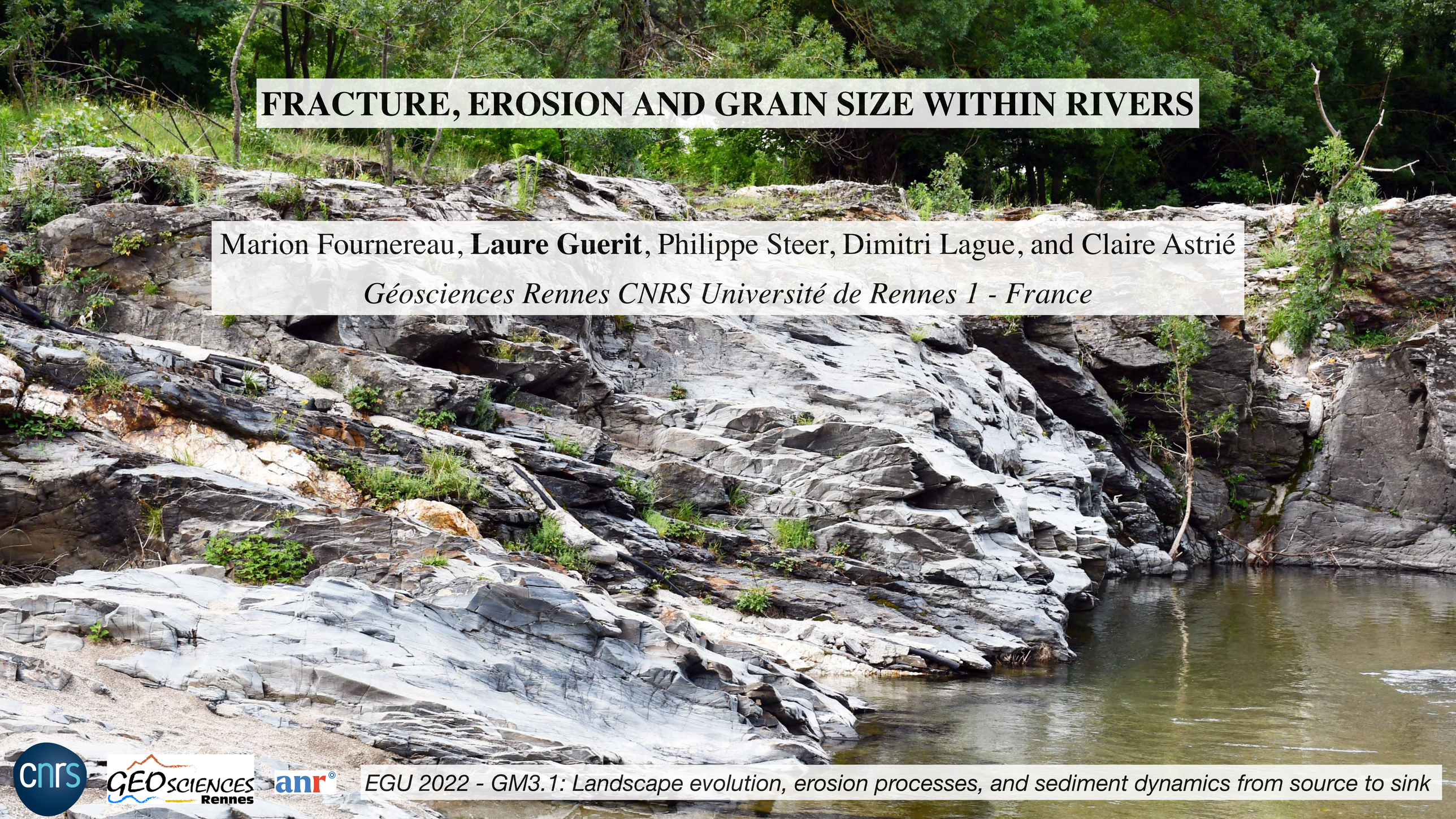
FRACTURE, EROSION AND GRAIN SIZE WITHIN RIVERS

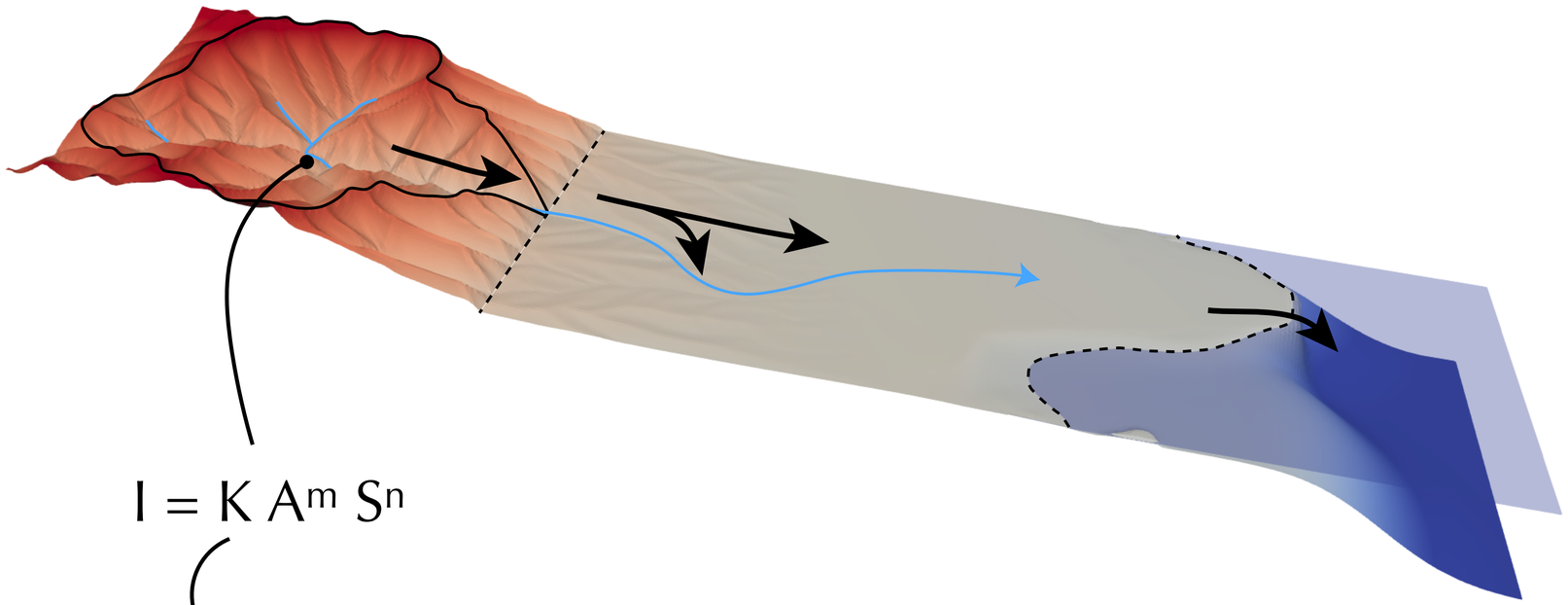
Marion Fournereau, **Laure Guerit**, Philippe Steer, Dimitri Lague, and Claire Astrié

Géosciences Rennes CNRS Université de Rennes 1 - France



EGU 2022 - GM3.1: Landscape evolution, erosion processes, and sediment dynamics from source to sink

