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Interactions of factors controlling the evolution of an incised meandering river

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This study tests the hypothesis that bedrock rivers have an internal feedback system that controls their morphological evolution through the incision and meandering of channels, which is regulated by sediment transportability. We analyzed the incision rates and topographic characteristics along a reach of a bedrock river (Oshika Gorge, western Japan) where both the longitudinal profile and planform morphology show marked changes over short distances even under an identical climatic, tectonic, and lithological setting. The long-term history of incision was reconstructed using cosmogenic 10Be surface-exposure dating of strath terraces. Channel sinuosity and gradient were measured from a laser-based digital terrain model. Sediment coverage on the riverbed was quantified using airborne photogrammetry and boulder size in the channel was evaluated using ground-based surveys. The size of boulders correlates with channel gradient, as larger boulders are commonly deposited in steeper segment, reflecting sediment transport capacity; however, this relationship between grain size and channel gradient disappears in sections where bedrock exposes widely or a substantial volume of sediment covers the riverbed. The incision rate decreases in the sediment-covered zone with the highest channel sinuosity, which implies that enhanced lateral erosion forms the meandering geometry of the river. This finding indicates that sediment coverage plays a crucial role in the reallocation of stream energy available for incision and the lateral erosion of channels, thereby establishing an internal feedback that controls the morphological evolution of bedrock rivers.