**Abstract**

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, is currently undergoing westward drainage-divide migration. The range has been subjected to near-vertical rock uplift and pronounced orographic rainfall for the last several million years, presenting an ideal test case for using low-temperature thermochronometric data to constrain its topographic evolution. We perform three-dimensional thermal-kinematic modeling of previously published thermochronometric data spanning both sides of the range to explore its likely structural and topographic evolution. We find that the thermochronometric data can be explained by topographic evolution, changes in the structures that have accommodated deformation through time, or both. By combining new 10Be derived catchment-average denudation rates with geomorphic constraints on probable fault activity, we are able to conclude that evolution of the range was likely dominated by west-vergent faulting on a high-angle reverse fault that underlies 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.