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The Great Tambora 2015 eruption: Could we see it coming?

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In this presentation I explore magma chamber stress conditions prior to a large-magnitude andesitic eruption and associated pre-eruptive ground deformation and gravity field perturbations. The analyis is informed by constraints from multi-disciplinary investigations of the data-rich and ongoing Soufrière Hills volcano (SHV) eruptive episode and the data-poor magnitude(M) 7 Tambora (TMB) 1815 eruption. Using analytical and numerical mechanical models accounting for self-gravitation and (to start with) mechanical elasticity I derive a set of conditions that simulate an andesitic magma chamber prior to a M7 eruption to deduce uniform chamber pressures upon failure, resultant ground displacements and Bouguer gravity anomalies. The results demonstrate that although a small and shallow-seated (SHV-type) chamber is more prone to pre-mature rupture upon pressurisation compared to a large TMB-type chamber, deduced uniform chamber pressures upon failure at SHV are unrealistically high. This implies that even for a SHV-type chamber, assuming elastic mechanical behaviour of crustal rocks is problematic to constrain magma chamber dynamics. I show that time-dependent stress dissipation is first-order in the evolution of small and, by extrapolation to pre-eruptive conditions for TMB 1815, also for large andesitic chambers even if topography, edifice load, and crustal mechanical heterogeneity are considered. A static failure criterion appears inadequate for system characterisation, necessitating a dynamic criterion, which is proposed to scale with volumetric strain rate upon chamber pressurisation. Informed by petrological and thermal constraints, a revised set of models predicts ground inflation of $\ll$1 cm/year from a large mid-crustal TMB-type chamber upon non-failure pressurisation at strain rates $<10^{-3}s^{-1}$. Although such rates of ground uplift may be difficult to resolve, the Bouguer gravity anomaly induced by such a chamber is significant. Implications of these findings include that protracted high-rate (order of dm/a or more) volcano uplift may be dominated by stresses induced by hydrothermal or hybrid processes rather than pure magma chamber pressurisation.