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Toy-model for the formation of rillenkarren by raindrop impacts

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Rillenkarren are dissolution features, adorning the inclined faces of bare soluble rocks, *e*.g. limestone or gypsum, appearing as an array of regularly-spaced parallel grooves along the incline (fig. 1a). A compelling viewpoint on their formation is that of the raindrop impact statistics conspiring to carve a coherent structure[1]. It is suggested that the transverse pattern would then be owed only to the anisotropy, caused by the incline, of the drops' dissolution "fingerprints" and to a simple steepest-descent-like coupling between raindrop paths and the topography.
In this contribution, we present a numerical experiment, in which a unique fingerprint is arbitrarily chosen to encode the dissolutive effect of a drop rolling down a soluble surface. One by one, random impact positions and raindrop sizes are drawn, following realistic raindrop statistics, such as the Marshall and Palmer distribution[2]. The fingerprint shape is rescaled to the drop's size and remapped along the path of steepest descent from the impact point and the topography is thus iteratively updated. These basic ingredients appear as sufficient for a transverse pattern to emerge (fig. 1b).
We discuss the influence of various parameters, such as the fingerprint shape or the drop size distribution, on some of the pattern's features of interest, namely its characteristic wavelength. We also explore the effect of the initial topography on the pattern's onset and compare the obtained geometries.

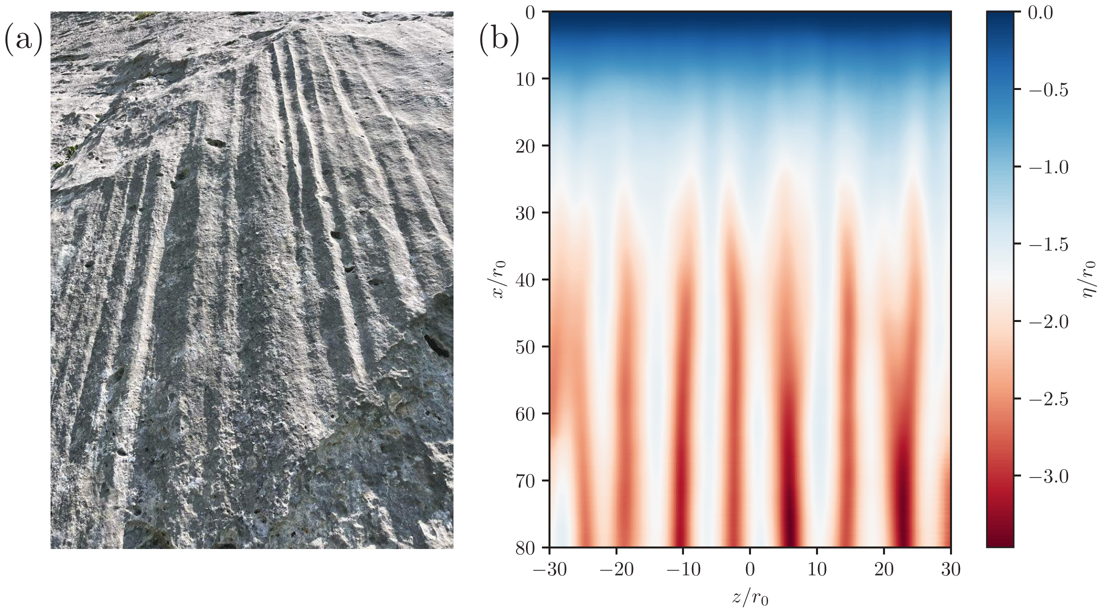

Figure 1: (a) Natural rillenkarren near *La Dent d'Oche* in the Chablais Alps. (b) Topography η after 2×10^5 impacts or around 100 h under a rainfall of 3.6 mm/h. Distances are rescaled by the mean raindrop radius $r_0 \approx 0.2$ mm for the same rainfall rate. Here, the solubility is that of gypsum, meaning that each drop can dissolve 10^{-3} of its volume from the solid, and transverse periodicity is imposed.

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[1]Glew and Ford, *Earth Surf. Process.* **5**, 25 (1980)
[2]Marshall and Palmer, *J. Meteorol.* **5**, 166 (1948)