Eocene to modern topographic evolution of an Andean retroarc foreland basin (35°S) from stable isotope paleoaltimetry: implications for tectonic and geodynamic models

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Andean basins contain a unique sedimentary record reflecting mountain building processes along the western margin of South America throughout its entire Meso-Cenozoic evolution (Horton, 2018). In particular, the retroarc foreland basins in west-central Argentina contain an archive of sediment accumulation rates, provenance, paleodrainage and deformation timings related to the growth of the Southern Central Andes (27°-46°30'S; Ramos, 1999). However, this dataset has non-unique tectonic interpretations, resulting in contrasting geodynamic scenarios. During the last decade, paleoaltimetry studies using proxies to obtain the stable isotopic composition of paleoprecipitation have proved to be a powerful tool when assessing such contrasting scenarios, not only by reconstructing topography, but also by adding a key element towards understanding changes in regional climate and biological diversification (Mulch, 2016).

The stable isotopic composition of precipitation reflects the degree of isotopic distillation during rainout as an airmass moves across a landscape. Thus, materials that record this geochemical variable can provide an indication of the present or past elevations along a moisture transport pathway. As volcanic ashes are deposited on a landscape, they readily hydrate, providing a record of the isotopic composition of ambient water over a timescale of 1-10 thousand years. Following hydration, water uptake ceases and this initial signature is preserved, providing a long-term record of stable hydrogen isotopes (ID) of paleo-precipitation. Therefore, given that the activity of the Andean magmatic arc has resulted in a near-continuous production of felsic ashes for more than 65 million years, the stable isotope content of hydrated volcanic glass from the Malargüe foreland basin (35°S) was extracted to analyze its topographic evolution and compare it to the geological record.

The ID of volcanic glasses preserved within strata of the Malargüe basin suggest high-standing topography since at least 55 Ma, along with an increase in orographic fractionation during middle Eocene to Oligocene times, followed by a decrease between the middle Miocene and the Pliocene. While the first event coincides with low accumulation rates during lacustrine and distal fluvial deposition in the basin, the second episode overlaps with high accumulation rates and proximal fluvial and alluvial sedimentation. These results support the hypothesis of a pre-Neogene orographic barrier and could be reflecting topographic changes associated with deep mantle processes that have been affecting the South American continent throughout most of the Cenozoic (Flament et al., 2015).

Flament, N., Gurnis, M., Müller, R.D., Bower, D.J., and Husson, L., 2015. Influence of subduction history on South American topography. Earth and Planetary Science Letters, 430, 9-18.
Horton, B.K., 2018. Sedimentary record of Andean mountain building. Earth-Science Reviews, 178, 279-309.
Mulch, A., 2016. Stable isotope paleoaltimetry and the evolution of landscapes and life. Earth and Planetary Science Letters, 433, 180-191.
Ramos, V.A., 1999. Plate tectonic setting of the Andean Cordillera. Episodes, 22(3), 183-190.