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Stable isotope paleoaltimetry: Coupled climate and surface uplift records in orogenic belts

A. Mulch (1), C.P. Chamberlain (2), C. Teyssier (3), S.A. Graham (2)

(1) Inst. f. Geologie, Callinstr. 30, 30167 Hannover, Germany (mulch@geowi.uni-hannover.de), Geological and Environmental Sciences, Stanford University, Stanford, USA, (3) Institut de Geologie, Universite de Lausanne, Lausanne, Switzerland

Over the past decade the stable isotope and tectonics communities have witnessed a rapidly increasing number of studies trying to assess the long-term topographic histories of orogenic belts and continental plateaus. Stable isotope paleoaltimetry in particular has stimulated ample discussion as it provides previously unavailable boundary conditions for tectonic and global scale climate models. Here we present examples of multi-proxy, multi-isotope studies aiming at reconstructing the surface uplift and relief development history of the Sierra Nevada and Basin and Range province (USA). In this context, the modern Sierra Nevada represents a very efficient barrier to zonal atmospheric flow patterns and thus creates a distinct rain shadow to the East of the range. The magnitude and duration of this rain shadow controls precipitation patterns in the Basin and Range and therefore not only impacts fluvial erosion and evacuation processes but also the temporal and spatial distribution of ecosystems. Hydrogen and oxygen isotope data from various proxy materials (hydrated volcanic glass, clays, mammalian bone and teeth) indicate that the Sierra Nevada rain shadow has been effective since at least the Mid-Miocene and thus persisted during Basin and Range extension. For the case of the western United States, the complex interplay of extensional processes acting in various levels of the lithosphere necessitates paleoaltimetry data to be collected such that the surface response of tectonic processes as recorded in e.g. terrestrial basins can be linked to the orogen-scale structural elements that control the overall architecture of the orogen.