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Erosion processes in granular flows: insights from laboratory experiments

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Experimental granular column collapse were conducted over an inclined channel covered by an erodible bed of granular material in order to reproduce at laboratory scale erosion processes of natural flows propagating over deposits formed by earlier events. The studied control parameters were the slope angle, the aspect ratio (i.e. height over length), the volume and the shape of the granular column released, and the thickness and compaction of the erodible bed. The results show that erosion processes affect the flow runout distance over a critical slope angle θ_c that depends on the column volume, aspect ratio, and shape. For slope higher than θ_c, the granular avalanche excavates the erodible layer immediately at the flow front, behind which waves traveling downstream are observed and help entraining grains from the erodible bed. Erosion efficiency (i.e. maximal depth and duration of excavation, waves dimensions) is shown to increase as the slope angle and the column's volume increase. It is also dependent on the aspect ratio and on the nature of the erodible bed: the maximal excavation depth and the duration of the excavation decrease as the degree of compaction of the erodible granular bed increases. Erosion processes notably increase granular flows runout distance at inclinations close to the repose angle of the grains, in particular for columns of small aspect ratio. We demonstrate, however, that the flow runout distance observed on an erodible bed cannot be reproduced on a rough bed by simply adding the entrained volume of erodible bed to the initial column volume.