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Estimating Uplift Rate Histories From River Profiles: Examples From the Colorado Plateau

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It is widely agreed that a region encompassing the Colorado Plateau has been uplifted by sub-crustal processes. Admittance calculations, tomographic studies and receiver function analyses suggest that dynamic support is generated by a combination of large-scale convective upwelling and lithospheric thickness changes. Notwithstanding important advances in our understanding of the present-day setting, uplift rate histories of this region are poorly constrained and much debated: an improved history will help to discriminate between a variety of proposed uplift models. Here, we show that a regional uplift rate history can be obtained by inverting longitudinal river profiles. Our approach assumes that the shape of a river profile is controlled by uplift rate and moderated by erosion. Inverse modeling of river profiles from the Colorado River and Rio Grande catchments shows that three phases of regional uplift affected the Colorado Plateau. The first phase occurred between 80 and 50 Myrs, when ~ 1 km of regional uplift was generated at a rate of ~ 0.03 mm/yr. A second phase occurred between 55 and 35 Myrs, when ~ 1.5 km of regional uplift was generated at a faster rate of ~ 0.08 mm/yr. A third phase of minor uplift started within the last 5 Myrs. Distinct phases of Late Cretaceous and Oligocene uplift are corroborated by thermochronometric data, and by stratigraphic evidence of periodic clastic efflux delivered into the Gulf of Mexico. An episodic uplift history is consistent with the staged removal of thick lithospheric mantle beneath a large region, which is currently centered on the Yellowstone Hotspot.