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Scaled experiments on volcanic cone-and-crater assembly, geometry and growth

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Volcanic cones are the most common volcanic constructs on Earth and are formed by explosive eruptions displaying a wide range of intensity and styles including hawaiian, strombolian, sub-plinian, even plinian. The morphology of small volcanic cone-and-crater constructs has been characterized (Porter, 1972; Wood, 1980) and rationalized using simple "sand cone-and-crater" analogue models (Riedel et al. 2003). Yet volcanic cones display a wide range of size and shape corresponding to a wide variability in characteristic morphometric ratios. For the Mauna Kea volcanic cone field, the crater-to- cone-base diameter ratio (W_{cr}/W_{co}) ranges from 0.15 to 0.57 and is perceived to be a time-integrated record of contrasting and successive eruption conditions. There is potential of learning about eruption conditions from analyses of the controls on the variability of their morphology. New analogue experiments are here presented. Sand, sugar and flour mixtures, in varying proportions, are used to construct cone piles, subsequently drained at their base, at the foot of the cone's apex. The effect of particles' cohesion on the cone height and crater diameter relative to the cone base diameter is systematically investigated. The influence of a sloping substratum on the crater and flank asymmetry is also investigated. The influences of an initial spatter-dominated or that of a phreatomagmatic initial eruption phase are modelled using corresponding clay models for the initial topography at the start of cone building. The results of the experiments are compared with several field cases. Other potential key controls on volcanic cone morphometric ratios such as temporal variation of eruption conditions and change in magma level in the conduit are proposed from a literature review and perspective for future experiments are presented.