

Preservation of inherited argon in plagioclase crystals in the Lesser Antilles: implication for residence time after reservoir remobilization

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We study samples from lava domes that erupted after magma mixing events in the Lesser Antilles. All samples contain plagioclase with distinct zoning patterns, as well as inclusion-rich zones, that reveal one or more crystal resorption events due to rapid temperature changes following injection of mafic magma and crystal mush remobilization. In these samples, the plagioclase cargo yields K-Ar ages 2 to 3 times older than the K-Ar ages obtained on groundmass. This age difference is explained by the fact that the antecrysts, remobilized by an incoming magma prior to eruption, contain inherited argon, i.e., radiogenic argon ($^{40}\text{Ar}^*$) that accumulated in the crystals by K radioactive decay while crystals were in cold storage. The timescales between intrusion and eruption were too short to heat up the antecrysts above their closure temperatures (T_C) for argon, and therefore were not completely reset.

We use this age difference to calculate timescales between magma mixing and eruption using an innovative approach that combines (1) multi-grains total fusion K-Ar ages and step-heating $^{40}\text{Ar}/^{39}\text{Ar}$ dating of plagioclase grains from samples for which eruption was dated independently, (2) argon diffusion modelling, (3) textural analysis of plagioclase crystals, and (4) finite element diffusion modeling of An and MgO.

We have calculated that the age differences observed require residence times of 10 to 100 years between the injection of a new magma and its eruption. This can be related to changes in the volcano's morphology due to large scale flank collapse or explosive events having remobilized the plumbing system relatively quickly. Our approach provides better constraints on the timing between magmatic intrusion, mixing, and flank collapse or explosive eruptions. The rapid remobilization and eruption of upper-crustal magmas indicates that the onset of eruptions at Lesser Antilles volcanoes may occur with very little warning.