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Numerical study of river bedrock incision by bedload sediment transport.

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Modelling approaches of bedload sediment transport have long been restricted to the detachment-limited and transport-limited regimes. However recent experimental and numerical studies have revealed the crucial influence of sediment load on the rate of bedrock incision [*Sklar and Dietrich (2001)*, *Lague(2010)*] by abrasion which results in the competition between the tool effect and the cover effect. We present a numerical study of the interactions between a bedload layer and an underlying bedrock. We use molecular dynamics to simulate the motion of solid particles entrained by a laminar viscous flow. These simulations are based on a combination of discrete and continuous approaches. Sediment particles are modelled by hard spheres interacting through simple contact forces, whereas the fluid flow is described by a "mean field" model. This allows us to compute individual particle trajectories inside the active layer and therefore to predict the transfer of energy between grains and the bedrock. The effect of three control parameters has been studied : sediment density, flow discharge and bedrock rugosity. We determine the phase space domain where the system reaches a saltation regime and calculate the resulting erosion rate of the bedrock. Our model exhibits a competition between tool and cover effects. The results of this mechanistic approach are compared with available experimental data and existing stochastic models.