

From precursory event to climactic caldera formation – variations in water saturation state in the Aso-4 super-eruptive system.

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Water saturation and volatile exsolution in upper crustal magma reservoirs play a key role in the growth of magmatic reservoirs, but also in influencing eruptive styles. Using the partitioning behavior of volatile elements between silicic melts, apatite, and exsolved water, we evaluate the pre-eruptive water saturation state of the magma prior to the effusive precursory eruption and the subsequent Aso-4 caldera-forming event (Aso volcanic system, Kyushu, Japan). Apatite is a common accessory mineral in many arc magmas, incorporating most of the major magmatic volatiles (OH, C, F, Cl, and S) in its crystal structure. Recent studies revealed that the measurement of halogens in apatite crystals are a powerful petrological tool to estimate the physical state of the volatiles in the magma chamber, for one due to its capability to incorporate halogens as major structural constituents, but also because Cl fractionates strongly from F upon water exsolution, making apatite valuable recorders of such processes. This represents a complementary tool to the evaluation of volatiles in melt inclusions. The F-Cl-OH record in apatite inclusions from the precursory event of the Aso-4 eruption indicate water-supersaturated storage conditions prior to the effusive event. In contrast, apatite inclusions and microphenocrysts from the caldera-forming eruption exhibit clearly distinct trends suggesting that storage conditions prior to the Aso-4 caldera-forming event were near water saturation, or under-saturated. Similarly, melt inclusions from the caldera-forming eruptions do not record any evidence of Cl loss with differentiation, suggesting evolution in a dominantly water-undersaturated magma. Hence, we suggest that the water saturation state in the upper crustal reservoir of the Aso-4 system changed just prior to the catastrophic caldera-forming event, recording a transition from water-saturated to water-undersaturated conditions from the effusive precursory event to the explosive caldera-forming eruption.