Investigating the collapse and inflation of erupting lava domes

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Actively growing lava domes can produce devastating block and ash flows from collapse of parts of the dome. These pyroclastic flows contain large blocks of rhyolitic lava of varying densities. The viscosity, volatile content and permeability of the lava control whether decompression associated with collapse will induce vesiculation in the clasts in the block and ash flow and the remaining lava in the collapse scar of the dome. A feature observed in many block and ash flow deposits are breadcrust bombs; rhyolitic lava that has inflated after collapse of the dome to produce a highly vesicular clast with a distinctive cracked surface.

The AD1315 Kaharoa eruption of Tarawera Volcano, New Zealand, produced 3 large, rhyolitic lava domes along with significant block and ash flow deposits on the surrounding plains. The domes at Tarawera have a vesicular and highly sheared solid carapace surrounding a denser, similarly sheared, interior. However, on one of these domes, Ruawahia Dome, we have found highly vesicular and large slabs of breadcrusting on the outer edge of the dome that correspond to the breadcrust textures observed in the block and ash flows. These vesicular zones are texturally distinct with large (up to 5mm) spherical (not sheared) vesicles. We theorise that the spherical nature of the bubbles suggests that the lava vesiculated in situ, following the cessation of shearing and movement of the lava. We propose that a collapse may expose the hot, dense interior of the dome, which will respond like the breadcrust bombs and vesiculate, inflating and partially erasing evidence of the collapse event.

To test this, we heat (750°C) dense lava dome material in an autoclave and vary the steam pressure from 0-5 MPa. In a series of experiments, we reduce the pressure at differing rates and compare the textural evolution of each sample. Porosity, permeability and textural analysis are performed on each sample post inflation, and we compare these textures to the breadcrust textures found in block and ash flows. Using the experimental data and extent of the vesiculated outcrops from mapping on Tarawera, we constrain conditions for in situ vesiculation of the dome during a collapse event. We use this to propose limits on the timeframe, temperature and pressure conditions of dome collapse events. We discuss the implications of this mechanism to erase collapse events from the morphology of the domes.

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