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Temporal variation of geological and petrological features of the Kattadake pyroclastic rocks in the Zao newest activity

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Based on petrologic analyses of successively corrected samples, we have examined the magmatic evolution in the newest activity (ca. 30 ka to the present) of Zao volcano. In this study, we will present geological and petrologic characteristics of the Kattadake pyroclastic rocks which is one of the units of the newest activity, and reveal the magmatic evolution of this unit.

The Kattadake pyroclastic rocks distribute inner part of the Umanose caldera which formed in early part of the newest activity. This unit is composed of more than 20 pyroclastic layers, which are divided into lower, middle, and upper parts. The deposits show four facies, scoriaceous ash, agglutinate, volcanic breccia, and tuff breccia. The dominant facies is scoriaceous ash all the way. The tuff breccia facies is observed in lower and upper parts, and the agglutinate and volcanic breccia facies are in the upper part. The agglutinate facies also occur in top of the middle part. The scoriaceous ash facies layers are composed of black scoriaceous ash matrix with planer stratification, and include black scoriae fragments. The agglutinate facies layers are composed of black scoria spatters, bombs and fragments. The volcanic breccia facies is characterized by abundant andesitic blocks in blown ash matrix. The tuff breccia facies layers are constituted of white to pinkish clay matrix with altered lithics.

The rocks belong to medium-K, calc-alkaline rock series, and are mainly olv-bearing-cpx-opx basaltic-andesite to andesite. In the upper part, olv-cpx-opx basaltic-andesite also occur. The range of the SiO_2 and K_2O contents are ca. 55.0-58.4 % and ca. 0.69-1.18 %, respectively. The whole rock SiO_2 contents of rocks from lower to middle parts are almost constant, ca. 55.5 %. In contrast, the contents increase to ca. 57.0 % in upper layers. In addition, the rocks form top layer of the upper part show Cr-Ni richer trends than the other layers.

By textural and compositional features, phenocrysts can be divided into following three groups. Group A includes low-An plagioclase (An = ca. 58-80), orthopyroxene (Mg# = ca. 64-68), and clinopyroxene (Mg# = ca. 65-71). Most of these plagioclases have patchy textured core, oscillatory zoned mantle with or without dusty zone, and thin clear rim. Some of An-richer ones have honeycomb textured core and clear rim. The pyroxenes show homogeneous core and have narrow Mg-rich zone (Mg#, up to 78) just inner part of rim. Glass inclusions in core are common. Group B includes high-An plagioclase (An = ca. 88-92) and olivine (Fo = ca. 74-85). Both plagioclase and olivine usually show a homogeneous clear core with normal zoned rim, whereas some Fo-poorer olivines (Fo, lower than 80) have narrow Fo-rich zone (Fo = ca. 83) just inner part of rim. Group C includes small and subhedral orthopyroxene (Mg# = ca. 70), although this phenocryst is always rare.

We inferred that the Kattadake pyroclastic rocks were formed by magma mixing between two end-member magmas for group A and B. Proportion of felsic end-member would increase form lower to upper parts. The bulk SiO_2 content and temperature of the felsic end-member magma are estimated to be ca. 59-61 % and ca. 950 degrees C. The similarity of the chemical compositions of group A phenocrysts among layers suggests that the felsic end-member magma had similar composition during the activity. The bulk SiO_2 content of the mafic end-member magma are estimated to be 50-52 %. Further, the olivines with Fo-rich zone indicate that the mafic end-member magma would be tapped by more mafic basaltic magma form deeper area. The more mafic magma would be effective in forming the Cr-Ni richer magma in top of upper part. During the injection of the mafic end-member magma into the felsic magma chamber and subsequent mixing, dusty zone of plagioclase, Mg-rich zone of pyroxene, and group C phenocrysts would be formed. Consequently, well mixed magma erupted.

Keywords: Magma evolution, Magma mixing, Phenocryst types, Kattadake pyroclastic rocks, Zao volcano, NE Japan