MOTIVATIONS

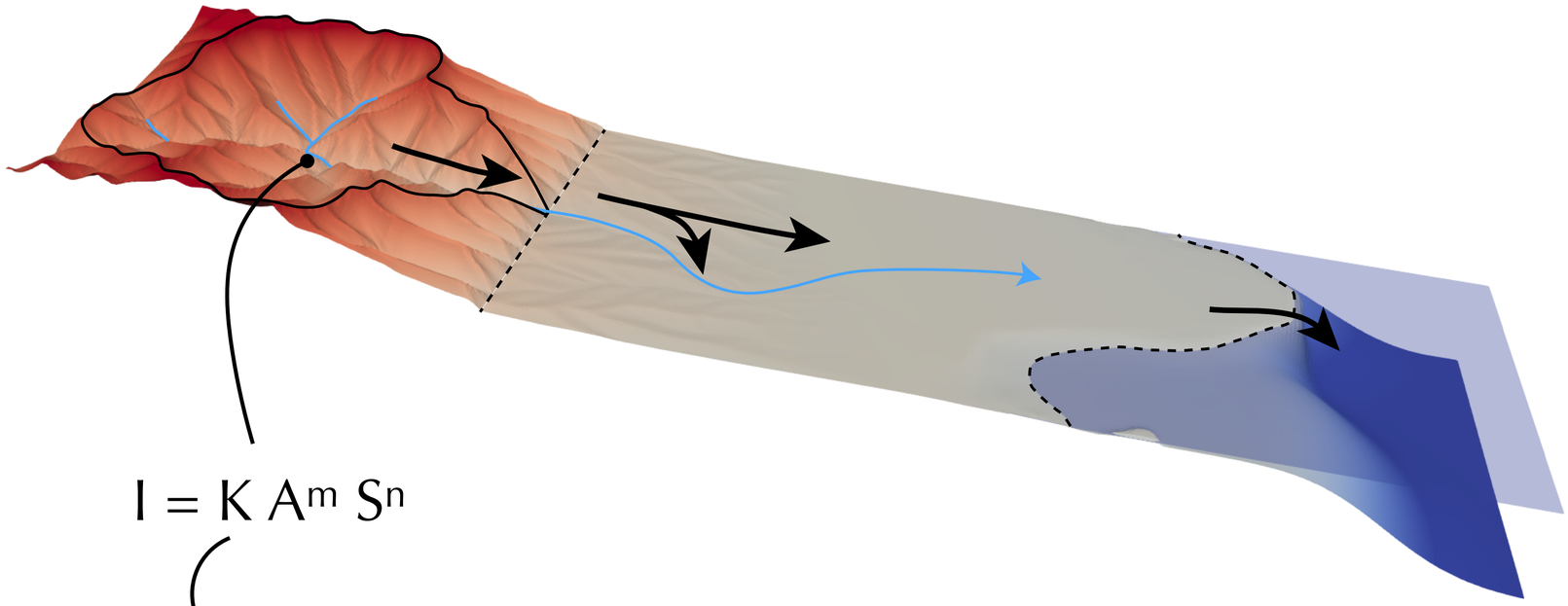


$I = K A^m S^n$

everything that modulates erosion

- climate&climate variability
- vegetation
- lithology

MOTIVATIONS



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everything that modulates erosion

- climate&climate variability
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- lithology
- mass and size of sediments in transport

Sklar and Dietrich, 2001

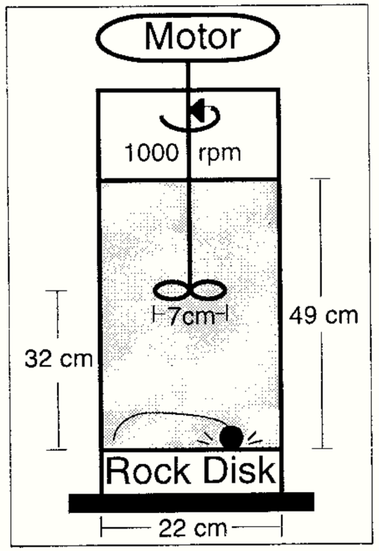
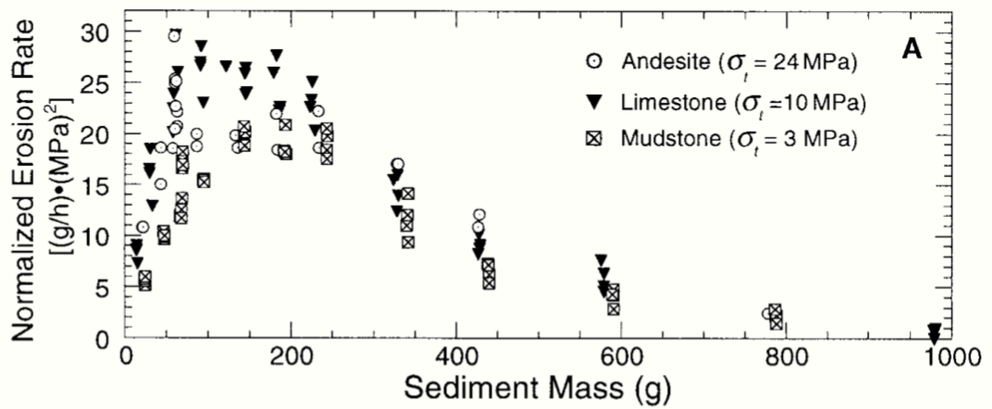
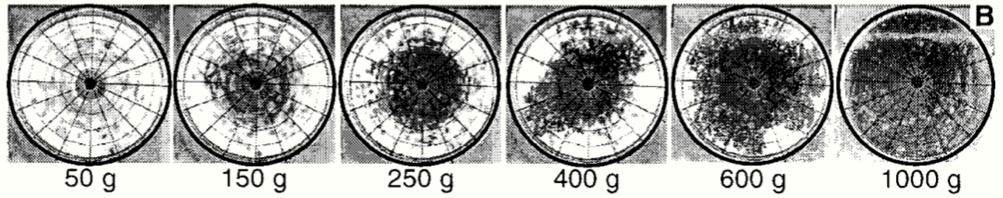


