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Blowing off steam: Sintering fragmented pyroclastic material to form tuffisites

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Tuffisites are veins of variably sintered, fragmented particles that form in magma columns and lava domes during explosive volcanic activity. Localised fragmentation events that produce ash-laden explosions are responsible for tuffisite generation. Tuffisites observed in-situ on the dome of Volcán de Colima during quiescence in 2012 range from failure-nuclei with fragmentation horizons and evidence of post-formation viscous flow, through to variable-thickness veins of poorly sintered granular aggregates. Further examination reveals complex "fracture" and "channel" patterns in the tuffisites, a reasonably constant grain size of 10-400 microns, and a wide range of porosity and permeability. In order to investigate the process of tuffisite formation, we took andesite from the tuffisite-hosting dome of Volcán de Colima and crushed and sieved it to 35-350 microns before sintering it at 940oC for different lengths of time. We then assessed the healing ability by measuring porosity and permeability evolution, and compare this to natural tuffisites. This study shows that tuffisite formation locally increases permeability, allowing passive degassing. Subsequent sintering reduces permeability over time, trapping gas and enabling pressure build-up. We find that the hours-to-days timescale of sintering of pyroclastic fragments correlates well to the cycling of vent locations, sometimes observed at Volcán de Colima, and the repeat interval of small magnitude Vulcanian explosions that occurred at Volcán de Colima during 2010-11 on a 2-7 hr basis. This reflects the multiple degassing pathways available in the upper edifice and dome. These results have important consequences for the modelling of Vulcanian explosions, common at many dome-forming volcanoes.