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Experimental simulation and morphological quantification of volcano growth

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Volcanoes display very diverse morphologies as a result of a complex interplay of several constructive and destructive processes. Here the role played by the spatial distribution of eruption centre and by an underlying strike-slip fault in controlling the long term growth of volcanoes is investigated with analogue models. Volcano growth was simulated by depositing loads of granular material (sand-kaolin mixtures) from a point source. An individual load deposited at a fixed location produces a simple symmetrical cone with flank slopes at the angle of repose of the granular material (∼33º) that can be considered as the building-block for the experiments. Two sets of experiments were undertaken: (1) the location of deposition of the granular material (i.e. the volcano growth location) was shifted with time following specific probability density functions simulating shifts or migrations in vent location; (2) the location of deposition was kept fixed, but the deposition rate (i.e. the volcano growth rate) was varied coupled with the movement of a basal plate attached to a step-motor simulating a strike-slip displacement under the growing cone (and hence deformation of the cone). During the progression of the experiments, the models were photographed at regular time intervals using four digital cameras positioned at slightly different angles over the models. The photographs were used to generate synthetic digital elevation models (DEMs) with 0.2 mm spatial resolution of each step of the models by applying the MICMAC digital stereo-photogrammetry software. Morphometric data were extracted from the DEMs by applying two IDL-language algorithms: NETVOLC, used to automatically calculate the volcano edifice basal outline, and MORVOLC, used to extract a set of morphometric parameters that characterize the volcano edifice in terms of size, plan shape, profile shape and slopes. Analysis of the DEM-derived morphometric parameters allows to quantitatively characterize the growth evolution of the volcano models in terms of vent distribution and growth rate-deformation rate ratios.