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Degassing of lava lakes: bubble behaviour in particle-rich suspensions

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Understanding how gases escape from the magma columns of basaltic open vent volcanoes has importance because the mobility of gas bubbles influences magma dynamics and eruptions and because this style of persistent outgassing is largely responsible for shaping our atmosphere. Previous analogue experiments to understand outgassing have focussed mainly on two phase flow and have not accounted for the crystal phase; these have led to an understanding of some of the modes of eruption and gas release. Here we report on a series of new three phase analogue laboratory experiments in which we have investigated the influence of analogue crystals on the flow of gas through a liquid. A mixture of glycerol and particles where inserted into a cylinder with a diameter of 5 cm and a length of 100 cm, which was connected with a pump to regulate the injection rate of air. By increasing the particle content in the liquid we explore how the crystals change the effective rheology and thereby influence the formation and dynamics of gas bubbles rising through the system. In particular, we report on the dependence of gas phase geometry and frequency in the conduit on crystal content e.g. as crystal contents increase (with constant gas flux and viscosity of the fluid), bubble regime changes from high frequency of small bubbles through a regime of bubble growth but a decrease in bubble number; and finally to a regime of gas slugs with a low rise rate at the highest crystal fraction. Building from these results, we examine the influence of crystals on the fluctuations in the depth of magma and the causes of persistent outgassing of basaltic open vent volcanoes.