Apatite sulfur isotope ratios in the 1257 Samalas eruption (Indonesia)

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The 1257 eruption of Mt. Samalas in Indonesia produced sulfate anomalies in bi-polar ice cores that are ~2 times larger than those of the 1815 eruption of neighboring Tambora volcano, despite the similar magnitude of both eruptions[1]. The build-up of such a large volume of eruptible sulfur is likely to be related to pre-eruptive degassing and magma redox conditions. Information about these processes can be preserved in apatite crystals, which integrate sulfur as a trace element at concentrations that allow for $\delta^{34}S$ isotope ratio characterization in-situ via Secondary Ionization Mass Spectrometry[2].

We investigated apatite crystals occuring as inclusions in plagioclase (Pl) crystals and as apatite microphenocrysts in contact with matrix glass, from trachydacitic pumices of both the climactic 1257 eruption and an earlier 2550 B.P. event[3]. The lowest $\delta^{34}S_{(CDT)}$ value observed in all four sample groups is 8.5‰, which we interpret as representative of evolved magmas entering the sub-volcanic system. Pl-hosted apatite inclusions from the 1257 eruption range up to a $\delta^{34}S_{(CDT)}$ of 11‰, while microphenocrysts reach 16‰, consistent with inclusions capturing an earlier stage of magma evolution. While Pl-hosted inclusions show no clear correlation between $\delta^{34}S$ and S counts per second (CPS, as a rough proxy for concentration), microphenocrysts display a negative correlation, with lower S CPS coupled to higher $\delta^{34}S$ values. We tentatively interpret these observations to reflect a shift to higher $\delta^{34}S$ in the melt during degassing of sulfur. This interpretation is corroborated by zoned microphenocrysts that have low $\delta^{34}S$ values and higher CPS in their cores and high $\delta^{34}S$ values and lower CPS in their rims, with a maximum core-to-rim variation of ~5‰ within a single apatite crystal.

[1]Sigl et al., 2015, *Nature,* [2]*Economos et al., 2017, G.C.A.,* [3]Vidal et al., 2016, *Sci. Reports*

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