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A laboratory approach to the complexities in rock/debris avalanche emplacement introduced by interaction with runout path material

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Landslides are influenced in their emplacement by the geometry of the initial failure area, their material dynamic properties, local topography and the available sedimentary materials in their runout paths. Empirical studies show that apparent mobility increases relatively from avalanches that entrained high friction debris to those that entrained weak/saturated sediments or water; and from those interacting with topographic obstacles, to dissipating energy through sediment deformation, to sliding on a weak basal layer to those experiencing reduced basal friction (e.g. emplacement over glacial ice). Examples for „landslide tectonized" forms in the sediments include folds and faults, shearing, injection of substrate material into the landslide (or vice versa), and erosion surfaces indicating entrainment of material into the moving landslide body. In small-scale analogue experiments, these forms were successfully reproduced. The processes involved in their formation as well as temporary avalanche-substrate interactions that were only visible during avalanche motion but were not preserved in the final deposit were documented with a high-speed video camera. For these in-situ observation of the processes acting at the basal contact of a granular avalanche the experimental flume was equipped with plexiglass side walls. In addition to the process study, the following parameters were investigated qualitatively with respect to their feedback on avalanche behaviour: substrate mechanical properties and grain size, substrate thickness and relative basal strength, and inerodible, non-deformable substrate conditions. Substrate materials with the least frictional resistance showed the greatest response to avalanche overriding, becoming entirely mobilized beneath and ahead of the moving avalanche and producing the longest runout observed with a deposit morphology that mimics the deformed substrate surface. A weak substrate base lead to failure along this plane; avalanche and substrate became coupled, and the avalanche tail retained mobility. With a strong base, temporary grain bridges formed in the substrate, the avalanche decelerated, and its tail section deposited earlier than for substrates with a weak base. Interesting complexities arose when varying substrate thickness, requiring further experiments for their full quantification. Inerodible, non-deformable substrate conditions showed changes in avalanche behaviour from basal sliding on low-friction surfaces to increasing granular agitation over rough surfaces.