Sulfur degassing and magma oxidation state at Mount St. Helens (WA) and Augustine (AK) Volcanoes

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Sulfur (S) is a highly redox-sensitive element. Redox changes associated with magmatic S degassing can potentially change magma fO_2, which in turn can affect phase stability, S solubility, and further degassing. We test whether S degassing and fO_2 are linked in oxidized systems (ΔNNO: ~0 to +2.5) by undertaking a combined EPMA and µXANES study of melt inclusions in recent eruptions from Mount St. Helens (WA, USA) and Augustine Volcano (AK, USA).

We analyzed matrix glass and melt inclusions from the 1980 plinian and 2004–2008 dome forming eruptions of Mount St. Helens, and the 2006 explosive eruption of Augustine. Sulfur in melt inclusions ranges from 40 – 340 ppm in Mount St. Helens samples and from 80 – 2600 ppm in Augustine samples, reflecting progressive S degassing during different stages of magma ascent and storage. At Mount St. Helens, µXANES melt inclusion measurements show a relatively narrow range of S speciation, and fO_2 determinations largely overlap fO_2 estimates from Fe-Ti oxides of ΔNNO 0 to +1 [1]. Augustine melt inclusions, in contrast, record a wider range of S concentrations and substantially more reduced melt fO_2 (ΔNNO +0.2 to +1.2 via µXANES) than determined by Fe-Ti oxides (ΔNNO +1 to +2.5 [2, 3]). Augustine melt inclusions generally become more oxidized with lower S contents, suggesting that S degassing may cause oxidation in these sulfur-rich systems. Mount St. Helens is a very S-poor system overall and does not show such a relationship between S and fO_2 changes.

In summary, we find that magmatic oxidation may be linked to S degassing, and that pre-eruptive fO_2 conditions may be substantially different from fO_2 conditions recorded by Fe-Ti oxides.

[1] Pallister et al. (2008), *USGS Prof. Paper* **1750**, 647–702. [2] Larsen et al. (2010), *USGS Prof. Paper* **1769**, 335-382. [3] Webster et al. (2010), *USGS Prof. Paper* **1769**, 383–423.