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A reappraisal of explosive-effusive silicic eruption dynamics

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The controls on the style of silicic eruptions – hazardously explosive, more gently effusive, or hybrid explosive-effusive – are poorly constrained. Current models invoke escape of gas through a connected foam, or through fractures, as the primary mechanism for the transition from explosive to effusive eruption. We propose a new model, in which hybrid and effusive silicic eruptions are typically explosive at depth, but the clastic products of this 'cryptic fragmentation' sinter and weld in the conduit to produce coherent lava at the surface. Drawing on numerous case studies of natural textures within eruptive products and dissected conduits, we show that effusive silicic eruptions are best interpreted as being the welded, squeezed-out remnant of ongoing or recent subsurface explosive behaviour. We demonstrate that effusively erupted lavas have microtextures diagnostic of a welding/sintering genesis and are comparable with those found in rheomorphic and welded ignimbrites. All eruptive products share pore network geometries and associated mechanical and hydraulic property-porosity relationships that are consistent with models for sintered materials. We conclude that silicic lava is generally clastogenic, and that, after it is sinter-assembled, it may undergo gas-driven fracturing that produces lava plug-cutting tuffisites (closed fractures filled with sintered particles), and sintered pyroclasts (from ash- to bomb-sized). At some sites (e.g. Volcán Chaitén 2008), the first material to be extruded from the vent is a pyroclastic rubble similar texturally to the volcanic bombs from the same site. We propose therefore that the shallow conduit is filled with pyroclastic and lithic rubble; a volume that variably compacts over time to produce a plug of densified lava. Envisaging the shallow conduit as a compacting rubble pile instead of a coherent magma-filled pipe or crack leads us to posit that the explosive-effusive transition is a blurred behavioural switch controlled by the competition between material supply at the underlying fragmentation front, and shallow particle capture, welding and lava production above. This framework has broad top-down implications for geochemical and geophysical predictions of shallow silicic volcanism, which we will explore in this presentation.