Geologic and petrologic study on basal part of the Goshikidake and adjacent lavas of the Zao volcano

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Zao volcano is an active stratovolcano in NE Japan, and has a long-eruption history of ca. 1 million years. Horse shoe shaped Umanose caldera was formed in the summit area at the beginning of the newest stage (ca. 35ka to present). The Goshikidake, the youngest cone, began to grow in the caldera at ca. 2ka. The present crater Okama is in the western part of the Goshikidake. We performed geologic and petrologic study on the basal part of the Goshikidake and adjacent lavas to reveal their magma feeding systems.
The Goshikidake is composed of Goshikidake pyroclastics, which is divided into 5 units. The lowest unit can be further divided into Goshikidake-nanbu pyroclastics, Goshikidake-toubu pyroclastics (pyroclastics main units). Near these pyroclastics, the Furikodaki lava and the Goshikidake-nanpo lava and pyroclastics (lavas main units) distribute.Goshikidake-nanbu pyroclastics are consisted of pyroclastic surge deposits and vent breccias. The latter intrude nearly vertically into the surge deposits. The Goshikidake-toho pyroclastics are composed of stratificated tuff ~ lapilli tuff ~ tuff breccia including various amounts of volcanic bombs. The Furikodaki lava flowed down from the northeastern base of the Goshikidake cone along a stream. The lava shows elongated shape with ca. 750m in length and 20~30m in width. The Goshikidake-nanpo lava and pyroclastics cropped out in a narrow area of ca. 650m south from the summit of Goshikidake. This unit is composed of upper brecciated lava with coarser lateral and finer vertical joints, and lower hyaloclastite-like tuff breccia.
All rocks are medium-K calc-alkaline olv bg. cpx-opx andesites (56-58wt% SiO_2, 0.89-1.02 wt% K_2O). Most of plagioclase phenocrycrysts has dissolution textures such as dusty zone and patchy zoning. We note that plagioclase phenocrysts in lavas main units lack the dusty zones.
The peak compositions of opx, cpx phenocrycryst core compositions are similar among units. These are 64-65 Mg# and around ca. 66 Mg#. The compositions of Mg-rich mantles of opx phenocrysts within ca. 30 um from rims are wider in rocks from the lavas main units than the pyroclastics man units. The core compositions of plagioclase phenocrycrysts show wide range of An_{62-92}. The main peak compositions in the lavas main units are in An_{68-70} and around An_{78}, and subordinate peak is in An_{90}. Those of the pyroclastics main units are in An_{64-66}, An_{76-78}, and An_{90}. These petrologic features suggest the products were formed by magma mixing of mafic and felsic end-member magmas.
Bulk SiO_2 contents of the lavas main units are 57.5-58wt%, while those of the pyroclastics main units are 56-57.7wt%. As a whole, all products are plotted on same variation trends in silica variation diagrams, but looking at detail, rocks from the pyroclastics main units show higher trend in FeO, TiO_2, Rb/Zr diagrams and lower trend in MgO diagram than the other products.
Although the bulk compositions are slightly different between the pyroclastics main and lavas main units, the bulk SiO_2, phenocryst assemblage, and T-P-H_2O conditions of the felsic end-member are similar for all units. These are estimated to be 62 wt% SiO_2, Mg# 63-66 opx + Mg#65-70 cpx + An_{60-70} plg, ca. 1000 ℃, 1.7-2.7kb, 2.5wt% H_2O, while those of mafic end-member are 48-49wt% SiO_2, An_{90} plg + olvine (Fo_{78}),ca 1100 ℃, <2kb, 2.0wt% H_2O.
We calculated the time scales from magma mixing to the eruption by comparing the zoning profiles and calculated diffusion ones for olv, plagioclase, and opx phenocrysts. The obtained time scales

for olv, plagioclase, and opx are 1 year to 3 years, 80 to 300 days, and ~ 100 years. The percentage of longer lived opx is higher in the lavas main units.

Keywords: Zao volcano, Andestic lava, Pyroclastic surge, Magma mixing

