Sulfur-rich basaltic magma injection into the magma plumbing system of Asama 2004 eruption: Melt inclusion study for magma compositions, the timing of degassing and mixing, and sulfur supply

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In the evolution of Asama volcano, most of the erupted materials have andesitic compositions, however, melt inclusion studies found no sign of primary andesitic melt and revealed that basaltic liquid formed a part of the ejecta. Melt inclusion study of 2004 scoria (23 September) (SiO_2 61 wt%) revealed that sulfur-rich basaltic magma (SiO_2 52 wt%, S <2600 ppm) injected into the reservoir beneath the volcano and mixed with a long-lived crystal-rich felsic-magma (SiO_2 64 wt%) in the ratio 36 : 64. Diffusion profiles of Fo composition in olivine phenocrysts suggest a short period (<a few months) from the basaltic magma injection to the eruption. There is no trace of new phenocryst growth from the mixed magma.

Olivine phenocrysts include ferric-bearing crystalline phases together with the basaltic melt, suggesting a high oxygen fugacity condition of the basaltic magma. Measured sulfur X-ray peak shifts for the trapped melt indicate that the dominant sulfur-bearing species is SO_4^{2-} (>NNO + 1), corresponding with high sulfur solubility in the magma. This initial high sulfur concentration has, however, mostly been diminished (from 2600 to 1300 ppm or lower) before the melt entrapment, due to magma boiling and sulfide phase precipitation. The melt inclusions commonly show various petrological features of the heterogeneous trapping (melt plus bubbles) of vesiculated magma. There are only a few pre-boiling melt inclusions. Further, common sulfide inclusions in olivine suggest that sulfur precipitations decreased continuously in sulfur concentration of magma during the crystallization. Hence, the most mafic (SiO_2-poor) and pre-boiling melts have the highest sulfur concentration (2600 ppm). These data provide us a valuable source of information about the primary sulfur budget and the sulfur supply systems in arc magmas in central-northeastern Japan.