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Contrasting bedrock channel morphology of three rivers on the South African Highveld

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Investigating the role of rivers in landscape development is a key theme in geomorphologic research. In non-tectonic settings, river incision is essential to creating relief. Variation in incision rates along river long profiles can arise from variation in lithologic resistance. In river catchments with heterogeneous lithologic resistance, higher resistance reaches form local base level, governing the delivery of base level change to the catchment upstream, largely controlling the rate of landscape evolution.

Rivers in the Highveld region of South Africa are influenced by variation in lithologic resistance due to extensive outcropping of dolerite sills and dykes that intruded the sedimentary sandstones and shales of the Karoo Supergroup. The dolerites create variation in lithologic resistance in most river long profiles in the region. A conceptual model of Highveld landscape development suggests that dolerite reaches form local base levels for upstream reaches that meander widely (1-2 km) over less resistant sedimentary lithologies, creating extensive floodplain wetlands. Over long timescales (105-106 yr), the rivers incise through the dolerite bedrock reaches into the underlying sandstones and shales initiating rapid river incision through the sedimentary units. The lowering of local base level propagates incision upstream to the floodplain wetland reaches resulting in channel-floodplain decoupling and eventual desiccation of the wetlands. The geomorphology of the dolerite bedrock reaches varies across the region due to differences in incision processes.

To examine the variation in geomorphic response to different incision processes in the dolerite bedrock reaches, we have studied three contrasting rivers on the South African Highveld. Field observations suggest that although the lithology is largely in concert, the incision processes and geomorphic responses are in contrast.

The Klip River has incised a $\sim$15 m deep valley. The inset channel is bedrock floored and characterized by riffles separated by runs or by long pools. The riffles are composed of locally plucked boulders and cobbles. Knickpoints are not evident and the incision process is that of continuous, gradual down-wearing or slope replacement. The channel planform is relatively straight with wide, structurally controlled valley bends. The floodplain wetland in the sandstone reach upstream remains intact. The Schoonspruit, incised $\sim$20 m into dolerite, has similar geomorphology and incision processes to the Klip but the channel upstream is slightly incised into shale and the adjacent floodplain wetlands are highly degraded. The Mooi River has incised $\sim$30 m through a dolerite sill and into the underlying sandstone. Near the upstream end of the dolerite reach, a plucked and potholed drawdown zone leads to a $\sim$15m high knickpoint just upstream of the dolerite-sandstone contact. The incision process on the Mooi River is parallel retreat. The valley is structurally controlled, but is wider than the Schoonspruit and Klip River. The incised reach is characterized by riffles, runs, and pools, and a series of small knickpoints (<1 m). Ingrown meanders and alluvial terraces suggest that there has been a complex response to knickpoint migration. The floodplain remains active in the sandstone reach upstream of the dolerite drawdown zone. It is likely that parallel knickpoint retreat will eventually erode the dolerite unit absolutely, lowering local base level, initiating rapid channel incision upstream, channel-floodplain decoupling, and wetland degradation.

Work is underway to determine bedrock river incision rates on the three study rivers using cosmogenic isotope analyses (3He, 36Cl). We are using Optically Stimulated Luminescence to establish ages of alluvial deposition in both the dolerite and floodplain wetlands. This work will establish chronological constraints for

conceptual models of Highveld landscape development and improve our understanding of the rates of fluvial incision and landscape development in the region as well as the variation of geomorphic responses to different incision processes.