Petrological and geochemical analysis on non-juvenile lithics from phreatic/hydrothermal eruptions

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Terminology

Suijoki-bakuhatsu 水蒸気爆発 and *Suijoki-Funka* 水蒸気噴火 are the terms used for non-juvenile eruption in the community of Japanese volcanologists, and the term phreatic eruption is preferred as the translated word, although *Suijoki-bakuhatsu* 水蒸気爆発 includes phreatic, hydrothermal, and even ultravulcanian (or gas) eruptions. Here, steam-blast eruption is used as the translation for *Suijoki-bakuhatsu* because of the similarity to the original word (*Suijoki* is steam, *bakuhatsu* is blast, and *Funka* is eruption).

Eruption derived from hydrothermal system beneath Akita-Yakeyama and Ontake, Japan

Non-juvenile ash from steam-blast eruptions are often intensely altered. Alteration types of the ash from the Akita Yakeyama 1997 eruption and the Ontake 2014 eruption were petrologically determined to investigate chemical characteristics of volcanic fluid under the craters (Ohba et al. 2007; Minami et al., 2016). Various types of alteration types are identified for each ash deposit, and these assemblages are similar to the hydrothermal alteration zones in geothermal fields and around epithermal-porphyry ores. Well established geologic models under volcanoes proposed by economic geologists (e.g., Silitoe, 2010) can be applied to these active volcanoes. Boiling of the hydrothermal fluid in the porphyry-system-like volcano-hydrothermal system is the origin of these eruptions (hydrothermal eruptions).

Brief acid alteration recorded in ash from Tokachi, Japan

The petrological analysis was carried out for volcanic ash from the steam-blast eruptions at Tokachi volcano, Hokkaido. The non-juvenile lithic ash consists of unaltered, partially altered, and completely altered rocks. Alteration mineralogy is monotonous, consisting of silica mineral, alunite, and minor kaolinite. Partial alteration with thin alteration film (<100 micrometer) is the most dominant in the ash, implying brief reaction with a flush of acid fluid (volcanic gas/fluid). The volcano is characterized by high frequency of magma intrusion (intervals of 20-40 years); this probably results in an unstable magmatic-gas-dominant system under the crater.

Magma intrusion into acid hydrothermal system beneath the crater at Tangkuban Parahu, Indonesia

Geological study and petrological analysis was carried out for volcanic ash from the steam-blast eruptions at Tangkuban Parahu volcano, Indonesia (Angkasa et al.,2019). Ten units of steam-blast eruptions were identified as Holocene volcanic ash deposits. All the samples are abundant in hydrothermally altered lithics and the alteration mineralogy exclusively shows siliceous alteration. Samples from two units contain abundant fresh juvenile fragments. This implies the origin of steam-blast eruptions, or hydrothermal eruption, is basically shallow acidic hydrothermal system, and intruding magma occasionally interacts with the hydrothermal system to result in magmatic-hydrothermal eruptions.

Preliminary report on sulfur isotopic study

We have measured sulfur isotopic compositions of the volcanic ash samples. Expected $\delta^{34}S$ values of ash are (1) bimodal for hydrothermal eruption (as high as +20 in sulfate and low in sulfide) and (2) ca. zero (up to +10) for ultravulcanian. The volcanic ash from Ontake shows the bimodal values, indicating isotopic fractionation between sulfate and sulfide in hydrothermal system. On the other hand, the samples from Tokachi and Tagkuban Parahu show lower $\delta^{34}S$ values from sulfate (0 - +10), implying magmatic sulfur is dominant. Stratigraphic variation in $\delta^{34}S$ at Tanguban Parahu indicates that after a big magmatic contribution to eruption, the $\delta^{34}S$ dropped from +10 to +3. Assumed the magmatic gas has the value around +3, the values around +10 of early hydrothermal eruptions may be the mixing resultant of steam-heated water with high $\delta^{34}S$ (ca. +20) and the later eruptions are less influenced by the isotopically fractionated hydrothermal fluid. Alternatively, the isotopic composition of magmatic gas might have changed from high to the low value. $\delta^{34}S$ values of magma (or fresh volcanic rock) from the volcanoes must be measured to compare the values from these steam-blast eruptions.

Main References

Ohba T et al. (2007) Mud plumbing system of an isolated phreatic eruption at Akita Yakeyama volcano, northern Honshu, Japan, JVGR, 146, 35-46

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