Comparison of Geomorphic and Isotopic Measurements for Erosion in the Rio Puerco, New Mexico

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The Rio Puerco basin (16,100 km^2) is the largest tributary to the Rio Grande in New Mexico, draining more than 20% if its area at San Marcial. The Rio Puerco delivers only 5% of the Rio Grandes runoff at San Marcial but over 70% of its average suspended-sediment load. Using data compiled by Milliman and Syvitski (1992) and Milliman and Meade (1983), the Rio Puerco has the third highest average annual sediment concentration behind the Yellow River, China, and is therefore, a world class river in terms of erosion and sediment transport.

Erosion (surface lowering by sediment removal) in the Rio Puerco basin was measured at two different time scales. The modern time scale using process geomorphic techniques and the geologic time scale using cosmogenic isotope dating. At the modern time scale (1-3 years), surface lowering by erosion was measured using sediment traps or Gerlach Troughs and sediment deposition behind small dams. The Gerlach Trough technique measured runoff and sediment during rainfall events in 70cm x 40cm x 13cm plastic traps. Dams were constructed of straw in 1-2nd order channels. The contributing area using these techniques ranged over several orders-of-magnitude (Gerlach Troughs - 0.84 to 37m^2 and dams 245 to 2,276 m^2) and permitted analysis of the effect of drainage area on sediment yields. At the geologic time scale (>10^6 years) surface lowering by erosion was measured using in situ produced cosmogenic ^{10}Be and ^{26}Al. Cosmogenic radionuclides dosages in near surface (<1m) quartz provides a measurement of the exposure and erosion history of sand grains moving through a basin. In low erosion areas, sediments at the earth's surface accumulate high abundances of radionuclides. Conversely, in high erosion areas the abundance of radionuclides in the sediment is low.

All methods for quantifying erosion rates were compared in the Arroyo Chavez (2.21 km^2) subbasin of the Rio Puerco. Ten sediment traps were installed along four geomorphic surfaces: mesa tops, colluvial slopes, alluvial fans, and the alluvial valley floor. Cosmogenic radionuclide samples were taken from mesa tops, colluvial slopes, an alluvial fan and the alluvial valley floor.

In Arroyo Chavez, between 6/96 and 1098, three monsoonal cycles were monitored. Sediment and runoff were collected over 52 rainfall events. Erosion measured in the traps ranged from 0.05 to 1.46 mm/year. Erosion rates measured with the straw dams ranged from 0.03 to 0.75 mm/year. The highest erosion rates were measured on the alluvial valley floor and the lowest erosion rates were measured on colluvial slopes. Using cosmogenic radionuclides, the basin-wide rate of mass loss was 2.7 +- 0.7 x 10^5 g/cm^2-y. Using a density of 2.4 g/cm^3, the denudation rate is 100 +/- 25 m/ Myr (0.1 mm/y). Results of this study indicate that both modern process geomorphic techniques and geologic time scale cosmogenic radionuclides produce comparable rates.

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