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Erosion patterns created by a thin free-surface flow of water over a soluble rock

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Erosion by dissolution is a decisive process shaping small-scale landscape morphology [1]. On the surface of soluble rocks like gypsum, salt (halite) or limestone, characteristic patterns known as Rillenkarren can be observed. These patterns occur when the dissolving surface is inclined and subjected to a thin run-off flow. The rock surface then erodes into nearly parallel channels (rills) directed along the main slope and regularly spaced. Although these patterns are commonly observed, the conditions of their occurrence remain incompletely understood to our knowledge [2]. Here, we study in a laboratory experiment the dissolution patterns appearing on inclined blocks of salt submitted to a thin free-surface flow.

Blocks of salt of rectangular shape (10×20 cm and 3 cm in thickness) are tilted at a controlled angle. A constant-head reservoir supplies water at the top of the slope. Water flows down by gravity in a thin film of water uniformly spread over the salt block. The top surface of this film is a free surface, and the flow naturally adapts its velocity and the depth of the film to the two control parameters of the experiment (the flow-rate and the slope).

Each experiment is performed with constant flow-rate and slope. First, we observe that the erosion rate depends on the flow-rate only. Second, we observe that characteristic erosion patterns spontaneously develop on the initially flat surface of the salt blocks. At the short times of the experiment, regularly spaced rills form parallelly to the slope, reminding of the Rillenkarren. These rills evolve with time and progressively destabilise into new patterns perpendicular to the slope. We discuss the morphology and the dynamics of these dissolution patterns with respect to the experiment control parameters.

[1] P. Meakin and B. Jamtveit, *Geological pattern formation by growth and dissolution in aqueous systems*, Proc. R. Soc. A 466 659-694 (2010)

[2] M. Perne and Franci Gabrovšek, *The problem of rillenkarren development: a modelling perspective*, in Karst Rock Features, Carsologica 9 (2009)