Early sulfide precipitation in basaltic magma intruding into felsic reservoir beneath the summit of Asama volcano: a melt inclusion study for the 2004 eruption

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During the 2004 eruption of Asama volcano, sulfur-rich basaltic magma repeatedly intruded into a long-lived crystal-rich felsic reservoir beneath the summit. Melt inclusion study of scoria (23 September) revealed that the major phenocrysts (plagioclase, ortho- and clinopyroxene, and Fe-Ti oxides) were principally derived from the felsic magma and the phenocrysts trapped sulfur-poor felsic melt (SiO_2 67-77 wt%, S mostly <1000 ppm). In contrast, olivine (>Fo_{80}), a rare phenocryst, was derived from basaltic magma, trapping sulfur-rich mafic melt (SiO_2 48-59 wt%, S <2600 ppm) before the mixing.

Two types of Sulfide precipitates, Cu and Ni-bearing heterogeneous sulfide spherules (Cu <31 wt%, Ni <10 wt%) and homogeneous pyrrhotite, are commonly trapped in olivine phenocryst. And they are also found to be scattered in the glassy groundmass. In contrast, the major phenocrysts includes the only homogeneous pyrrhotite, together with the sulfur-poor felsic melt.

Petrologic observation of the melt and various crystalline inclusions trapped in olivine phenocrysts here provides relevant information about the primary composition of the basaltic magma. The three pieces of information are as follows. 1) Primary large SO_4^{2-} concentration of magma. 2) A high oxygen fugacity condition (> NNO + 1) of magma. 3) Primarily hydrous nature of magma and the consequent boiling of magma during crystallization.

It is likely that, during the ascent of this SO_4^{2-}-rich hydrous magma, transformation of sulfur species on cooling from SO_2 to H_2S oxidized iron of magma, and led to the extensive precipitation of sulfide phases in the magma. The sulfur separation from the melt continuously decreased 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 petrologic data provide us with valuable information about the sulfur budget and the sulfur supply system. The ascent of the hydrous basalt magma transfers a large amount of sulphur, together with copper and probably other chalcophile metals, from the subduction slabs in the mantle to the felsic reservoir beneath the summit of the frontal volcanoes in central-northeastern Japan.

Apatite inclusions in Hadean zircon from Jack Hills, Australia

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Clues about conditions during Hadean era can be deduced from detrital zircons as old as 4.4 Ga preserved in metaconglomerate at Jack Hills in the Narryer Gneiss Complex, Western Australia. Previous investigations of these grains have suggested the existence of a hydrosphere, granitic continental crust and sedimentary cycling [1]. Especially, granitic mineral inclusions, such as quartz, plagioclase and K-feldspar, in Hadean detrital zircons provide strong evidence for the existence of granitic crust on early Earth. However, [2] proposes that inclusions of plagioclase and K-feldspar in zircon do not constrain a source rock. Moreover, *in-situ* U-Pb dating of monazite and xenotime inclusions in 4.25–3.35 Ga detrital zircons from Jack Hills shows ages with 2.68 Ga or 0.8 Ga, suggesting that the most mineral inclusions suffered from metamorphic/metasomatic overprint during late stage metamorphism [3]. These results call for a reassessment of source magma based on mineral inclusions in Hadean zircons.

We investigated apatite inclusions in Hadean zircons using Laser-Raman microscopy, SEM-EDS and electronprobe micro-analyzer (EPMA). Chemistry of apatite inclusions in zircon reflects the chemical compositions of the whole rocks and can characterize the host magma [2, 4]. Although low-abundance of apatite inclusions in detrital zircons from Jack Hills compared to those in granitic rocks suggests a secondary replacement on mineral inclusions [3], we observed 6 primary apatite inclusions with no visible cracks in 106 Hadean zircons. Y_2O_3 and SrO abundances in apatite determined by EPMA negatively correlate, ranging from 0.02 to 0.9 wt% and from 0.08 to below detection limit (0.01 wt%), respectively. High concentrations of Y_2O_3 (>0.4 wt%) and low concentration of SrO (<0.02 wt%) in apatite inclusions in Hadean zircons in Jack Hills are indicative of evolved, felsic host magma >65 wt% SiO_2 [2].

[1] Harrison (2009) *Annu. Rev. Earth Planet. Sci.* **37**, 479-505. [2] Jennings *et al.*, (2011) *Geology* **39**, 863-866. [3] Rasmussen *et al.*, (2011) *Geology* **39**, 1143-1146. [4] Belousova *et al.*, (2002) *J. Geochem. Expl.* **76**, 45-69.

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