASUDA[1]

1. Earthquake Research Institute, Department of Earth and Planetary Science, University of Tokyo

Plinian-style eruption is characterized by a large-scale column formed by an explosive magma rising. It often shows variation of eruptive style such as pyroclastic flows and lava flows, and the eruption styles change complicatedly in the same series of activity. Determining the factors controlling the eruptive style and its change is important for predicting the sequence of the eruption. In this study, we focus on the 1783 eruption of Asama volcano in order to understand the magma ascent process and factors controlling eruptive style through analysis of chemical composition and observation of rock texture. In the climactic phase of the 1783 eruption, a large column was established and pumice-fall deposits were formed at first, then the eruptive style changed to pyroclastic flows. Magma composition in the pyroclastic flow phase changed to be lower SiO_2. Pumice-fall deposits are divided into 16 layers. Upper half of the deposits were formed in climactic phase. In the middle level of deposits, there are some red ash layers which may have formed by pyroclastic flows before climactic phase. The main units of pyroclastic flow deposits include gray scoriaceous juvenile clasts. The bottom layer of pyroclastic flows contains juvenile pumice clasts, so the changes of chemical composition and eruptive style was not simultaneous.

Pumice clasts from fallout and pyroclastic flow deposits were chosen for measurement of density, microscopy, and chemical analyses. The apparent density ranges 0.6-0.9 g/cm^3 in fall deposits, 0.7-0.95 g/cm^3 in pumiceous pyroclastic flow deposits, and 0.7-1.2 g/cm^3 in scoriaceous pyroclastic flow deposits. The ratio of the connected vesicles ranges 87-96% in fall deposits, 83-98% in pumiceous pyroclastic flow deposits, and 91-95% in scoriaceous pyroclastic flow deposits. The ratio of connected vesicles ranges widely in pumiceous clasts, pyroclastic flow deposits have lower ratio than fall deposit. Scoriaceous clasts have higher ratio than pumiceous clasts. Phenocryst types are plagioclase, orthopyroxene, clinopyroxene, and Fe-Ti oxide, and olivine is rare. SiO_2 content of groundmass glass shows bimodal distribution around 67wt% and 72wt%. Pyroclastic flow deposits contain abundant low-SiO_2 clasts than pumice-fall deposits. Magma temperature and water content are estimated from chemical composition of plagioclase and matrix glass (Putirka, 2008; Waters and Lange, 2015), then SiO_2= 67 wt%, T=1060-1100℃, H_2O=0.8-1.0 wt% and SiO_2=72 wt%, T=1000-1015℃, H_2O=1.2-1.4 wt%. Vesicles in pyroclasts in the upper units are more connected and elongated. Clast types in pyroclastic flows are similar to the lower part of fallout units, but scoriaceous ones have thick bubble wall glass. We analyzed crystal and vesicle textures by using the shareware program ImageJ and CSD correction (Higgins, 2006). Crystallinity range 7-14% and poor in microlite. The average vesicularity of each layer ranges around 75% in pumice-fall deposit, excepting middle level, and 65-67% in middle level fall deposit and pyroclastic flow deposit. Bubble number density (BND) ranges 2.0-4.0×10^{13} m^{-3}, then the flow deposits show higher in BND than the fall deposits. Decompression rate for each layer can be estimated from BND, SiO_2 content, water content, and temperature (Toramaru, 2006). It was calculated at 3.2-4.7×10^7 (Pa/s) in fall deposits, 5.0×10^7 (Pa/s) in pumice flow deposit, and 1.0×10^8 (Pa/s) in scoriaceous flow deposit.

The change of the decompression rate has a correlation with changes of the eruptive style from column formation to pyroclastic flow generation. Fall deposits accompanied by red ash in the middle layer, which indicates simultaneous generation of pyroclastic flows, show high decompression rate. Based on these results, it is suggested that the increase of magma decompression rate is densely related to generation of pyroclastic flows during the climactic phase of the 1783 eruption.

Keywords: Asama Volcano, eruptive style, magma ascent process, textural analyses

