Geophysical Research Abstracts, Vol. 7, 08887, 2005
SRef-ID: 1607-7962/gra/EGU05-A-08887

Evaluating tectonic rock uplift and erosion-uplift feedback, western Great Plains, United States

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Although rock uplift and deformation in intraplate areas is generally much more subtle than that in plate marginal orogenic belts, the limited magnitude of uplift-driven erosion in such settings commonly allows preservation of pre-deformation markers that may be used to assess deformation. This study uses the Miocene sub-Ogallala surface of the western U.S. Great Plains as a marker to assess magnitudes and patterns of post-Miocene rock deformation, to tease apart the tectonic and isostatic components of rock uplift, and to assess the development of positive feedback between rock uplift and erosion in an intraplate area of relatively low uplift rates ($\leq$0.25 mm/yr).

The western Great Plains of southern Wyoming, Colorado, and northern New Mexico extend east several hundred kilometers from the Rocky Mountain front. They are currently incised up to a kilometer or more below their Miocene surface, with incision magnitude decreasing eastward. Preserved Miocene (Ogallala) rocks on major interfluves have been tilted to the east and broadly warped along north-south transects since deposition. Amplitude of the N-S warping approaches 1 km near the mountain front but decreases eastward. The magnitude of eastward post-depositional tilt exceeds 1 km on the southern plains but decreases northward. Comparison of modeled flexural isostatic response to post-Ogallala river incision with these patterns of post-Ogallala deformation indicates that half or less of the deformation can be explained isostatically. The remainder must reflect tectonic forcing. The magnitude of tectonic forcing decays eastward and northward over a distance of several hundred kilometers away from the flanks of the Rio Grande Rift, which is propagating northward through the Rocky Mountains.

A positive feedback relationship between rock uplift and fluvial erosion can be documented on the Great Plains. Near the western margin of the plains where both tectonic

and total rock uplift are greatest, most (ca 60%) of the uplifted rock mass has been removed by post-Miocene erosion, and the magnitude of resulting erosionally driven isostatic rock uplift approaches the magnitude of tectonic rock uplift. To the east, where the total magnitude of rock uplift is much smaller, a smaller proportion (ca 35-40%) of the uplifted mass has been removed by erosion and compensating isostatic rock uplift is similarly limited in relation to tectonic forcing.