Figure 1. Schematic of bedrock abrasion mill.

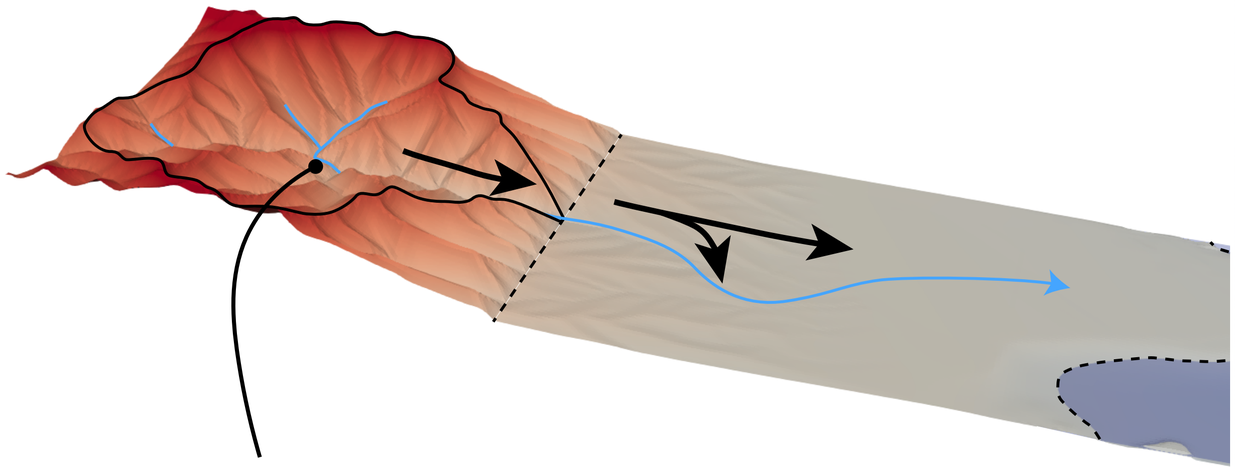




MOTIVATIONS

! hillslopes !

Neely et al, 2019



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everything that modulates erosion

