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Erosion patterns created by a water film flowing over an inclined soluble rock.

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Erosion by dissolution is a decisive process shaping small-scale landscape morphology [1]. Thin films of water flowing on inclined soluble rocks (salt, gypsum or limestone) are known to create nearly parallel channels directed along the main slope, the Rillenkarren [2]. These characteristic erosion patterns are commonly observed, yet their occurrence remain incompletely understood. Here we study in a laboratory experiment the erosion dynamics and patterns appearing on inclined blocks (20cm x 10cm) of salt or gypsum (plaster) submitted to a thin free-surface flow (typical depth 100-500 μm). First, the dissolution rate averaged over the whole surface of the rock increases with the square root of the flow-rate. We explain this scaling law with a simple model of solute transport. Second, approximately 1mm-wide parallel rills spontaneously develop on the initially flat surface of the rock, on a time scale of one minute on salt and of a few hours on gypsum. These rills directed along the slope could constitute the first step in the apparition of Rillenkarren. The typical wavelength and pattern amplitudes are extracted from 3D reconstruction of eroded blocks using a laser scanner. Interactions between the rock surface and the flow induce a heterogeneity of the velocity field, which in turn induces a heterogeneity of the solute concentration and of the local dissolution rate.

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[2] Karst Rock Features. Karren sculpturing. Edited by: Angel Ginés, Martin Knez, Tadej Slabe, Wolfgang Dreybrodt. Carsologica 9 (2009)