A Geomorphic-Stratigraphic Perspective of Topographic Evolution of the Sierra Nevada, California and Alternative Explanations of Isotopic Paleoaltimetry

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Geologic relationships in the Sierra Nevada, California, show negligible stream incision between Eocene and late Miocene/Pliocene time. Stream incision of up to ~1 km began at (from south to north) about 20 Ma in the Kern to Kings River drainages, between 6 and 10 Ma in the San Joaquin River drainage, 3.6 to 4 Ma in the Stanislaus and Mokelumne River drainages, and ca. 3 Ma in the American and Feather River drainages. These differences in incision timing greatly exceed the time of knickpoint retreat, based on the example of the North Fork Feather River, where the knickpoint may have retreated over 100 km in less than 300 ka based on ages of interfluve-capping andesites and an inset basalt flow. The knickpoint in the Stanislaus River may have retreated over 50 km in less than 400 ka based on somewhat looser constraints. Eocene paleochannels show lowest gradients parallel to the range axis, steepest ones perpendicular, and reaches with significant "uphill" gradients that rise in the paleo-downstream direction. Modern Sierran rivers lack this relationship. The azimuth-gradient relationships of paleochannels, especially the uphill gradients, require late Cenozoic tilting and uplift. Incision began in spite of decreasing discharge and increasing sediment load and must have resulted from steepening associated with tilting and uplift. Stable isotope paleoaltimetry apparently records a profile similar to the modern range and areas east of it, in spite of significant vertical deformation that postdates the age of the sampled deposits, suggesting fairly recent reequilibration, in contrast to the published interpretations of closed system behavior since the Oligocene or Eocene. Such apparent open system behavior agrees with studies showing progressive hydration of volcanic glass and the correspondence between weathering and erosion rates. Northward-younging initiation of late Cenozoic uplift and stream incision suggests a relationship with triple junction migration, possibly associated with slab window development, with a second uplift pulse related to delamination and limited to the southern Sierra (San Joaquin River drainage and southward). Basement features may have significantly influenced along and across-strike differences in Cenozoic tectonics and geomorphic response.