Solitary Step in Bedrock Rivers

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A solitary step is often observed to be formed in the mixed alluvium and bedrock rivers, which will be described later as "bedrock river" for simplification. Once a step is formed on the river bed, due to bedrock erosion, it is wondered whether the step is maintained and propagates in the upstream direction, or change its profile continuously. Compared with the bed of alluvial rivers which is easily eroded by flow, the mechanisms of bedrock erosion are more complicated, mainly including abrasion by bedload, plucking and macroabrasion. Based on this complexity, in this paper, we employ the Macro-Roughness Saltation Abrasion Alluviation model to analyze the evolution of a convex solitary step, featuring a subcritical region upstream and supercritical region downstream, in abrasion-dominated bedrock rivers. From the results of the analysis, we obtain that the convex solitary step cannot migrate in the direction of upstream with maintaining its profile. In addition, the erosion rate tends to be constant in the downstream reach, while the erosion rate increases drastically in the upstream reach. From a numerical simulation, it is found that the slope of the upstream region becomes larger and the curvature of the step downstream reach is maintained in relatively long time.

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