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Fluvial geomorphology of the Dades River, Morocco: Implications for fault activity along the Southern Atlas Fault

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Within Africa, the Moroccan High Atlas Mountains are the highest (2-4 km elevation) topographic relief formed by Alpine tectonics. The range is part of an extensive ENE-WSW orientated, 2400 km long mountain belt system that has developed by diffuse Africa-Europe plate collision and sits on an anomalously thin crust. However, mechanical crustal shortening via thrust faulting and folding cannot account for the excessively high topography. Thus, a component of mantle-related thermal support and uplift has been inferred to have occurred during the Late Cenozoic relief generation. This research explores the role of active tectonics on the geomorphological development of the Dades River in the south-central High Atlas region, an area that coincides with some of the highest topography of >3.5 km.

Geomorphological data including channel width and depth, channel gradient and rock mass strength measurements were made from the Dades River in foredeep, wedge-top basin and fold-thrust belt locations of the High Atlas orogenic system. These field observations are compared to the river long profile that was extracted from an SRTM-derived DEM (resolution $\sim$ 90 m). The long profile exhibits non-equilibrium features, with a prominent over-steepened reach upstream of the intersection of the river and the Southern Atlas fault (a major thrust fault marking the boundary between the foredeep and wedge top basin areas of the orogen). This over-steepened reach corresponds to changes in the geometry of the river, principally valley narrowing resulting in the formation of the Dades Gorges, and a loss of hydraulic scaling, i.e. the concept that width and depth of the channel will change in a predictable way downstream depending on the drainage area. There were no major changes in the bedrock strength indicating that lithological differences are not the cause of these changes in channel geometry. However, these observations are characteristic features of rivers that have been shown to be undergoing a transient fluvial response to acceleration in the slip rate on the crossing fault. This indicates that the slip-rate of the Southern Atlas fault has probably increased within the last 1-2 Myr; slip rates for the last 5 Ma have been estimated at $\sim$ 0.1 mmyr-1, which might underestimate the current rate of motion. Furthermore, previous work using fluvial geomorphology for tectonic purposes has mainly concentrated on responses of rivers crossing normal faults. Our data suggests that similar fluvial / tectonic geomorphological responses may also occur in response to thrust faulting.