Erosion patterns produced by the evaporation of a film of water dissolving its substrate.

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Internship location : **Laboratoire Matière et Systèmes Complexes (MSC)**

Level: L3, M1 or M2, internship mostly experimental. A basic knowledge in fluids mechanics is appreciated.

Context :
The evaporation of water initially charged of dissolved ions leads to non-trivial patterns of crystallisation. For example, when a droplet of water charged of dissolved salt evaporates on a hydrophilic substrate, salt first crystallises along the contact line of the droplet (i.e. along its edge). The crystallisation process then grows outside of the initial droplet area, in a dendritic pattern (figure 1a). The opposite case of a droplet of pure water evaporating on a salt substrate also leads to a characteristic pattern. The dissolution excavates the substrate at the center of the droplet while a thin and narrow seam forms along the contact line (figure 1b).

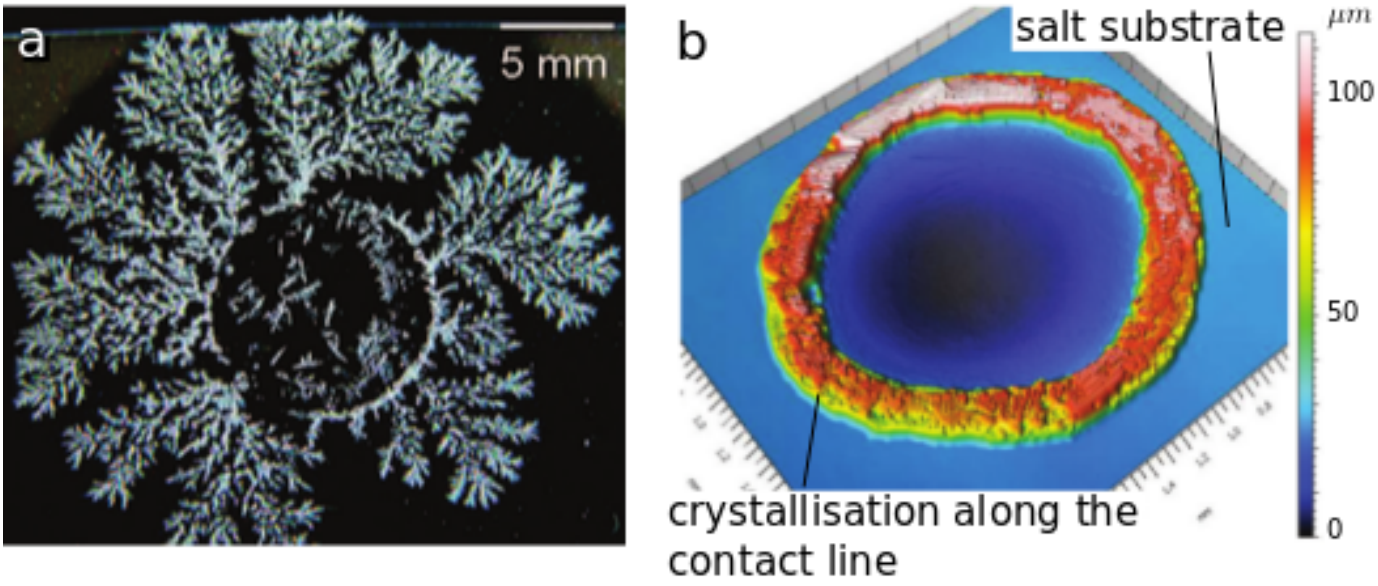

Figure 1 : *a) The evaporation of a droplet of water charged in salt leads to a specific pattern (Shahidzadeh et al. 2008). b) The evaporation of a droplet of pure water on a salt substrate leads to the excavation of the substrate at the center of the dropletand the formation of a seam along the contact line (Mailleur 2016).*

In the laboratory, a block of salt (Himalayan salt) was submitted to cycles of condensation/evaporation. During the condensation phase, a thin film of water formed on the initially plane surface of the salt block. This film of water partly dissolved the salt and, during the evaporation phase, the salt re-crystallised at the surface of the block. After several cycles, we observed the creation of a labyrinthic erosion pattern at the surface of the block (figure 2a). This pattern is reminiscent of the one observed on a calcite rock found in the Oman desert (figure 2b). The conditions at the origin of the erosion pattern on this rock are still to be understood.

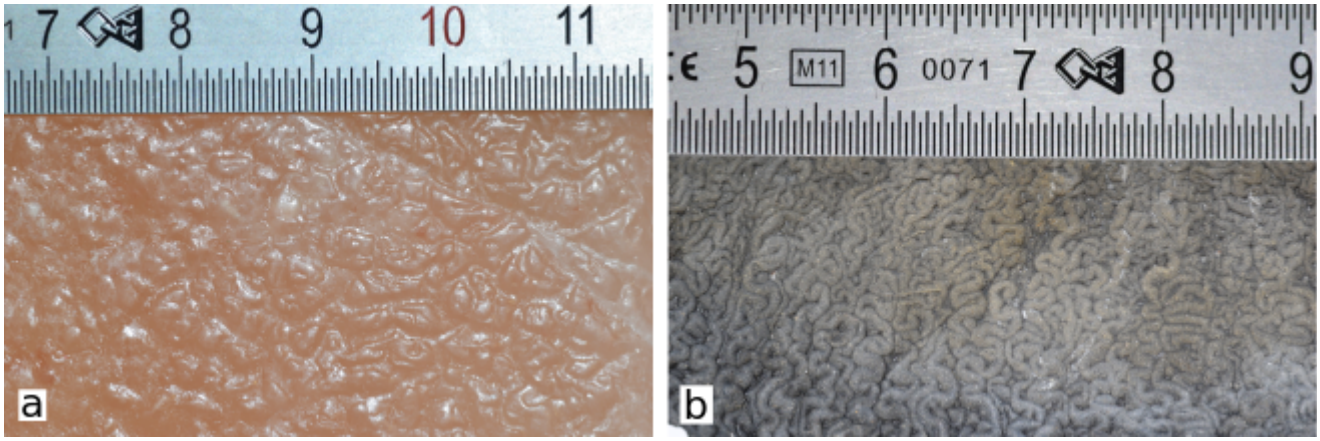

Figure 2 : *a) Erosion pattern produced on an initally plane surface of a salt crystal after several cycles of condensation/evaporation. b) A stone (calcite) discovered in the desert of Oman (courtesy of Stéphane Douady).*

Internship:

We propose to investigate experimentally the patterns created by a thin film of water evaporating on a salt substrate. We will determine the conditions allowing the formation of these labyrinthic patterns when the experimental parameters vary: depth of the water film, initial concentration of salt dissolved in the water, slope of the salt surface, relative humidity of the atmosphere… We will then characterise the shape of these patterns according to the parameters.

References:

Shahidzadeh-Bonn, N., Rafaï, S., Bonn, D., & Wegdam, G. (2008). *Salt crystallization during evaporation: impact of interfacial properties. Langmuir*, *24*(16), 8599-8605.

Mailleur, A. (2016). *Évaporation de goutte sur substrat soluble* (Doctoral dissertation, Université de Lyon 1).