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Post eruptive permeability evolution of volcanic conduits and tuffisites

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Gas overpressure is the single most important driving force for explosive eruptions and remains one of the most challenging variables to characterize during the eruption cycle. Pressure build up in a volcano occurs once the amount of gas escaping the magma exceeds total flow capacity of all available gas pathways (Farquharson et al., 2017; Kolzenburg and Russell, 2014). Welding and compaction processes that operate in the gas escape systems of volcanoes cause critical reductions in porosity and permeability leading to reduced rates of outgassing. There are now a range of tools available for modelling the evolution of porosity (Quane et al., 2009) and permeability (Wadsworth et al., 2016; Wright and Cashman, 2014) during compaction. Here, we employ a combination of the most up-to-date models to track the time- and temperature-dependent compaction of tuffisite veins (i.e. hydro fractures in the edifice propped with fragmental juvenile and accessory material) and pyroclastic deposits infilling volcanic conduits, and model the associated porosity / permeability reduction. We use the model results to explore the relative importance and 'lifetimes' of the two dominant degassing pathways (conduit vs. tuffisites). We find that the flow capacity of the dominant part of the conduit, albeit being drastically higher during the time just after eruption, is rapidly reduced below that of tuffisite veins in the edifice. This is the result of their contrasting cooling timescales: heat loss from the conduit is much less efficient than from tuffisites and, therefore, post eruptive compaction and welding can act more effectively. The results also show that tuffisite thickness has a large effect on the efficiency of permeability reduction, where increasing vein thickness results in slower cooling and both faster and more intense permeability reduction. This suggests that, albeit volumetrically small, tuffisite veins may play a more important role in volcanic degassing than they are attributed to date.

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