Influence of decompression path in the shallow conduit on eruption dynamics: first insights from laboratory experiments

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Volcanoes are moody creatures. They are well known for their ability to display a wide spectrum of eruptive styles, ranging from effusive phenomena, as lava flows or dome growth, to violent explosive eruptions, generating vast amounts of ash eruption plumes and pyroclastic flows. Rapid changes in the eruptive style can occur during an ongoing eruption, and are, amongst others, likely to be related to variations in the magma ascent rate. Indeed, the rate at which magma reaches the surface, i.e. its speed of decompression, is a key parameter affecting the eruptive style. This ascent rate depends on several factors like the pressure in the magma chamber, the physical properties of the magma, and the rate at which these properties change. Laboratory decompression experiments can give quantitative information about the interplay of those factors, the dynamics of nucleation, growth and coalescence of bubbles in a volatile-bearing magma and the related impact on the eruption style. We carried out decompression experiments at varying decompression rates, using silicon oil as analogue of the magmatic melt which allows encompassing a range of viscosity values. Additionally, for a set of experiments we added particles to simulate the presence of crystals in the magma. The pure liquid or suspension was mounted into a transparent autoclave and pressurized to 10 MPa. Then the sample was saturated with a noble gas (Argon or Helium) for a fixed amount of time (i.e. 24, 48, 72 h for Argon). The samples' decompression path consists of three main parts mimicking magma ascent in the shallow conduit: (1) a slow decompression, (2) a phase of stable pressure and finally (3) rapid decompression to atmospheric condition. We were able to reproduce different ascent rates, accordingly to values reported in literature for different magma chemistry and type of eruptions. In phase (3), the fluid goes through a fast decompression, which causes the exsolution of the volatile phase and eventually its fragmentation. The entire decompression path was monitored with pressure sensors as well as regular and high-speed video cameras; Image analysis of the videos allowed for a qualitative analysis of the fluid dynamics inside our samples and above. Indeed, until now the relationship between the history of magma ascent and the eruptive dynamics has been investigated mostly by looking petrological studies, i.e. on degassing related reactions or melt inclusions. Our approach is complimentary to these studies and focus on the physical aspects during decompression.