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Quantifying drainage-divide migration from orographic rainfall over geologic timescales: Sierra de Aconquija, southern Central Andes

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Drainage-divide migration, controlled by rock-uplift and rainfall patterns, may play a major role in the geomorphic evolution of mountain ranges. However, divide-migration rates over geologic timescales have only been estimated by theoretical studies and remain empirically poorly constrained. Geomorphological evidence suggests that the Sierra de Aconquija, on the eastern side of the southern Central Andes, northwest Argentina, is undergoing active westward drainage-divide migration. The mountain range has been subjected to steep rock trajectories and pronounced orographic rainfall for the last several million years, presenting an ideal setting for using low-temperature thermochronometric data and exhumation rates derived from in situ produced ^{10}Be to explore its topographic evolution.

We perform three-dimensional thermal-kinematic modeling of previously published thermochronometric data spanning the windward and leeward sides of the range to explore the most likely structural and topographic evolution of the range. We find that the thermochronometric data can be explained by scenarios involving drainage-divide migration alone, or by scenarios that also involve changes in the structures that have accommodated deformation through time. By combining new ^{10}Be-derived catchment-average denudation rates with geomorphic and stratigraphic constraints on fault activity, we conclude that the evolution of the range was likely dominated by west-vergent faulting on a high-angle reverse fault underlying the range, together with westward drainage-divide migration at a rate of several km per million years. Our findings place new constraints on the magnitudes and rates of drainage-divide migration in real landscapes, quantify the effects of orographic rainfall and erosion on the topographic evolution of a mountain range, and highlight the importance of considering drainage-divide migration when interpreting thermochronometer age patterns.