Modelling gas transfer, storage and resulting displacement in a 3d permeable volcanic edifice

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We use previous experimental data on permeabilities to create 3D numerical models to investigate gas transport and storage in a permeable volcanic edifice. We combine the continuity equation, Darcy's law and the ideal gas law to derive a partial differential equation which is solved using a finite element method to obtain the gas pressure. The associated pressure gradient is then used within Darcy's law to calculate the gas flux. Additionally, we investigate how the presence of gas and variations in permeability influence the rate and degree of deformation in the volcanic edifice.

This method allows the modelling of two and three dimensional structures, both in stationary and time-dependent evolution. Different geometries are created and the pressure and permeabilities incorporated into the model as boundary and domain conditions respectively.

We present two case studies in order to illustrated how variable permeability and pressure gradients influence the gas flux. Firstly we investigate an event at Soufriere Hills Volcano during March 2012 which culminated in significant ash venting. Secondly we attempt to model degassing rings on volcanoes such as Santiaguito and Colima.

Our model is highly versatile and aims to shed new light on the understanding of gas storage and transport in a permeable volcanic edifice.