Incremental growth of magma reservoirs: Insights on the room problem through the use of finite element models

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Résumé

Magma accumulation in the lithosphere leads to the formation of either plutonic rocks or magmatic reservoirs, which give birth to large volume of silicic volcanic rocks. The accumulation and sustainability of such reservoirs though time is believed to be controlled by the magma emplacement rate. The accumulation of large quantities of magmas in the crust is however not a trivial mechanism since it involves large deformation of the country rock. Such deformation is believed to occur currently in the Andes where InSAR data are showing large and persistent uplifts at seemingly constant rates of several centimetres per year over nearly two decades. The observed deformation can however reflect different rheological processes happening within the crust: either 1- an elastic response of an ongoing deformation, or 2- an ongoing viscoelastic response of a now ceased deformation. In this work, we aim to address this issue by studying the mechanical response of the country rock to the incremental growth of a magma reservoir using finite element models and seek to better constrain the interpretation made from remote sensing data.
Using the modeling capabilities of COMSOL Multiphysics®, we have developed a methodology allowing for incremental growth of a magma reservoir by successive sill intrusions. The methodology was developed using the module LiveLinkTM for Matlab® to automatize the process which consider several stages of five successive steps: 1- building the geometry, 2- imposing the physics, 3- meshing the domains, 4- computing the model, and 5- exporting the state of stress and the deformed geometry. At the end of each stage, the exported data are used as initial conditions in the subsequent stage, for which the 5 steps are repeated. The methodology has been developed using axisymmetric elastic models with each intrusion having a radius of 500 m long.
We will present the methodology itself and the initial results obtained in the initial and simple case of an elastic domain.

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