Stratigraphy and temporal variation of petrologic characteristics of the past ca. 30-ky eruptive products of the Zao volcano

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The newest activity of the Zao volcano began at about 30ka, and numerous small to medium sized eruption has continued for the past 30ky. In this study we examined the stratigraphy of eruptive products of this activity and clarified the ages of each eruptive episode based on 14C ages of palaeosols intercalate to tephra layers. We also examined the temporal variation of petrologic characteristics of the past ca. 30ky eruptive products.

A small cone Goshikidake situates inner part of a horse shoe shaped Umanose caldera (ca.30ka, 1.7km in diameter), which is located in the central part of the Zao. Crater Lake Okama is in the western part of the cone and pre-Okama crater is just southeastward of Okama. The past ca.30ky eruptive products of the Zao are divided into the Komakusadaira agglutinate and the Goshikidake pyroclastic rock. The Komakusadaira agglutinate are spattered over along the top of the caldera wall, while the Goshikidake pyroclastic rock comprises the Goshikidake (0.1km3). Most of these are pyroclastic surge deposits and can be divided into five units. Unit1-3 products were erupted from pre Okama crater and unit4,5 products were from Crater Okama. Most of unit5 products were erupted in AD1895.

Imura (1994) recognized ten volcanic sand layers (Z-To1-10) formed during past 30ky activity, and estimated their ages; ca.31ka for Z-To1, 28ka for Z-To2, 26ka for Z-To3, 18ka for Z-To4, younger than 1.5ka for Za-To5-10, however, Kawanabe (1998) reported ca.2.4ka (14C) age for a palaeosol between Z-To8 and 9. Thus we re-examined the stratigraphy of the upper part of the tephra layers. We newly recognized two volcanic sand layers (named Z-To5a and b) between Z-To4 and 5. We re-divided Z-To9,10 to Z-To9-14 by intercalated white colored clay layers formed by phreatic eruptions. Stratigraphic and petrologic data show Z-To1-4, Z-To9-10, and Z-To11-14 correspond to the Komakusadaira agglutinate, Goshikidake pyroclastic rock unit1-3, and unit4, respectively. Volumes of Z-To5a-7 based on isopach maps are 1.5x107m 3, 2x107m3, 4x107m3, 5x107m3, 5x107m3, respectively. We obtained 14C ages from 20 palaeosol samples intercalating to the tephra layers and estimated ages of the upper part of the tephra layers as follows, ca.7.5ka, 6.1ka, 5.8ka, 5.3ka, 4.5ka, 4.1ka, 1.7-1.4ka, 1.4-1.2ka for Z-To5a-10, respectively and ca.1.2-0.4ka for Z-To11-14. These data point to being two major active periods from the upper part, ca.7.5 to 4.1ka and 1.7 to 0.4ka, which include six magmatic episodes each.

Phenocrystic assemblage of each tephra is cpx, opx, pl, and mt except for Z-To5. Considerable amounts of ol can be found in Z-To5 as well. Sagawa and Ban (2001) revealed the Z-To5 products were formed by mixing between mafic magma containing ol+An rich-pl phenocrysts and andesitic magma containing Mg-poor px+An-poor pl phenocrysts. Most of the other samples also show evidences for magma mixing, such as reverse zoning in px phenocrysts and wider compositional range in pl phenocrysts. Bulk silica contents of each eruptive products are as follows; ca.55-56% for the Komakusadaira agglutinate, ca.58% for Z-To5a,b, 55-56% for Z-To5, 57-57.5% for Z-To6, 58% for Z-To7, 56-57% for Z-To10 (Goshikidake pyroclastic rock unit1 shows 56-58%, and unit2,3 show 56-57%), 57-58% for Z-To11-14 (Goshikidake pyroclastic rock unit4 shows 57-58%). We could not obtain any suitable samples for whole rock analyses from Z-To8,9. These data show that periodic variations in silica contents can be found in the two major active periods. In these periods, silica contents decreased from 58 to 55-56% and recovered up to 58%, which can be explained that when the mafic magma played more effectively during the mixing, the silica contents decreased.

Samples from the active period ca.7.5 to 4.1ka plotted on the higher part than samples from another active period ca.1.7 to 0.4ka in the Cr-silica diagram. These data are suggesting different pulses of mafic magma for the two major activities.