



Rate and style of canyon incision and knickzone retreat in South India

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Major drainage basins in south India (Penner, Palar, Ponnaiyar) have broad bands of 100 m-high knickzones cutting into the slowly-eroding continental interior (10–20 m/m.y.). River incision produces a stepped landscape consisting of plateaus with upland inselbergs above a canyon zone and broad alluvial plains with inselbergs below it. In the Penner River basin, canyon zones in the granite are complex but exhibit a consistent downstream sequence of morphologic elements where incision rates have been determined by in-channel and strath-terrace cosmogenic ^{10}Be sampling. Characteristic features include 1) a convex-up bevel above the knickzone where incision rate increases beyond the rate of saprolite production until alluvium is removed from the channel perimeter; 2) 10–20 m vertical falls or cascades where plucking eclipses abrasion processes and where incision climbs to orogenic rates that are 50–100 times greater than on the plateau; 3) a clast-rich zone where the supply of knickpoint and sidewall debris modulates the degree and depth of incision; and 4) an extended canyon reach comprising smaller knickzones and detachment-limited reaches separated by transport-limited reaches. The similar shape of the upper knickzone in two rivers suggests that the falls are governed by feedback between bedrock characteristics (such as joint spacing) and debris removal facilitated by stream power below the knickpoint. Upstream migration of the knickzones is calibrated by the incision rates, knickzone geometry, and the stream power erosion law, mediated by bedrock resistance to the same degree that erodibility regulates slope in the river network. Outliers in the predicted location of other basin knickzones suggest changes in the history of drainage

integration or other nonuniform driving conditions including climate.