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Father's Day Intrusion at Kilauea volcano: Tracking volume changes through realistic mechanical models

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Kilauea Volcano (Hawaii, USA) is one of the most active volcanoes in the world, providing an excellent natural laboratory to study processes of basaltic magmatism. Within the last 20 years, the establisment of a dense global positioning system (GPS) network and acquisitions of satellite synthetic aperture radar (SAR) data sets provide a way to measure surface displacement on the volcano. Here, we study the subsidence at the summit caldera occurred during east rift zone dike intrusion and eruption in 2007. We use GPS and InSAR measurements of surface deformation.

Understanding the magmatic system is important because measurements of surface ground deformation could be use as a proxy of magma transport through the crust. Therefore, surface deformation is informative of where and how much magma could be eruptible. Moreover, the inference process is not direct and surface deformation observations need to be coupled with mechanical numerical models. Current numerical modelling allows realistic media features such as topography and crustal heterogeneities to be included, although it is still very time-consuming to solve the inverse problem for 1) studying volcano processes or 2) even volcano monitoring purposes.

At Kilauea, we apply efficient and realistic mechanical models that show how the mechanical heterogeni-ties and topographic features of the medium could bias the deformation source depth (and therefore volume decrease). Specifically, the effect of rock rigidity around the source is taken into account to revise the depth of the active magma reservoir underneath the Kilauea's summit caldera in 2007. In addition to show the effects of medium features at Kilauea, this work aims to show how data inversion with numerical models can speed up the source parameters estimation.

The tools and methods presented in the study (efficient state-of-the-art numerical solving schemes) will al-low us to gain new knowledge that can be applied to any unrest volcano by accounting for a realistic mechanical medium. This will have implications for providing effective volcano monitoring, early warnings to civil authorities and eruption forecast.