- climate&climate variability
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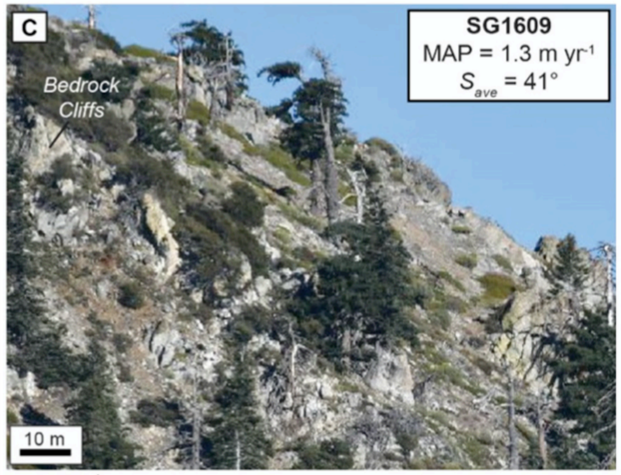
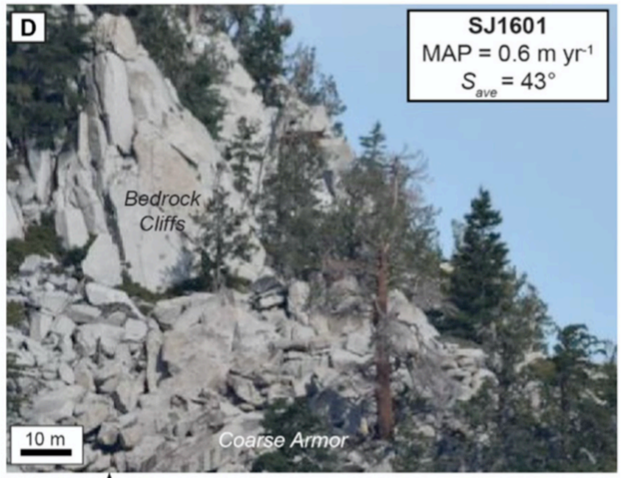
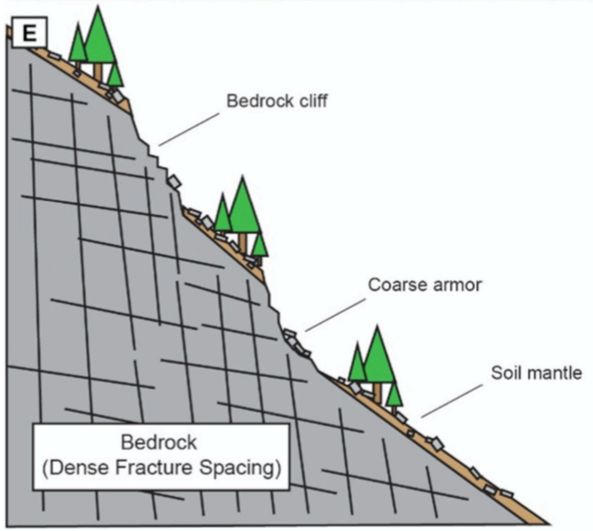
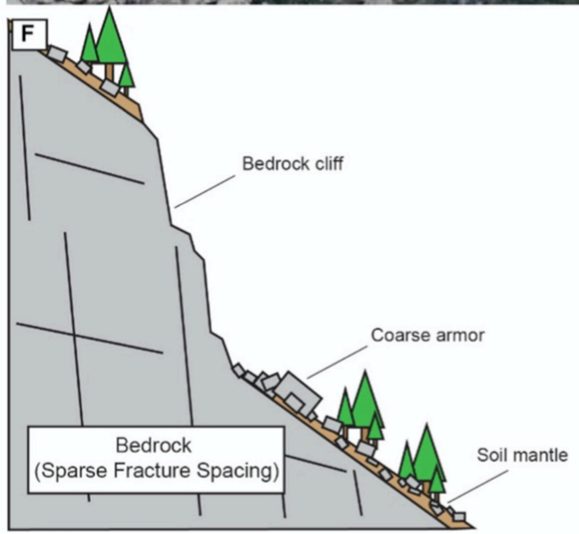
- lithology
- mass and size of sediments in transport
- fractures in the bedrock ?









San Gabriel Mountains

North San Janito Mountains

5 times more fractured, erodes faster, less steep

OBJECTIVES: WHAT ABOUT FRACTURES IN BEDROCK RIVERS ?

