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Deep structure beneath Uturuncu volcano in the central Andes: Insights from new density anomaly models

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Volcanic activity in the central Andes during the Quaternaty has evolved from very large silicic volcanic centres that generated huge volumes of ignimbrites to, more recently, the eruption of silicic lavas that built large composite cones. The deep structures of these volcanic systems can be broadly inferred from a density anomaly inversion model. As part of an integrated multidisciplinary investigation of the on-going uplift of Uturuncu volcano in southern Bolivia, we are interested in understanding the constraints of sub-surface architecture and regional structures on the spatio-temporal variations in geophysical parameters during the emplacement and evolution of the active mid-crustal intrusion. Herein, we present a density anomaly 3D inversion model of an area of 5000 km^2 around Uturuncu. This survey saw the combined use of spring gravimeters and dual frequency GPS receivers, at 143 new static stations with average station spacing of about 5 km. Gravity data uncertainty is below 100 μGal for individual benchmarks and GPS data uncertainty is below 6 cm in the vertical. At the scale of the current survey, these settings allow for a precise determination of the anomalous gravimetric signature. Alongside the static gravity survey, six free air gradients and a microgravity survey have been carried out in the area. Static gravity data are employed to construct a detailed Bouguer anomaly map and, from it, a 3D model of the subsurface density distribution. The inversion routine builds a subsurface model defined by the 3D aggregation of parallelepiped cells, based on a controlled 'growth' process of anomalous density bodies (with a density contrast of $\pm$ 150 kg m^{-3}) by means of an exploratory approach. The regional gravity trend is calculated as part of the inversion routine and for this 60 regional data points are added. A new visualising tool allows us to generate 3D images of the density anomalies and hence better understand their geometries and relation to surface manifestations of volcanism. Our results show that Uturuncu and other neighbouring volcanoes are centred over a bowl-shaped low density body that extends to, at least, 15 km depth, where the 70 km-wide footprint of the current deformation anomaly constrains the source of the deformation, a region that other regional geophysical data indicate is the top of a thick region of hot partially molten rock. Strong negative anomalies root up towards the volcanic centres and smaller bodies are in some cases clearly related to hydrothermal systems with surface manifestations. One deep and large negative anomaly corresponds to the location of the large Vilama caldera system. Smaller and superficial positive and negative density bodies are aligned in N-S trends, in agreement with regional tectonic features.