Effects of rainfall intensity and permeability on the development of experimental landform

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Uplift rate, rainfall intensity and characteristics of sand mound are the main factors controlling the development of experimental erosion landform with complicated interactions. This time, based on the results of runs listed below, the effects of interaction between rainfall intensity and permeability of sand mound are reported.

run - permeability --------- rainfall ----------- uplift rate -------------duration of uplift/rainfall
26 - 2.57 x 10^{-4}cm/s ---- 40-50 mm/h ------ 0.36 mm/h ------------ 1000h/1000h
27 - 3.23 x 10^{-4}cm/s ---- 80-90 mm/h ------ 0.36 mm/h ------------- 960h/1000h
32 - 1.84 x 10^{-4}cm/s ---- 80-90 mm/h ------ 0.36 mm/h ------------ 1000h/1000h
38 - 1.53 x 10^{-3}cm/s ---- 80-90 mm/h ------ 0.36 mm/h ------------- 960h/1540h
39 - 1.37 x 10^{-3}cm/s ---- 40-50 mm/h ------ 0.36 mm/h ------------- 960h/1540h

When a flat-topped square (60x60cm) sand mound emerges from the ground level under the mist type artificial rainfall, incipient valley erosion starts from the edge of uplifted area. As the mound rises with uplift, valley incision advances and ridges and slopes develop. Slope failures start to occur and stabilized stream channels become the path of transport for the material produced by slope failures. The occurrence of large slope failures or landslides tends to concentrate on a certain cycle, and the average surface height starts to change around a certain height depending on uplift rate as far as the uplift continues. The average height decreases in the periods of landslide concentration and increases between these periods.

The deposition area surrounding the area of uplift is 100mm wide in runs 26 and 27, and 200mm in runs 32, 38 and 39. This difference, however, did not have significant effects on the development of experimental landform. Similar landform developed in runs 27 and 32, which have the same experimental setting except for the width of deposition area. Permeability of sand mound made of a mixture of fine sand and kaolinite 10:1 by weight was set by the degree of compaction. Tight compaction is expected to yield low permeability and high shear strength. Shear strength, however, appeared to be less sensitive to the degree of compaction within the range of this series of experiments. The permeability of sand mound was in the order of 10^{-4} cm/sec for runs 26, 27, 32, and 10^{-3} cm/sec for runs 38, 39. In run 26, with low rainfall and low permeability, a massive mountain of higher average height developed, while lower ridges separated by valleys appeared in run 27 of high rainfall. The different rainfall intensity, which determines the quantity of surface runoff, was apparently responsible for the difference. In run 38, with high rainfall and high permeability, a somewhat massive and higher mountain like the one in run 26 developed, while landform similar to run 27 appeared in run 39 with low rainfall and high permeability. The same reasoning employed to explain the difference between runs 26 and 27 cannot be applied to runs 38 and 39. Higher permeability can reduce the surface runoff and make the development of landform in run 38 similar to run26. However, higher permeability can never work to increase surface runoff. In run 39 of low rainfall, surface runoff is considered to be significantly smaller than in run 27 or 32, as indicated by the lower valley density in earlier stages of run 39. Valleys in run 39 were wider and shallower, suggesting that slope processes, such as shallow slope failures and creep, worked intensely on valley side slopes. Slope processes can remove a large amount of material quickly, and the erosion would be accelerated if stream flow enough to transport the material exists. This can explain the active erosion in run 39 despite its lower rainfall and higher permeability. In run 38 with higher rainfall, larger quantity of surface runoff promoted the development of valley systems, and this works to drain water effectively and may not have left enough water for surface processes on the highly permeable surface.

Keywords: experiment, uplift, erosion, permeability, surface runoff, slope failure

