EGU2020-7941
https://doi.org/10.5194/egusphere-egu2020-7941
EGU General Assembly 2020

Mountain building and species radiations in the Andes: a reconstruction of surface uplift and species diversification since the Late Cretaceous from a compilation of paleo-elevation estimates, thermochronology, and phylogenetic data.

Lydian Boschman[1], Mauricio Bermúdez[2], and Fabien Condamine[3]
[1]Environmental System Science, ETH Zürich, Zürich, Switzerland (lydian.boschman@usys.ethz.ch)
[2]Escuela de Ingeniería Geológica, Universidad Pedagógica y Tecnológica de Colombia, Sogamoso, Colombia
[3]CNRS, Institut des Sciences de l'Evolution de Montpellier, Université de Montpellier, Montpellier, France

The Andes are the longest continental mountain range on Earth, stretching from tropical Colombia and Venezuela in the north to temperate to sub-polar Patagonia in the south along the western margin of the South American continent. Biological diversity is extraordinarily high, especially in the northern tropical Andes, which are considered to be the richest biodiversity hotspot in the world. The Andes are relatively young; a large part of the modern topography is the result of surface uplift that occurred during and since the Miocene. However, large differences exist in the timing of shortening, exhumation, and surface uplift between the northern, central, and southern Andes, as well as between the various parallel Cordilleras. Mountain building directly links to climate dynamics, the development of drainage patterns, and the evolution of biomes and biodiversity. Therefore, determining the timing of surface uplift for each of the different Andean regions is of crucial importance for our understanding of continental-scale moisture transport and atmospheric circulation, the origin and evolution of the Amazon River and Rainforest, and ultimately, the origin and evolution of species in South America.

Determining surface elevations through geological time is not straightforward because the geological record does not contain a direct measure of topography. Commonly used methods to indirectly estimate paleo-elevation include low temperature thermochronology, palynology/paleobotany, the identification and dating of paleosurfaces, and analyzing the stratigraphic record of foreland basins that quantitatively record the topographic and erosional history of an adjacent mountain range. Additionally, paleo-elevation can be estimated more directly by stable isotope paleo-altimetry: atmospheric $\delta^{18}O$ and δD vary with elevation as precipitation from ascending air parcels along an orographic barrier removes the heavy isotopes. The $\delta^{18}O$ and δD values in authigenic/pedogenic materials (paleosols or lakes), biogenic archives (e.g. fossil teeth), volcanic glass, or organic biomarkers (e.g. leaf-wax n-alkanes preserved in soils or sediments) may thus record paleo-elevation.

In this study, we present a compilation of (direct and indirect) estimates of paleo-elevation of the Andes. We generate a reconstruction of surface uplift, per latitudinal sector of the Andes and per

Cordillera or range, containing elevation values per 1x1 degree cell and per Myr. We discuss the areas and/or times where this reconstruction is uncertain as a result of either a lack of data, or a discrepancy between different data sets. Next, we present a compilation of low temperature thermochronology data, and compare the paleo-elevation history of the Andes with its exhumation history. We analyze spatial and temporal variations in erosion rates during Andean mountain building. Last, we use the paleo-elevation reconstruction to analyze the role of Andean mountain building in the rates of species diversification for hummingbirds (clade of Brilliants and Coquettes), iguanians (Liolaemus), tree frogs (two families), and flowering plants (centropogonids and orchids). We use a model□testing approach that compares various diversification scenarios including a series of biologically realistic models to estimate speciation and extinction rates using a phylogeny, while assessing the relationship between diversification and environmental variables.