

## Decoding pre-eruptive magma evolution and water behavior from plagioclase phenocrysts: Application to the Hoei eruption of Mt. Fuji

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Explosive eruptions are often accompanied by signs of mixing of felsic and mafic magmas in their eruptive products, suggesting the potential link between explosive eruptions and magma mixing. Yet, the underlying mechanism of such eruptions remains elusive. The key to this debate is understanding pre-eruptive magma evolution including water behavior in the magma and the time lag between the magma mixing and eruption.

Water behavior in pre-eruptive magma has been widely studied using melt-inclusions in phenocrysts. More recently, it has been shown that hydrogen concentration in plagioclase phenocryst can be used as a hygrometer of pre-eruptive magma (Hamada et al., 2013). Furthermore, zoning of hydrogen content in the phenocryst can be used as a high-resolution chronometer, as hydrogen diffusion in plagioclase is sufficiently fast.

Here we report the first study that combines in-situ measurements of the contents of major and trace elements, including hydrogen, in plagioclase phenocrysts using the EPMA, LA-ICP-QMS, and SIMS, respectively. These analyses were carried out on sequential eruptive products of the 1707 Hoei eruption at Mt. Fuji. The Hoei eruption is characterized by its explosivity and wide chemical variation in the eruptive products (e.g.,  $\text{SiO}_2=50\sim70$  wt%), and the interaction of mafic and felsic magmas has been considered as playing a role in triggering the explosive eruption (Fujii et al., 2002).

We found that the light REE concentrations of plagioclase phenocrysts split in two clusters. These results suggest that there were at least two magma reservoirs underneath Fuji volcano in which magma differentiation had individually proceeded before the Hoei eruption, and also that plagioclase phenocrysts crystallized from these individual magmas were partly mixed before or during the eruption.

Our results further reveal that most melt inclusions have lower water contents than those estimated from hydrogen contents of the host plagioclase phenocrysts and the plagioclase-melt hydrogen partitioning. This suggests that water in melt inclusion could be more easily lost by secondary events than hydrogen in plagioclase phenocryst. Measured hydrogen contents in plagioclase phenocrysts suggest that the early-erupted felsic magma contained water up to 17wt%, whereas the late-erupted mafic magma had lower contents of ~5 wt%. Moreover, the combination of REE and hydrogen contents in the plagioclase phenocrysts (Figure) revealed that the higher water contents, Ce contents, and lower Anorthite contents in the evolved magma can be attributed to fractional crystallization. Moreover, intra-grain chemical variations suggest that rapid crystallization of plagioclase likely driven by decompression accompanied by the exsolution of water occurred in the felsic magma several hours before the explosive eruption. The decompression and water exsolution may result from the convection of the felsic magma caused by the injection of the hot and water-poor mafic magma.

Keywords: plagioclase, hygrometer, magma mixing, explosive eruption, Mt. Fuji

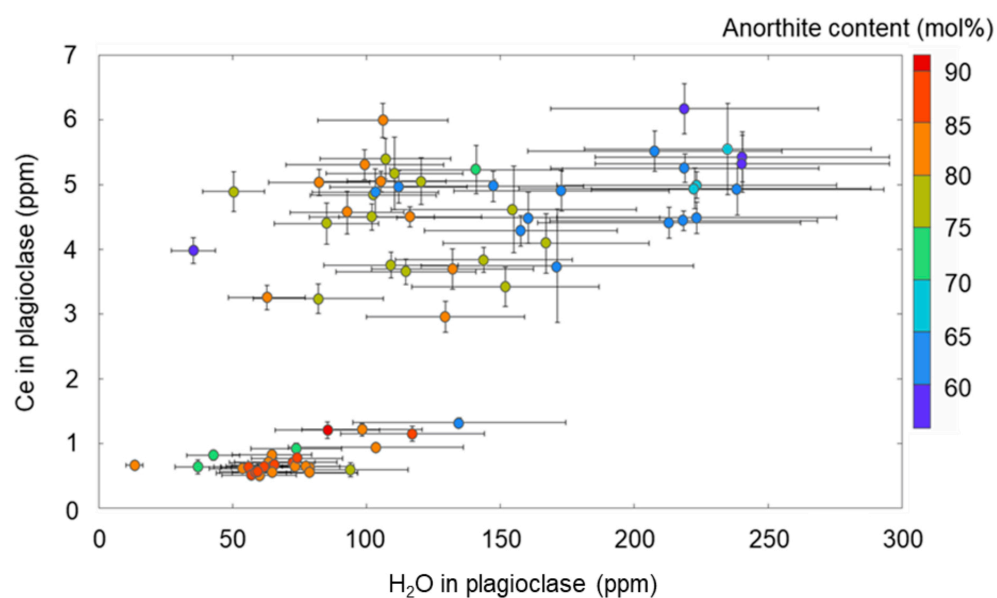


Figure: Cerium versus water contents in plagioclase phenocrysts. The plots are color-coded according to anorthite content. The water contents were calculated from the measured hydrogen concentrations in the phenocrysts.