



Laboratory evidence of fragmentation during slow decompression of a magma analogue containing volatiles and solid particles.

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With the motivation of studying switches in the eruption regime at Stromboli volcano, we performed a series of shock-tube experiments decompressing Gum Rosin dissolved in acetone (GRA mixture) as a volatile-bearing analog of magma, obtaining for the first time evidence of fragmentation of a natural system containing solved volatiles and solid particles during slow decompression. We exposed the magma analog to sudden decompression and to slow decompressions of the order of about $100\text{-}400\text{ Pa s}^{-1}$ from atmospheric pressure p_{atm} down to different pressures p_L . We used five different concentrations of acetone in the mixture: 15%, 23%, 30%, 35%, 40%. This corresponds to about 2 - 6% H_2O in magma. We use our sudden decompression experiments to draw a phase diagram of our mixture. During fast decompression, we first observe bubble nucleation for $p_L \approx 25\text{ kPa}$. For $13\text{ kPa} < p_L < 18\text{ kPa}$ we observe progressively more intense boiling of acetone in the mixture. If the mixture is decompressed down to $p_L = 5 - 12\text{ kPa}$, we observe slow expansion of foam (velocity of the order of a few mm-cm per second). If $p_L < 5\text{ kPa}$, we observe fragmentation (velocity of expansion is tens of meters per second). Mixtures of different concentrations show somewhat different values of the maximum pressure at which fragmentation is observed. During slow decompression, in general we observe a similar behavior, albeit with slightly different threshold values of p_L , except that in general fragmentation does not occur at all. However, in some cases we surprisingly do not observe any bubble nucleating around the boiling point of acetone. In those cases, fragmentation occurs when pressure reaches about $p_L = 8 - 10\text{ kPa}$. The mixture apparently becomes supersaturated even if small rosin particles, which should ease nucleation, populate the mixture, as we could ascertain observing the samples at the microscope. Fragmentation events during slow decompression occurred only - but not always - when decompressing the mixtures at 35% and 40%, while we never observed it for mixtures of 30% concentration or below. Using the 40% mixture, fragmentation occurred about in half of the cases (4 times out of 8), for the 35% it occurred in one case out of four. In conclusion, fragmentation during slow decompression occurs when the gas content is high (or when the content in particles is relatively low). A pressure threshold exists, which is about half of the pressure of the acetone's boiling point and might mark the onset of homogeneous nucleation. This process seems to be highly non-linear since different runs of the experiment in approximately the same conditions lead to different results. Further studies are necessary in order to constrain better the conditions promoting fragmentation during slow decompression and to make inferences on the dynamics of the plumbing system at Stromboli volcano.