

Experimental observations of H-bonding symmetrization of δ -AlOOH

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Introduction

δ -AlOOH is a high-pressure polymorph of diaspore and boehmite. The wide P-T stability field of δ -AlOOH attracts geophysical attentions and it is noteworthy that strong hydrogen bond is involved in its crystal structure even at ambient pressure. A theoretical simulation predicted that δ -AlOOH undergoes H-bond symmetrization at 28 GPa and the bulk modulus increases substantially after the transition [1]. The present study intended to observe experimentally the H-bonding symmetrization of δ -AlOOH.

Experimental Procedures

In situ high pressure powder X-ray diffraction patterns were obtained using a diamond anvil cell at BL-4A, Photon Factory, KEK, Japan. Infrared and Raman spectra at high pressure were obtained using a diamond anvil cell [2]. Helium pressure transmitting medium was used to maintain quasi-hydrostatic pressure condition. All measurements were conducted at room temperature.

Results and Discussion

With increasing pressure, the *a*- and *b*-axes of δ -AlOOH, which accommodate the H-bond, stiffen at 10 GPa, although the *c*-axis shows no marked change [3]. The bulk modulus increased substantially at the transition pressure. These experimental results suggest that the compression mechanism changed notably at the pressure. Pressure dependences of peak positions in both Raman and infrared absorption spectra showed a kink at approximately 13 GPa. In addition, some of peaks disappeared around this pressure. These changes are consistent with the H-bonding symmetrization transition. This study has shown experimentally that H-bond symmetrization of δ -AlOOH occurs at much lower pressure than theoretically predicted.

[1] Tsuchiya *et al.* (2002) *GRL* **29**, 1909-1912. [2] Kagi *et al.* (2008) *High Press. Res.* **28**, 299. [3] Sano-Furukawa *et al.* (2009) *Am. Mineral.* under review.

Tracing magma mixing under Mt. Etna using combined thermodynamic and kinetic modeling

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Understanding igneous processes (e.g. magma mixing, assimilation, crystallization) requires the ability to unravel the information that is recorded in the crystal cargo of magmatic systems. While thermodynamics provides the means to constrain the ambient intensive variables (e.g. pressure, temperature, oxygen fugacity), kinetics (e.g. crystal growth, diffusion) allows us to extract temporal information. The combination of the two is a powerful tool that can allow us to constrain the dynamics of a magmatic system. We have studied the recharge-eruption cycle feeding the plumbing systems of Mt. Etna between 1993–2008 using a combination of thermodynamic and kinetic modeling.

Petrological observations and geochemical data show that most eruption products share the same four olivine populations with different zoning patterns and core compositions (Fo66-70, Fo80-82, Fo75-78, and Fo72-77). We interpret these to record at least two mixing events preceding the eruption. With the MELTS algorithm [1] and using the bulk-rock and melt inclusion compositions reported in literature (e.g. Métrich *et al.* [2]) we were able to reconstruct plausible magmatic mixing/mingling end-members and conditions recorded in the zoned olivines. The chemistry of the other major minerals - clinopyroxene and plagioclase - further constrain the nature of these processes. We find very An-rich compositions in resorbed plagioclase cores that are more primitive than, and out of equilibrium with, any melt or crystalline component found in the erupted products. Modeling the compositional zoning observed in the olivine crystals using diffusion models [3] we find that these series of mixing events occurred within a couple of years before eruption, the latest ones often preceding the eruption by only a few days.

[1] Ghiorso MS & Sack RO (1995) *CMP* **119** 197–212. [2] Métrich N, Clocchiatti R, Mosbah M & Chaussidon M (1993) *JVGR* **59** 131-144. [3] Costa F, Dohmen R & Chakraborty S (2008) *RiMG* **69** 545-594.