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Volcano collapse and pit crater formation using analogue models: an application to Myiakejima, Japan.

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We use analogue models to reproduce the collapse of volcanic edifices characterized by a high aspect ratio (thickness/diameter = T/D>1) of the crust overlying the magma chamber. We build up a transparent sand box filled with cohesive crushed silica material and a subsiding piston at its base to simulate magma withdrawal. We then analyze the internal structure evolution by recording from the side of the box using a digital camera sampling at 0.2 Hz and by a laser to observe topographic changes at the surface. We run several experiments, varying the aspect ratio of the model and also testing the role of the topography. Results show that all models start with high angle reverse faults propagating upward and becoming subvertical. These then converge at a specific point, forming an incremental arching shaped void when the depth of the model is greater than the convergence point location; this latter condition occurs for T/D>2; when the volume of the void overcomes a certain threshold, a sudden collapse propagates up to the surface, ending by a bottle-neck structure, above which a crater forms. Filling the collapsed portion with new material (as in the case of new freshly deposited volcanic material in nature) and continuing the subsidence further shows the activation of a single piston sliding along pre-existing structures, from the base of the model up to the surface. New structures propagate in the previously undisturbed refilled material and we observe a combination of reverse, normal and antithetic faults at the crater bottom and edge that accommodate the subsidence. Our experiments show that: 1) when T/D>2, the fractures propagating in an undisturbed material allow for the development of voids at depth, followed by sudden collapse and/or pit crater formation at the surface, 2) the reactivation of pre-existing structures prevents void formation and leads to the formation of collapse structures triggered by faster subsidence. The experimental results are being compared to natural examples, including the 2000 collapse of Miyakejima, Japan, which shows close similarities.