Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC47-P09 Room:Convention Hall Time:May 26 18:15-19:30

Magma evolution and time scales of magma mixing of the Kumanodake agglutinate of Zao volcano, northeastern Japan

TAKEBE, Yoshinori[1*] ; HIROKAMI, Chihiro[1] ; BAN, Masao[1]

[1]Faculty of Science, Yamagata Univ.

To understand the evolution of magma system for the activity of newest stage (c. 33 ka to present) of Zao volcano in northeastern Japan, we have investigated the eruption products of the Komakusadaira activity (c. 33 ka to 12 ka). In this study, we will infer the evolution of magma system based on detailed petrological features of the Kumanodake agglutinate which was formed during initial period of the activity.

The Kumanodake agglutinate drapes the summit area of Mt. Kumanodake whose inner part is comprised by the older stage products. This unit piles up successively without any unconformity or secondary deposits. The succession is ca. 30 m thick, comprising stratified pyroclastic layers (agglutinate, agglomerate, tuff breccia, and lapilli tuff). The layers include various amount of black scoriae (~1m), gray andesitic bombs (~20cm), and subordinate amounts of gray andesitic lapillus to volcanic block in the matrix of reddish brown scoriaceous ash. The explosivity is inferred to have increased over time because the abundance of the scoriae increased. Futhermore, the large scoriae are usually found in the top part.

The rocks are mixed medium-K calc-alkaline olv-cpx-opx basaltic-andesite (55.2-56.2% SiO_2, 0.82-0.85% K_2O). From the base to the top, SiO_2 and Zr contents decreased gradually, whereas the CaO and MgO contents increased.

Based on petrologic features, we deduced the products were formed by magma mixing of felsic magma and mafic magma. The estimated felsic magma (59-62% SiO_2, 956$\pm$17 degrees Celsius in the lower part and 967$\pm$22 degrees Celsius in the upper part) with orthopyroxene (Mg# = 60-69), clinopyroxene (Mg# = 65-71), and An-poor plagioclase ($An_{ca.60-70}$) was stored in a shallower region. The mafic magmas are further divisible into two types: less and more differentiated, designated respectively as mafic magma-1 and mafic magma-2. The less differentiated mafic magma-1 was olivine (Fo_{84}) basalts (ca. 49-51% SiO_2, 1110-1140 degrees Celsius). The differentiated mafic magma-2 was basalt (1070-1110 degrees Celsius) having olivine ($Fo_{ca.80}$ with reverse zoned part of Fo_{84}) and An-rich plagioclase ($An_{ca.90}$) phenocrysts was the basalt formed occasionally at 3-6 km depth. The mafic magma-1 was the dominant mafic magma because of Fo_{81-84} olivine phenocrysts are more common than Fo_{76-80} ones.

We estimated the time scales from magma mixing to the eruption on the basis of zoning analysis of olivine (Fo_{84}) phenocrysts rim (~50 μm from phenocrystic optical edge) and diffusion calculations. The zoning analysis revealed that a significant mixing process occurred 250 days to 3.5 years before the eruption in the lower part, while 15 to 130 days in the upper part. In the lower part, up to 40% An-poor plagioclase and orthopyroxene phenocrysts in the same thin section have multiple dusty zones or oscillatory zoning part inside the phenocrystic rim. The abundance of those phenocrysts decreases 15% up-section. These phenocrysts are antecrysts formed by injection of mafic magma prior to the eruption. Thus, the duration of the time scale correlates to the amount of antecrysts. Consequently, in the early part of the activity, the erupted magmas had more antecrysts.

The erupted magma composition became more mafic, which reflects increased percentage of mafic magma involved in mixing. At the beginning of the activity, the mafic magma also acted as a heat source for activation of the cold felsic magma chamber, thereby suppressing the volume percentage of mafic magma in the mixing, and also resulted in longer residence time before the eruption. As the activity proceeded thereafter, the shallow felsic chamber would become more mobile, consequently the mafic would be able to mix with felsic magmas more easily, resulted in higher percentage of the mafic magma in the mixing, and prompt eruption.

Keywords: Magma evolution, Magma mixing, Time scale, Kumanodake agglutinate, Zao volcano, NE Japan