Differentiating post-magmatic cooling and erosional exhumation in the thermochronological record of the northern Chilean Forearc (22.5° and 24.5° S)

Ana María Patiño Acevedo[1], Mauricio Parra[1], Fernando Martínez[2], Cristopher López[3], Rodrigo González Tapia[3]

(1) University of São Paulo, Geoscience Institute, Rua do Lago, 562, São Paulo, Brazil
(2) Universidad Andrés Bello, Facultad de Ingeniería, Campus República, Santiago, Chile
(3) Universidad Católica del Norte, Ciencias Geológicas, Av. Angamos 0610, Antofagasta, Chile

Exhumation of the upper crust is a consequence of tectonic deformation and associated mountain building. In cases in which the tectonic deformation results in kilometric-scale uplift, thermochronology can potentially provide ages of cooling that can be interpreted as a response to erosional exhumation. The forearc of the Central Andes of northern Chile hosts a widespread record of Mesozoic and Cenozoic arc magmatism and sediment accumulation in adjacent basins. The early stage of Andean orogenesis in the forearc led to the closure and inversion of former extensional basins through contractional reactivation of Mesozoic normal faults since the Late Cretaceous-Paleocene. This compression is also recorded by changes in the sedimentary systems and post-tectonic magmatism. Ongoing convergence during Eocene–Oligocene resulted in vertical-axis rotations and thrusting, and its record is preserved in syn-tectonic units. These contractional events have been also related to cooling ages from low-temperature thermochronology. The Neogene tectonic setting of the forearc is debated between an extensional and compressional regime. Overprinting of multiple compressive episodes affecting the continental margin hinders the recognition of their individual contribution to crustal thickening over time.

A positive correlation between the spatial distribution of Cretaceous to Cenozoic intrusive and hypabyssal rocks with available U-Pb crystallization ages between ~110 and 30 Ma, and low-temperature thermochronological ages precludes ruling out that cooling resulted from post-magmatic refrigeration instead of from exhumation. This alternative has been underestimated in a continental margin with long-live magmatism as the Andes margin.

In this scenario, discriminating the cooling of the forearc upper crust between a signature of deformation versus post-magmatic cooling by estimating the depth of emplacement of intrusive rocks contributes to better constraining the Late Cretaceous to Cenozoic pulses of orogenesis and their potential effect on changes in the crustal thickness.

Fieldwork was carried out in a transect between the Coastal Cordillera and the Salar de Punta Negra basin and in the surroundings of Calama (~22.5-24.5° S). In the field was recognized preserved normal and thrust structures involving Meso-Cenozoic units and the Neogene sedimentary cover affected by brittle deformation.

Available and new thermochronological ages illustrate that the younger ages are spatially correlated with the Domeyko fault system. The youngest ages of the highest temperature systems (zircon fission-track and zircon (U-Th)/He) are Eocene (~ 57-47 Ma, a cluster of ~30 Ma could be correlated with hydrothermal alteration), suggesting that the deepest exhumation was controlled by structures of the Precordillera. In contrast, the ages of the lowest temperature thermochronometers (apatite fission track and apatite (U-Th)/He) became younger to the east. This contribution aims to determine the thermal evolution of the upper crust through the use of structural modeling, low-temperature thermochronology, and paleo-crustal thickness estimations from geochemical proxies and paleobarometry markers of the emplacement of Late Cretaceous to Cenozoic plutonic rocks. Our multi-method approach will enable the recognition of exhumation modulated by tectonics and will provide constraints of crustal thickening in a pre and syn-orogenic phase. Thermokinematic modeling incorporating all datasets will allow us to quantify the magnitude of shortening over time.