Distribution of melt beneath the Altiplano-Puna volcanic complex from magnetotelluric data

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Abstract

The Central Andes is magmatically very active and characterized by both a well defined volcanic arc and an ignimbrite flare-up over the last 10 million years. Recent geophysical and geodetic studies have shown that this region remains magmatically very active. The Altiplano-Puna magma body (APMB) is recognized as one of the largest magma bodies on Earth and is spatially associated with the major ignimbrite eruptions of the Altiplano-Puna Volcanic Complex (APVC). Volcan Uturuncu in Southern Bolivia is located near the centre of the APMB and has been inflating over the past two decades at rates of 1-2 cm/year. It has been suggested that this represents a location where pluton formation may be occurring in real time.

The PLUTONS project is making a comprehensive set of geological and geophysical measurements to define the distribution of magma beneath Volcan Uturuncu, and also to understand how this is related to the APMB. This has included geological studies, seismic monitoring, and detailed geodetic measurements. Magnetotelluric (MT) data use passive electromagnetic signals to image subsurface resistivity from the surface to the upper mantle. Electrical resistivity is an important property because it is sensitive to the presence of partial melt and hydrothermal fluids in the crust. An extensive MT data set was collected at Volcan Uturuncu in 2011 and 2012. Broadband MT data in the frequency band 0.001-300 Hz were collected at 149 stations. These data have been used to generate both 2-D and 3-D resistivity models of the subsurface.

The resistivity model shows a pronounced mid-crustal low resistivity layer that can be clearly identified with the APMB. Shallower zones of low resistivity connect this layer with the surface in the vicinity of Volcan Uturuncu. There is considerable non-uniqueness in interpreting zones of low resistivity in volcanic environments, as they can be due to aqueous fluids, partial melt or hydrothermal alteration. To address this problem, the composition of these low resistivity zones is being interpreted with constraints from laboratory studies of partial melts and brines. This shows that the resistivity of the APMB is consistent with 5-10 percent melt with andesitic composition. Shallower features may represent zones of aqueous fluids exsolved from the crystallizing magma body.

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