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Timescales of bubble coalescence, outgassing, and foam collapse in decompressed rhyolitic melts

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The timescale of degassing and outgassing in hydrous rhyolitic melts is investigated in a wide range of conditions by means of decompression experiments. The evolution of vesicularity, bubble diameter, and number density is characterized as a function of time either of decompression or spent at final pressure, in order to determine the effect of final pressure, temperature, syn- versus post-decompression degassing, melt composition, and microlites, on the timescale of bubble growth, coalescence, and outgassing.

The result suggest that different bubble evolution and degassing-outgassing timescale corresponding to explosive and effusive eruption regimes can be cast in bulk viscosity (melt + bubbles; n_{bulk}) versus decompression time (rather than path) space. The n_{bulk}–time relationships defines three domains of (i) bubble nucleation and growth, restricted to short durations and high n_{bulk} ($<$ $\sim$0.03 h for n_{bulk} $\sim 10^{5-6}$Pa.s), (ii) equilibrium degassing with coalescence increasing from negligible (permeability $> 10^{-13}$ m^2) to extensive (permeability $\sim 10^{-11-12}$ m^2), and (iii) outgassing, restricted to long durations and low n_{bulk}($>$ $\sim$10 h for n_{bulk} $< 10^6$ Pa.s; permeability $>10^{-10}$ m^2) that eventually leads to foam collapse.

These findings are applied to the case studies of Mt Pelée and Mt Pinatubo to infer the transition from pumice to dense pyroclasts in volcanic eruptions and the possibility of evolving from an explosive Plinian eruption to an effusive dome-growth event by giving the vesicular magma enough time to outgas and collapse (i.e. hundreds to tens of hours for n_{bulk} $\sim 10^5$ to 10^4 Pa.s, respectively). We also show the drastic effect of microlites on re-arranging preexistent bubbles and potentially triggering a late nucleation event.