One-Km of Subduction-Induced Subsidence of the Eastern Side of the Southern Andes at 10 Ma, as Measured Using Hydrogen Isotopes in Hydrated Volcanic Glass

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We report new results for the topographic evolution of the eastern flank of the South-Central Andes at ~35 S latitude. Our work is based on a piggy-back basin near Malargüe, Argentina, which provides a continuous stratigraphic record from 55 to 10 Ma. We have separated volcanic glass and measured hydrogen isotopes (δD) from 107 samples. Studies over the last several decades show that volcanic glass will take up precipitation water by hydration on a 1 to 10 ka time scale. This reaction is irreversible, and later diffusive exchange is too slow to alter the initial isotopic composition. Thus, we conclude that our data provide a record of the isotopic composition of precipitation for most of the Cenozoic. Empirical and theoretical work indicate that the isotopic composition of precipitation decreases in a linear fashion with increasing orographic lifting. We have calibrated this relationship by isotopic modeling of modern water isotopes (152 samples) at 35 S across Chile and Argentina, and that work indicates a lifting relationship for precipitation δD ~20‰/km.

Our glass isotope record shows a steady decrease in δD through the Cenozoic, which matches well with the isotopic response predicted for global cooling at that time. After correction for this climate effect, our glass isotope record indicates that the Malargüe region had a steady elevation from 55 to 20 Ma, and then was subjected to a cycle of 1 km of subsidence and an equivalent amount of rebound, between 20 to 0 Ma.

Ongoing geodynamic modeling provides independent evidence of a large subsidence event in this region of South America as determined from the history of slab age and subduction velocity, both constrained by plate kinematics. This dynamic subsidence would have affected both the Andes and the eastern "retroarc" basin. Previous workers have viewed the subsidence history of the retroarc basin as providing a diagnostic record of the growth and decay of orogenic topography, but our work shows that subduction-induced dynamic topography can produce effects of similar magnitude.