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# Post-emplacement cooling and contraction of lava flows: InSAR observations and thermal model for lava fields at Hekla volcano, Iceland

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Gradual post-emplacement subsidence of lava flows has been observed at various volcanoes, e.g. Okmok volcano in Alaska, Kilauea volcano on Hawaii and Etna volcano on Sicily. In Iceland, this effect has been observed at Krafla volcano and Hekla volcano. The latter was chosen as a case study for investigating subsidence mechanisms, specifically thermal contraction. Effects like gravitational loading, clast repacking or creeping of a hot and liquid core can contribute to subsidence of emplaced lava flows, but thermal contraction is considered being a crucial effect. The extent to which it contributes to lava flow subsidence is investigated by mapping the relative movement of emplaced lava flows and flow substrate, and modeling the observed signal.

The slow vegetation in Iceland is advantageous for Interferometric Synthetic Aperture Radar (InSAR) and offers great coherence over long periods after lava emplacement, expanding beyond the outlines of lava flows. Due to this reason, InSAR observations over volcanoes in Iceland have taken place for more than 20 years. By combining InSAR tracks from ERS, Envisat and Cosmo-SkyMed satellites we gain six time series with a total of 99 interferograms. Making use of the high spatial resolution, a temporal trend of vertical lava movements was investigated over a course of over 23 years over the 1991 lava flow of Hekla volcano, Iceland. From these time series, temporal trends of accumulated subsidence and subsidence velocities were determined in line of sight of the satellites. However, the deformation signal of lava fields after emplacement is vertically dominated. Subsidence on this lava field is still ongoing and subsidence rates vary from 14.8 mm/year in 1995 to about 1.0 mm/year in 2014.

Fitting a simple exponential function suggests a exponential decay constant of 5.95 years. Additionally, a one-dimensional, semi-analytical model was fitted to these data. While subsidence due to phase change is calculated analytically, subsidence due to thermal contraction gives additional subsidence, which is calculated numerically. Inversions were carried out for initial lava thickness, thermal expansivity, thermal diffusivity, latent heat and specific heat as the crucial parameters governing lava flow subsidence.