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3D Geodynamic Models of the Present-Day Altiplano-Puna Magmatic System

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For the past decades, several numerical studies have successfully reproduced the concentric uplift pattern observed above the Altiplano-Puna Magma Body (APMB) in the central Andes. However, the temperature- and strain rate-dependent viscoelastoplastic rheology of rocks, the buoyancy of magma, the effects of modelling in 3D as well as the shape of the magma body have often been simplified or neglected.

Here, we use a joint interpretation of seismic imaging and gravity anomalies to constrain location, 3D shape and density of the magma body. With the help of the thermo-mechanical finite difference code LaMEM, we then model the surface deformation and test our results against observations made by Interferometric Synthetic-Aperture Radar (InSAR) missions. This way, we gain insights into the dynamics and rheology of the present-day magmatic system and can test how a change to the current conditions (e.g., magma influx) could impact it.

We find that only an APMB with a maximum thickness of 14 to 18 km and a corresponding density contrast to the surrounding host rock of 100 to 175 kg/m³ satisfies both tomography and Bouguer data. Based on that and the chemistry of eruption products, we estimate the melt content of the APMB to be on the order of 20 - 25%. We also find that the observed uplift can be reproduced by magma-induced buoyancy forces without the need for an additional pressure source or magma injection within the mush, and that the geometry of the top of the magma body exerts a major control on the deformation pattern at the surface.