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Analogue modelling of deformation structures at Mt Cameroon analysed with a digital image correlation technique

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Mt. Cameroon is a large, 4090 m high, continental volcano. It is characterized by repetitive basaltic lava flow eruptions, the most recent ones occurring in 1999 and 2000. Upper flanks of Mt Cameroon are exceptionally steep ($\sim$30°) for a lava-dominated volcano and are constrained by sharp breaks-in-slope. Field work enabled to identified well-defined inward-dipping structures bordering a flat summit plateau and thrust faults associated with topographic terraces around Mt Cameroon's base, suggesting summit subsidence and gravitational spreading of the volcano flanks above its sedimentary base. To better understand the structural configuration and morphology observed, scaled analogue experiments were designed. A volcanic ridge, made out of fine quartz sand, was let spread under gravitational forces above a ductile silicone layer. Experiments were conducted in 2D and 3D configurations. A digital image correlation (DIC) procedure was used to record fault formation and evolution through time. 3D spreading of an elongated edifice favors displacement perpendicular to the long axis, and formation of a summit graben and basal thrusts or folds parallel to this axis. Results of the DIC highlights the strain concentration in the central part of the main graben and along specific strike-slip faults bordering secondary grabens. This deformation is however not associated with slope increase or instabilities. 2D spreading of a volcanic ridge between two glass panes is associated either with two outward-dipping listric normal faults and inward-dipping antithetic faults or with two sets of deep and shallow normal faults, defining a central graben and forming steep mid-slopes with local instabilities, depending on the thickness of the underlying ductile material. Results from the experiments are compared with structural lineaments mapped at Mt Cameroon. It is concluded that the elongated morphology of Mt Cameroon promotes directional spreading perpendicular to its long axis, probably enhanced by local buttressing. Directional spreading is associated with both deep-seated normal listric faults causing summit subsidence as well as shallow outward dipping normal faults causing large scale slumps at mid-flanks. These shallow slumps, combined with inflation of upper flank through magma intrusion, account for the unusual steep slopes and flank landslides observed at Mt Cameroon.