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New constraints on the uplift history of the western Andes, north Chile, using cosmogenic He-3 in alluvial boulders

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To constrain mechanisms responsible for mountain belt growth independent methods for determining accurately the rate and timing of surface uplift are needed. Within the Central Andes paleoelevation proxies are afflicted by either large uncertainties or reliance on assumptions about past climate-elevation histories (Barnes and Ehmer. 2009). This leads to paleoelevation data being unable to distinguish between the two main uplift models of the Andes; gradual uplift of the Andes from the Late Eocene due to crustal shortening/thickening, and rapid uplift in the Late Miocene due to large-scale mantle delamination (Barnes and Ehmer. 2009). Here we present a new paleoelevation tool based on the varying production rate of in situ cosmogenic isotopes with elevation. It can constrain surface uplift histories independently of paleoclimatic fluctuations, making it potentially more accurate than previous methods.

Within the Atacama Desert Northern Chile, a stable arid-hyperarid climate has persisted over the last 23 Ma (Dunai et al. 2005). This has lead to exceptionally low erosion rates and high cosmogenic nuclide concentrations within alluvial boulders overlying the Pacific Planation Surface (PPS). In the Aroma Quebrada region, the PPS can be constrained as forming post 13.4 Ma, using underlying volcanics (Evenstar 2007). Alluvial boulders that lie on this PPS have high concentrations of cosmogenic He-3 that suggest deposition soon after surface formation. Comparing concentrations of cosmogenic 3He in the boulders to those calculated for varying uplift histories the timing of the uplift of the western margin of the Andes can be constrained. The models require the Pacific Planation Surface to reach at least 2/3 of its current elevation by 13.4 Ma. These results are not consistent with rapid uplift of the Andes due to mantle delamination in the Late Miocene but support progressive shortening and thickening of continental crust initiating in the Early Miocene or earlier.