Contrasting pre-eruptive histories of Laacher See (Germany) and Taapaca (Chile) volcanoes constrained by diffusion chronometry

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We applied diffusion chronometry to different eruption products from Laacher See volcano (Germany) and Taapaca volcano (Chile).

(a) Laacher See volcano: Modeling of (1) K-Na interdiffusion in sanidines from carbonatitic syenites of known pre-eruptive age gives 630-670 °C as effective storage temperature, just above solidus for the phonolite compositions. A conduction model constrains the inward growth of the syenite carapace at ~8 cm/year. Uphill diffusion modeling across exsolution boundaries in sanidine gives maximum time between destabilisation of the system and eruption of only 40-50 days. (2) Ba-diffusion modelling of Ba-rich overgrowths on sanidine crystals constrains the time between the last basanite recharge and eruption at <4-7 years. Diffusion times obtained from inner zones suggest a recharge frequency of 0.3-0.6 ky^{-1}. Cumulates (3) are devoid of zoned crystals. However, thin overgrowths (microns) with sharp compositional boundaries imply their activation only months before eruption.

(b) Taapaca volcano: In sanidine megacrysts of dacite samples, sharp jumps in Ba concentration is observed at resorption interfaces that reflect distinct heating events. Amphibole-thermometry from inclusions in different growth zones separately gave temperatures of ~700-850 °C at Al-in-Hornblende pressures of 1-3 kbar. Non-isothermal diffusion modeling of Ba-profiles across many successive diffusive boundaries for different crystals from different eruptive units gave diffusion times from 1 to 50 ky, adding up to a total residence of 30 - 470 ky. Thinly banded overgrowths indicate that the magmatic system heated up only ~1-3 ky before the eruption that brought the crystals to the surface.

Magmas within the same system can be stored at near-solidus or well-above solidus temperatures; but, the time is very different (20 ky vs. <470 ky) for the two volcanoes. Time spans of reactivation and magma mixing that triggered the eruptions are also very different (4-7 yr vs. 1-3 ky). We present genetic models for the process and timing of storage and activation of both systems, and discuss the differences and similarities.