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What happens before eruption? Effect of strong crystal content and time dependence of permeability at very low gas content in immobile silicic magmas

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Magmatic outgassing plays a crucial role in the eruptive dynamics of silicic volcanoes. Gas escape from the volcanic conduit is facilitated by the coalescence of gas bubbles, leading to permeable bubble chains that are usually constrained by a crystalline framework within the magma. Our research provides experimental evidence of decompression-induced permeability in gas-poor crystal-rich silicic magmas that are not subjected to external strains. Synthetic samples were produced in Internally Heated Pressure Vessels (IHPV) to constrain and compare gas behavior with varying crystal content and size, and dwelling time. The permeable samples have a mean gas permeability of 10^{-14} m² for bulk porosity lower than 10% and bulk crystal contents of up to 75 vol%. Our results show that outgassing is possible in stagnant conduit at greater depths than initially assumed. This outgassing occurs even at low gas content, provided that the high crystallinity contains at least a microlite population with possible phenocrysts. Results also reveal a strong time dependence of the permeable bubble-chain lifetime in a closed magmatic system. If the dwelling time is too short, the coalescence process is incomplete, whereas if it is too long, the bubble chains resorb and become impermeable. Even with no magma deformation, the phenomenon of coalescence and percolation, therefore, remains dynamic. Our findings imply a new mechanism of deep outgassing for immobile magmas dominated by capillary forces, which has key implications on the explosive–effusive transition.