Geophysical and laboratory constraints on the size and composition of crustal magma bodies

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A number of magnetotelluric (MT) and seismic studies have detected coincident zones of low resistivity, low seismic velocity, and high attenuation in the mid-crust of active orogens. These have been detected in both continent-continent collisions such as the Tibetan Plateau (1), and in the thickened crust formed above a subduction zone in the Altiplano (2). These anomalies have been interpreted as zones of fluids, most likely a combination of aqueous fluids and partial melts.

In addition to causing volcanic eruptions, these zones of partial melt are key geodynamic features since they weaken the crust and can control how the orogen deforms. However, the rheology is very sensitive to the amount of melt, its composition, and distribution. Geophysical data alone cannot define these parameters reliably. Laboratory measurements of the electrical and rheological properties of melts provide invaluable constraints when determining these properties. In this paper we analyse MT data from Southern Tibet and the Altiplano with available seismic and laboratory data to constrain the properties of mid-crustal magma systems.

In Southern Tibet, magnetotelluric studies have reported a high conductance in excess of 10000 S. This is the product of the layer thickness and conductivity, and is the quantity most reliably determined from MT data analysis. These observations were combined with laboratory data from partial melting experiments on metapelites (3) and passive seismic studies. The results suggest that the pure melt phase has a higher resistivity than previously thought, requiring a relatively thick layer of leucogranite partial melt.

Magnetotelluric and passive seismic data from the Southern Altiplano has detected a major magma body termed the Altiplano-Puna Magma body. Seismic data gives a thickness and velocity constraint that can be combined with the high conductance to yield revised estimates of the melt fraction and layer thickness.

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