The dynamics of separate two-phase flow in basaltic magmas has been investigated in a series of scaled experiments in a 6.5 m tall, 0.24 m diameter bubble column. The experiments used glucose syrup mixtures with viscosities ranging from $10^0$ to $10^2$ Pa $\cdot$ s. We investigated the relation between gas flow rate and bubble content and distribution in the mixture coupling visual observations, pressure measurements and electrical capacitance tomography. The total vesicularity of the column increases with gas flux according to the drift flux theory, and tends towards an asymptotic value, which marks the transition to annular flow. The maximum value decreases with increasing liquid viscosity, due to increase of the liquid film thickness around gas slugs.

In all the experiments, the bubble size distribution is bimodal, consisting of i) large (dm-size) bubbles, and ii) small (submm-cm size) ‘matrix’ bubbles which are unable to move within the liquid. These small bubbles are continuously formed by air trapping during the collapse of the liquid films in the burst or coalescence of the gas slugs. Their average size is controlled by shearing and coalescence and decreases with increasing gas flux. With increasing gas flow rate, frequency and length of the large bubbles increase but the volumetric concentration of small bubbles does not change significantly showing that the outgassing processes are dominated by the large, pipe-scale structures.

Scaling to magmatic conditions show that this dynamics could characterize conduit degassing of crystal free magmas, suggesting a complex relation between scoria textures and magma permeability.