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# A model for the evolution of fluid permeability in welding volcanic ash

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Magmas fragment forming a transiently granular material, which can weld back to a fluid-continuum. This process results in dramatic changes in the porosity of the material, which impacts the fluid permeability. First, we present stochastic simulations of spheres, designed to represent ash particles, in a 3D volume, for which the spheres are permitted to overlap. We use these simulations to show that we can quantitatively predict the surface area and pore-cluster size distribution of these geometrical objects through the full range of inter-sphere gas volume fractions. Second, we perform high temperature sintering experiments using analogue viscous droplets while imaging the internal structure of the sintering packs in situ using synchrotron-source X-rays and volume-reconstruction algorithms. We show that the evolution of structure in these time-resolved 3D datasets are comparable to the sphere-population simulations and to ex-situ tests. We use LBflow, a lattice-Boltzmann fluid flow simulation tool, to quantify the fluid-permeability between the sphere populations (simulation) and the sintering droplets (experimental). We scale the fluid permeability in both systems with the quantitative prediction of internal surface area and find a universal behaviour that additionally agrees well with other published datasets for natural samples. Finally, we use a model for the kinetics of sintering to convert the scaling between the permeability and the internal surface area into a model for the kinetics of the decay of permeability. We propose that this will be a useful tool for predicting the longevity of degassing pathways in granular-filled cracks in conduits and shallow lava domes as well as during the sedimentation of exceptional hot ignimbrites that undergo compaction and welding. Fruitful future research would quantify the effect of pore-cluster anisotropy development in the evolution of fluid permeability.