Preliminary study of viscoelastic crustal deformation in the Krisuvik volcano, southwest Iceland

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Crustal viscoelasticity plays an important role in the crustal deformation, particularly in the volcanically active region beneath which the effective crustal viscosity is likely to be lowered by the presence of magma. However, volcano deformation has usually been examined in terms of crustal elasticity, in which the crust instantaneously responses to the incremental/decremental volume change in a deformation source. Thus, the potential of crustal viscoelasticity is still necessary to be examined for more reasonable interpretation on geodetic data precisely measuring volcano deformation. This study preliminary evaluates geodetic data from the Krisuvik volcano, southwest Iceland, to explore the applicability of crustal viscoelasticity. We use available GNSS time series of displacements from two sites: at Krisuvik (KRIV) and Mohalsadalur (MOHA). The data show surface uplift followed by exponential-like continuous subsidence, similar to that reported in some other calderas, e.g., Kutcharo Caldera and Yellowstone Caldera. Adoption of a simple viscoelastic model prediction, using sill-like magma source, to the observed post-inflation subsidence reveals that the inflation source was at ~0.5 km west of and ~0.5 km south of MOHA and at 4 km north of KRIV, at a depth of the ~5 km. The thickness change of the sill at the centre at the end of the inflation period is ~1-2m, and the effective crustal viscosity is significantly lower than that having been estimated from glacio-isostatic deformation in Iceland (in response to thinning ice caps). However, the present viscoelastic model can not explain some features of the observations, like that post-inflation the surface has subsided to be lower than the elevation that existed before the surface inflation initiated. This clearly indicates a necessity of additional subsidence mechanism, possibly including depressurised deformation source due to degassing and/or regional plate spreading. This study shows further the potential of crustal viscoelasticity to explain volcano deformation as a first-order approximation, but a higher ordered better fitting to the data may require other additional deformation mechanisms.

