Geomorphic and Incision History of the Northern Rio Grande River Gorge near Questa, New Mexico

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ABSTRACT

We investigate relationships between river incision, aggradation, and widening in a ~5 km stretch of the northern Rio Grande River Gorge near the confluence with the Red River in New Mexico using detailed geomorphic mapping and cosmogenic ^{3}He surface exposure dating. This wide and deep stretch of the river exhibits a unique set of cohesive, stacked toreva blocks, incoherent landslides, rockfalls, and slumps developed within ~3-5 Ma Servilleta basalts and intercalated weak Red River gravels and Pliocene Santa Fe Group gravels. Toreva blocks of paired upper and lower Servilleta basalt are best developed along the eastern side of the river—they exhibit coherently-dipping, patinated tops that can be reconstructed to the gorge walls, but with toes that are truncated or buried by later deposits. Located below these landslide features is a flight of fill and fill-cut terraces spanning 6 levels at elevations of 60, 45, 29, 25, 15 and 7 m above the modern river grade, on average. Terraces at 29 m can be correlated across and along the river axis, whereas others are more locally preserved. All terraces exhibit well-defined boulder levees and risers constructed from alluvium sourced from upstream, and rounded and sculpted basalt clasts on their treads.

A set of minimum ^{3}He surface exposure ages clustering at ~62 ka was obtained from the uppermost terrace tread (Qt6); additionally, a ^{10}Be exposure age of ~28ka and ^{3}He exposure ages clustering ~20ka were obtained from the Qt4 terrace tread, with more dating in progress. If initiation of gorge incision was coeval with capture of the San Luis Valley of southern Colorado at ~386 ka, average incision rates prior to the formation of Qt6 were 0.55 mm/yr. This incision was likely coincident with toreva block formation and substantial gorge widening, as the toreva blocks and large-scale uncohesive landslide deposits predate terrace development. Average incision from ~62 ka to present day appears to have been faster, with maximum rates of 0.65 to 1.6 mm/yr from Qt6 to Qt4, and Qt4 to present, respectively. Gorge narrowing is observed during this time period, with only minor widening accommodated by slumping and incoherent landsliding that post-date terrace treads. This period of incision was punctuated by aggradational events that may correlate with late Pleistocene MIS climate cycles and/or regional climatic events, with terraces incised into and abandoned during transitions from glacial to interglacial climate. Rates of surface uplift from dynamic topography and/or active slip rates along basin bounding normal faults are over an order of magnitude too small to explain the observed incision rate increase over time. These increasingly rapid incision rates mirror the phenomena seen in other western US river systems since the Pliocene.

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