Using cosmogenic nuclides to decipher desert piedmont surface histories and process rates

We used cosmogenic ^{10}Be and ^{26}Al as cosmic ray dosimeters to track sediment across several Mojave Desert piedmonts. Comparison of the different data sets allows us to see similarities in piedmont behavior over time. Nuclide activities in sediment from source basins, and from abandoned piedmont surfaces, allow us to estimate rates at which sediment is supplied to piedmonts. Analysis of amalgamated sediment samples, collected along contour parallel transects spaced at 1 km intervals from the mountain front, indicate the exposure history of sediment as it is transported down each piedmont. Nuclide activities in sediment samples from two soil pits, on each piedmont, allow for estimates of deposition rates and piedmont history.

Model results suggest that the Chemehuevi and Iron Mountains are eroding between 34 and 40 mm ky^{-1}. Cosmogenic nuclide profiles in soil pits from both piedmonts suggest a complex history of deposition (at rates between 18 to 37 mm ky^{-1}) and stability over the past 60 ky. A change in process from sediment deposition to sediment transport occurred on the Iron Mountain piedmont and on the distal portion of the Chemehuevi Mountain piedmont near the Pleistocene-Holocene climatic transition, while the proximal Chemehuevi Mt. piedmont surface has been stable for ~5 ky. Long-term average sediment speeds, calculated using a coupled mass and nuclide balance model, suggest tens of meters per year of movement in confined bedrock channels near the Chemehuevi Mt., to decimeters per year in unconfined channels of the distal Chemehuevi Mt. piedmont and on the active surfaces of the Iron Mt. piedmont.

The East Range Road piedmont is fed by old, uplifted alluvial fan deposits and is incising at much slower rates, 13 mm ky^{-1}. Nuclide data suggest that a large volume of sediment was deposited on the proximal piedmont, nearest the uplands, ~ 76 kya, and has subsequently been stable or eroding slowly; the distal piedmont has experienced alternating periods of surface stability, erosion, and deposition over the last 70 ky. Nuclide data from amalgamated transect samples suggest long-term average down-gradient sediment speeds of decimeters per year.

Looking at each site individually we can begin to unravel local piedmont histories and quantify process rates. By comparing the suite of study sites we can start to determine regional climatic controls on piedmont processes as demonstrated by change from sediment deposition to sediment transport on the Chemehuevi and Iron Mt. piedmonts.