EGU2020-20063, updated on 03 Jun 2021
https://doi.org/10.5194/egusphere-egu2020-20063
EGU General Assembly 2020

Investigating H2O contents in clinopyroxene from explosive versus effusive eruption products from Merapi volcano, Indonesia

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The 2010 eruption of Merapi produced pyroclastic deposits and lava flows that are compositionally very similar, raising the question as to the underlying reason of the differences in eruptive styles between the various phases of the 2010 eruptive events. To test whether primary magmatic volatile content is the reason for the different eruption styles, we analyzed magmatic water contents in nominally anhydrous clinopyroxene crystals contained in lava and ash from the 2010 eruptive events. We utilized two analytical approaches: (i) Fourier-transform infrared spectroscopy (FTIR) analysis of fresh clinopyroxene from the ash and lava samples and (ii) FTIR analysis of clinopyroxene both prior to and after experimental re-hydration. By employing calculated partition coefficients, we determined the magmatic water content of the magma from which the various crystals grew. The magmatic water content determined from the unmodified clinopyroxenes from lava samples yield a range of 0.35 wt.% to 2.02 wt.% H_2O, whereas magmatic water contents determined from untreated clinopyroxene contained in the ash samples range between 0.04 and 3.25 wt.%, with two outliers at 4.62 and 5.19 and wt.%, respectively. In contrast, for the rehydrated crystals the range for lava derived clinopyroxene crystals is between 1.94 and 2.19 wt.% and for ash between 1.74 and 2.66 wt.%, with two crystals at extreme values of 0.85 and 3.20 wt.%. We interpret these results to indicate that crystals from different populations are present in the 2010 eruptive products, with the dominant group reflecting relatively low magmatic H_2O contents (around 2 wt.%) due to storage in shallow magma reservoirs and pockets at high levels within the Merapi plumbing systems (e.g. top 3 km). The overall higher H_2O range and the occasionally more extreme values recorded in clinopyroxenes from ash deposits may then represent the presence of a crystal population that last equilibrated at deeper levels and at higher water contents, i.e. these crystals derive from the replenishing magma that activated the shallow portion of the plumbing system during the 2010 events. While this is work in progress, our results so far seem to suggest that the pyroclastic deposits of the 2010 Merapi eruption may contain a higher fraction of clinopyroxene derived from 'deeper magma' with higher H_2O contents then what we have detected in associated lavas.