The effect of external water to plinian and phreatoplinian eruption

*Yoshimi Hiroi[1], Tsuyoshi Miyamoto[1]

1.Center for Northeast Asian Studies, Tohoku University

Phreatoplinian eruption is one of phreatomagmatic eruption that occurs when vesiculated and fragmented felsic magma come into contact with external water. This eruptive style has not been observed yet, and it is defined by typical characteristics of deposits, which include enriched fine-grained ash particles produced by water cooling contraction granulation (Houghton et al., 2000) or phreatomagmatic explosion (Self and Sparks, 1978). Results of experiments on water-magma interaction (Hiroi and Miyamoto, 2012) and analyses of whole-grainsize distribution (Hiroi and Miyamoto, 2015) are contradictory to both fragmentation mechanisms, and therefore, this fine-grained feature must be the result of accretion by liquid water during transportation (Self and Sparks,1978). Generally, the eruptive style is controlled by magma-water ratio, and magmatic eruptions occur when the amount of water is small enough than magma (Wohlets and Heiken, 1984). Koyaguchi and Woods(1996) simulated the behavior of an eruptive column affected by external water and showed that the column has been kept even if containing water account for 30wt%. Both plinian and phreatoplinian eruptions form eruptive columns; therefore, their borders appear to be dependent on the amount of water in the column. This study examines the effect of external water on plinian and phreatoplinian eruptions. The latest activity in Towada volcano is the Heian eruption, where the inner caldera lake in a double caldera was the vent, and all eruptions occurred through the lake water. Although the first unit OYU-1 erupted in contact with external water, it has been classified as a plinian eruption considering the features of the deposit such as facies, sorting, and F-D plot (Hiroi et al., 2015). OYU-1 contains cauliflower pumice (Heiken, 2006), which is rare although plinian eruptions are very common in the world. In addition, it does not exist in older plinian deposits in Towada volcano. The formation of cauliflower pumice requires an amount of water greater than that in the aquifer. However, the presence of cauliflower pumice implies that phreatoplinian eruptions do not occur unless external water is taken into the eruptive column even though magma come into contact with a large amount of external water. OYU-2 mainly consists of base-surge, and its characteristics such as fine-grained feature and vesiculated tuff correspond to phreatoplinian eruptions (Hiroi et al., 2015). The eruptive rate of OYU-2 is possibly larger than that of OYU-1. Although the water-magma ratio indicates magmatic eruption, OYU-2 is definitely a phreatoplinian eruption. The heat transfer efficiency from magma to water is expected to have increased because bubble growth in magma before contacting water increases successively from OYU-1 to OYU-2 (Hiroi and Miyamoto, 2011). Through heat transfer, steam is generated and the amount of water taken into the column is increased, effectively creating a wet column for phreatoplinian eruption. Plate-like glass shards indicating large expanded bubbles are outstanding in many phreatoplinian ejecta (Wohlets and Heiken, 1985). Cauliflower pumice did not form under quenching in phreatomagmatic activity, indicating that efficient heat transfer occurred. These suggest that bubble growth and heat transfer efficiency are very important for phreatoplinian eruptions to occur. With the abovementioned results, this study proposes that plinian eruptions affected by external water are common, because of non-existence both phreatomagmatic explosion and water cooling contraction granulation, the initial condition of phreatoplinian and plinian eruptions are the same, and phreatoplinian eruptions may occur if both the conditions of sufficient water and bubble growth are satisfied.

Keywords: phreatoplinian eruption, plinian eruption, Towada volcano, cauliflower pumice, heat transfer efficiency

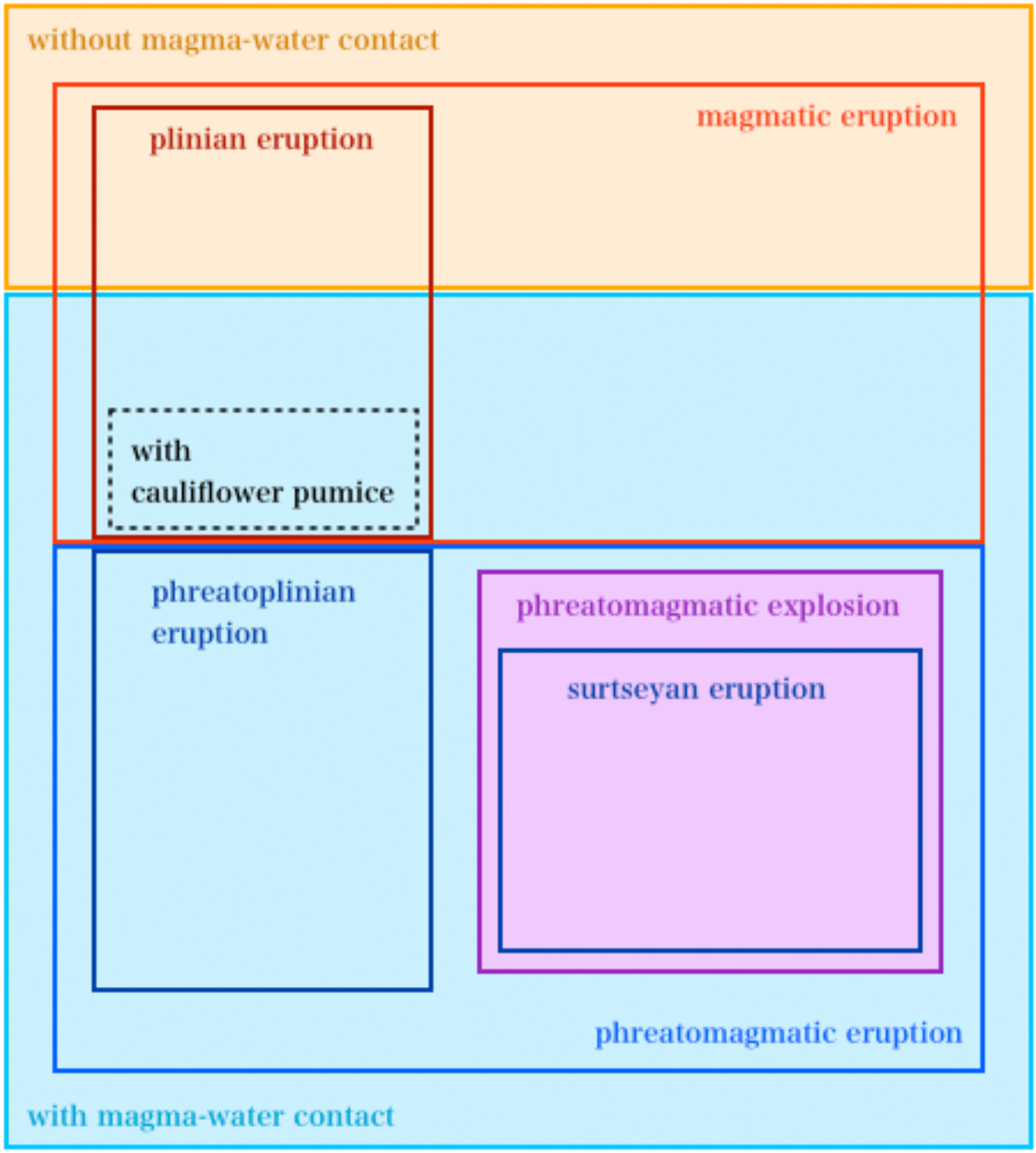

図. 本研究の結論から導かれる外来水の関与と噴火形態及び噴火様式の関係分類図

Fig. The new classification diagram of eruptive style on magma-water contact from this study.

