

Tectonic vs. magmatic processes and the anatomy of Andean arcs

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The evolution of Andean arcs is a complex interplay between tectonic processes in the upper plate, magmatic addition from the mantle wedge and melting of the overriding plate lower crust.

Structural control

I will review some of the most important new ideas that have been advanced with respect to the structural evolution of Andean arcs: (1) the concept of vise tectonics and its role in extruding magmatic sheets, (2) backarc lithospheric scale thrusting, (3) lateral spreading currents caused by the weakness of mid- to lower crustal arc sections and, and (4) convective removal of arc lower crust and recycling into the mantle.

Melting function

The primary input of heat and mafic material in an Andean arc comes from wet melting of the mantle wedge. I will review the evidence we have for the fluxes of these magmatic additions, the range of permissible primitive compositions, and the fractionation trends of primitive magmas in the lower crust. Re-melting of wet basalts in the lower crust is the most viable mechanism for making large tonalite-granodiorite batholiths – the upper crustal expression of an Andean arc. I will quantify the melting functions for this process and the composition of residual masses left behind in the lower crust. Overall, the processes outlined above, shape the vertical architecture of Andean arcs – several examples will be presented. Laterally and over time, many arcs transition from migrating to static, from intermediate to silicic.

The surface connection

An important issue in the study of Andean arcs is the connection between magmatic products in batholiths and the surface volcanism in modern arcs. The case will be made here that ignimbrite centers correspond to the large granodiorite suites of the static arcs at depth, whereas andesitic volcanoes are the surface expression of migrating arcs represented at depth by tonalitic sheet-like intrusions.

Examples

The concepts above will be exemplified with arc sections from Big Sur (central coastal California), the Coast Mountains (British Columbia), the Sierra Nevada (California), the Xolapa arc (southern Mexico), and the Famatinian arc (Argentina).