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Effects of uplift rate change on the development of experimental erosion landforms

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Development of experimental landforms, which can show the time sequence of landform development in a scale of experiment, may provide some ideas for better understanding of the long-term landform development. This time, the latest runs of experiment, in which miniature erosion landforms were developed with rainfall-erosion and the uplift of changing rate, are reported.
A mixture of fine sand and kaolinite compacted in a square-prism-shaped stainless container (c.a., 60 x 60 x 30 cm) was pushed out above the ground level by a stepping motor and worm gears set beneath the bottom plate. Artificial rainfall of about 40mm/hour was applied on this square sand mound rising from a flat surface. The surface topography in the area of 110x110cm, including surrounding areas, was periodically measured by a laser point gage. One run (run21), which lasted 1350 hours with the uplift rate of 0.22 mm/h, and two runs with uplift of changing rate (5.0mm/h from 0h to 30h and 0.22 mm/h for 30-710h in run22; the uplift rate was gradually accelerated and then decelerated for 0-238h and kept constant at 0.22 mm/h for 238-710h in run24) are reported. Runs22 and 24 continued to 1222h after the uplift ended at 710h.
In run21 with the constant uplift of 0.22 mm/h, a wide flat erosion surface and small hills with relatively steep side slopes developed. The height of hills increased with uplift towards 1000h, but they gradually became thinner and a very low flat surface with small sporadic residual hills appeared at 1350h. The initial rapid uplift (5.0 mm/h) in run22 caused the development of cliffs around the mound and a massive mountain like topography appeared at the end of the rapid uplift (30h). After the uplift rate reduced to 0.22 mm/h, the surface lowered quickly with slope failures and fluvial erosion formed a wide erosion surface with some small hills by 710h. The surface became very flat and low at 1222h after the uplift ended. In run24, a mountain-like topography developed with the increase in uplift rate, but a massive mountain as in run 22 did not develop even after the rapid uplift of 3.2 mm/h. Some ridges and peaks appeared instead. After the uplift took the constant rate of 0.22 mm/h, the surface became similar to that in run22.
Average height increased with uplift, but it started to decrease or became stable when the relief (and erosion rate) increased. In run21, average height became stable after a long period of slow increase. Average height also became relatively stable at the similar height during the period of slower uplift of 0.22 mm/h in runs22 and 24. After uplift ended in runs22 and 24, average height showed an exponential decrease. Similar sable average height with slow constant uplift of same rate indicates the possibility of an attainment of equilibrium state between average height and uplift in a long period. In rainfall-erosion experiments erosion occurs as two styles of fluvial erosion, 'erosion with knickpoints' and 'erosion of declining slopes,' and failure/creep on steep slopes. When steep slopes disappear, relief of the surface increases with 'erosion with knickpoints' promoted by uplift and decreases with 'erosion of declining slopes.' This process repeats to make average height stable at a certain height corresponding to the uplift rate. In this series of experiment, steep slopes appeared with the rise of small hills by uplift and disappeared by failure/creep, and this process repeated during the period of slow constant uplift (0.22 mm/h) contributing to make average height stable. In run24, average height increased as the uplift rate increased. It

started to decrease when the uplift rate lowered, but the way of decrease did not follow the uplift rate. Average height takes rather long time to adjust to the decrease in uplift rate while it can easily increase with uplift.

Keywords: rainfall-erosion experiment, uplift rate, landform evolution, erosion style, equilibrium