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Composition and structural control of crustal domains in the Central Andes

Mirian Mamani: *Abt. Geochemie, Universität Göttingen, Goldschmidtstr. 1, 37077 Göttingen, Germany.*
Andrés Tassara: *Dep. de Geofísica, Universidad de Chile, Blanco Encalada 2002, Santiago, Chile.*
Gerhard Wörner: *Abt. Geochemie, Universität Göttingen, Goldschmidtstr. 1, 37077 Göttingen, Germany.*

Abstract

Present-day ratios of Pb isotopes (266 published samples, 435 new) and Nd-Sr isotopes (150 published, 180 new) on Proterozoic to Holocene igneous, metamorphic and sedimentary rocks define - at high spatial resolution - distinct isotopic domains of the crust in the Central Andes. These domains correlate with the internal compositional structure of the crust as revealed by a 3D density model. Pb-Nd isotopic boundaries thus correspond to variations in crustal compositional structure and reflect Proterozoic mafic- and Paleozoic felsic-dominated crustal heterogeneities. Age and composition (mafic versus felsic) of these domains have controlled the rheology of the Andean crust, have influenced crustal deformation patterns, and correlate with the Central Andean plateau segmentation.

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Geochemical variations in igneous rocks of the Central Andean Orocline (13° to 18°S): Tracing crustal thickening and magma generation through time and space

Mirian Mamani, Gerhard Wörner
Abt. Geochemie, GZG Universität Göttingen, Goldschmidtstr. 1, D-37077 Göttingen, Germany
Thierry Sempere
IRD and Université de Toulouse, UPS (SVT-OMP), LMTG, 14 av. Edouard Belin, F-31400 Toulouse, France

Abstract

Compositional variations of Central Andean subduction-related igneous rocks reflect the plate-tectonic evolution of this active continental margin through time and space. In order to address the effect on magmatism of changing subduction geometry and crustal evolution of the upper continental plate during the Andean orogeny, we have compiled more than 1500 major- and trace-element and 650 Sr-, 610 Nd-, 570 Pb-isotopic analyses of Meso-Cenozoic (190-0 Ma) magmatic rocks in southern Peru and northern Chile (Central Andean Orocline) mostly from new data and the literature. This data set documents compositional variations of magmas since Jurassic time, with a focus on the Neogene period when major crustal thickening developed and its influence on magma composition was most pronounced. We relate the observed variations in Sr/Y, La/Yb, La/Sm, Sm/Yb and Dy/Yb ratios, as well as in Sr-, Nd- and Pb-isotopic ratios, to the crustal structure and evolution of the Central Andean Orocline. In particular, the evolution of the Dy/Yb and Sm/Yb ratios, which respectively track the presence of the higher-pressure minerals amphibole and garnet in the lower crust, documents that crustal thickness has grown through time. Spatial variations in trace elements and isotopic ratios further suggest that crustal domains of distinct composition and age have influenced magma composition through some assimilation. The crustal input in Quaternary magmas is quantified to have been between 7 and 18 % by simple two-components mixing. When comparing our geochemical data set to the geological record of uplift and crustal thickening, we observe a correlation between the composition of magmatic rocks and the progression of Andean orogeny. In particular, our results support that major crustal thickening and uplift were initiated in the mid-Oligocene (30 Ma) and that crustal thickness has kept increasing until now. Our data do not support delamination as a general cause for major Late Miocene uplift in the Central Andes, and instead favor continued crustal thickening.