Diachronous episodes of Cenozoic erosion in southwestern North America and their relationship to rock uplift, paleoclimate, and paleoaltimetry

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The history of erosion of southwestern North America and its relationship to uplift processes is a long-standing topic of debate. We use geologic and thermochronometric data to reconstruct the erosion history of southwestern North America. Erosion events occurred mostly in response to rock uplift by tectonism, although important isostatic components of uplift can be demonstrated during the late Miocene–Recent. We recognize four regional episodes of erosion and associated rock uplift: (1) the Laramide orogeny (ca. 75–50 Ma), during which individual uplifts were deeply eroded as a result of uplift above thrusts, but Laramide basins and the Great Plains region remained near sea level as shown by the lack of significant Laramide exhumation in these areas; (2) late middle Eocene erosion (ca. 42–37 Ma) in Wyoming, Montana, and Colorado occurred in response to epeirogenic uplift from rebound that followed the cessation of Laramide dynamic subsidence; (3) late Oligocene–early Miocene deep erosion (ca. 27–15 Ma) that affected a broad region of the southern Cordillera (including the southern Colorado Plateau, southern Great Plains, trans-Pecos Texas, and northeastern Mexico) that was uplifted in response to increased mantle buoyancy from major concurrent volcanism in the Sierra Madre Occidental and adjacent volcanic fields. (4) Late Miocene–Recent erosion (ca. 6–0 Ma) of a broad area of southwestern North America, with a locus of deep erosion in the western Colorado–eastern Utah region that reflects mantle-driven rock uplift as well as an important isostatic component related to deep fluvial erosion. We cannot estimate the amount of rock or surface uplift associated with each erosion episode, but the maximum depth of exhumation for each was broadly similar (typically ~1–3 km). Only the most recent erosion episode is correlated with climate change.

Paleoaltimetric studies, except for those based on leaf physiognomy, are generally compatible with the uplift chronology we propose here. Physiognomy-based paleoelevation data commonly show that near-modern elevations were attained during the Paleogene, but are the only data that uniquely support such interpretations. High Paleogene elevations, however, require a complex uplift/subsidence history for the Front Range and western Great Plains area that is not compatible with regional sedimentation and erosion events. Our results suggest that near-modern surface elevations in southwestern North America were generally not attained until the Neogene, and that these high elevations are the cumulative result of four major episodes of Cenozoic rock uplift of diverse origin, geographic distribution, and timing.

Keywords:

erosional history, uplift, paleoclimate, altimetry, Laramide orogeny, exhumation

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