A tool to measure ascent rate : volatile element concentration profile in embayment

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In September 2017, Ambae (Aoba), Vanuatu's largest volcano, entered a new phase of eruptive activity, triggering the evacuation of the island's 11,000 inhabitants. Three subsequent eruptive phases in November 2017, March 2018 and July 2018 expelled some of the largest SO_2 clouds observed in the last decade. These phases eruption produced olivine-bearing scoriae. Olivines are typically 0.5 to 2 mm containing melt inclusions (up to 100 μm diameter) and melt tubes or embayments. Most inclusions were alkali basalt, trachy-basalt or basaltic trachy-andesite in compositions, containing H_2O content up to 2.2wt. % and CO_2 up to 3899 ppm.

The incomplete exsolution of H_2O along the melt tube creates a volatile element profile, that we could measure *in situ* by SIMS (CRPG-Nancy, France). Because of the lack of gas bubble nucleation in the tubes and the fact that the mouth of the tube is the only passage to loose H_2O (and other volatile elements), the depletion profile can be fitted by a diffusion model in which volatile depletion is controlled by decompression degassing. Therefore such a model determines the decompression rates during the magma ascent. A diffusion model shows that embayments from the second phases of activity indicate a rapid magma ascent in the range of 32 to 270 km/h (decompression rates of 0.24 to ~2 MPa/s) corresponding to a short travel time between a shallow reservoir and the surface of less than a minute. This range in ascent rates is greater than those generally associated with sub-Plinian eruptions [1], and furthermore comparable or faster than to the ascent rate of Kilauea volcano, Hawaii eruptions (e.g. [2]). It should be noted that such fast events pose great challenges to mitigate risk for population in place.

[1] Cashman, 2004, AGU Monogr.
[2] Fergusson et al., 2016, Bull. Volc