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# Three dimensional continuum percolation of bubbles in magma and explosive volcanism

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The standard model of volcanic eruptions assumes that they are triggered by sudden increases of stresses or strains beyond critical thresholds. Recently, on the basis of simulations of bubble in 2D magma cross-sections a new mechanism has been proposed based on the catastrophic, singular overlap of bubbles at a critical porosity threshold called the percolation point (pc2D). Although rheological properties such as yield strengths were not directly calculated, it was observed that at pc2D almost surely any (possibly infinite) cross-section would be cleaved by a "spaghetti-like" network of overlapping bubbles. From this it was inferred that the volcanic structure - the ascending magma - would catastrophically fail under an imposed stress in the conduit at a critical porosity near pc2D; i.e. the eruption is thus triggered by the porosity exceeding a critical level.

In this work, we extend the previous work from 2D to the more complex but more realistic 3D case considering the effect of both monodisperse and scaling (power law) bubble size distributions. Whereas in 2D there is a single percolation threshold corresponding to percolation of either the bubbles or the non-gaseous phase (with pc2D≈0.65-0.72 depending somewhat on the bubble size distribution), in 3D there are 2 distinct percolation thresholds one for the bubbles (pc3Dbub≈0.2-0.3) and one for the non-gaseous phase (liquid and crystals) pc3Dng≈0.9-0.95). At each of the critical thresholds pc2D, pc3Dbub, pc3Dng, we calculate the distribution of bubbles, fragments, their porosities and relate these to field measurements of pumice rock.