To simulate in the lab the erosion of a fractured bedrock due to sediment transport

To explore the impact of the geometry of the fracture network on the rates and modes of erosion (abrasion vs plucking)

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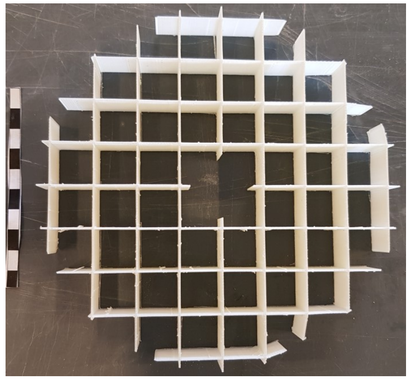
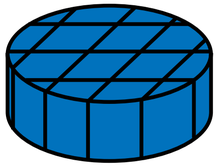
1. 3D print of fractures and concrete disk



printed in PVA (thermoplastic)

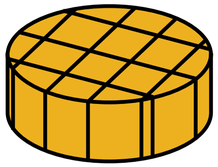
various azimut, spacing and dip

+ gravels (1-2 cm in diameter)



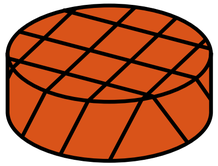
diamond shape blocks, vertical fractures

spacing of 20 mm, azimut of 45°, 67°, or 90°, dip of 90°



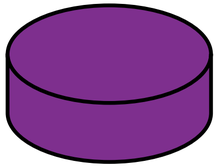
square/rectangle shape blocks, vertical fractures

spacing of 10, 20, 30 or 40 mm, azimut of 90°, dip of 90°



square shape blocks, oblique fractures

spacing of 20 mm, azimut of 90°, dip of 45°, 67° or 90°



no fracture (for reference)

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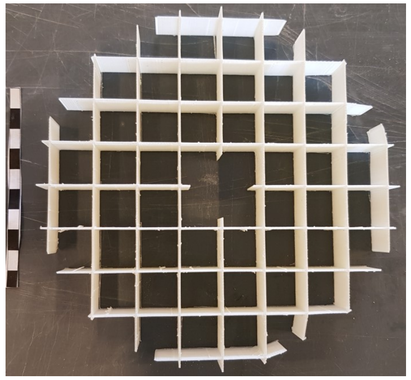
1. 3D print of fractures and concrete disk → 2. Erosion



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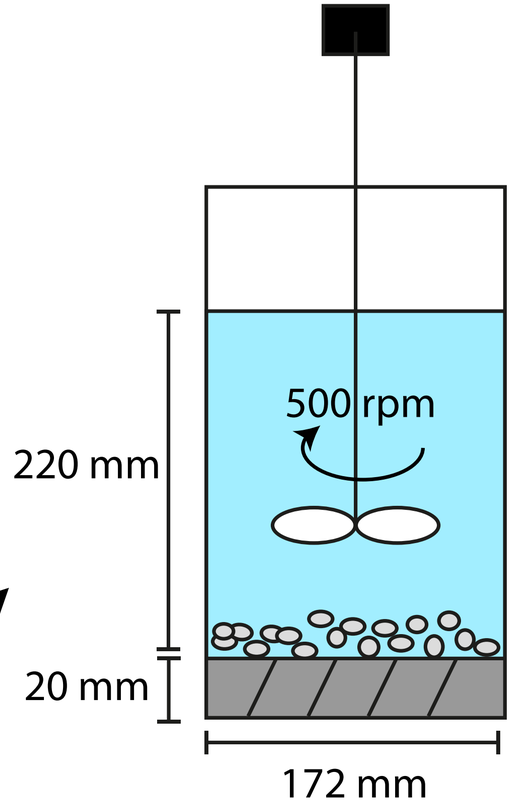

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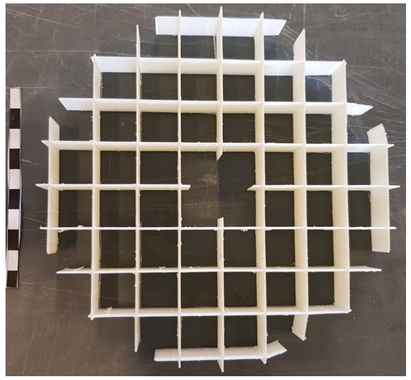
1. 3D print of fractures and concrete disk → 2. Erosion → 3. Topography acquisition (SFM)



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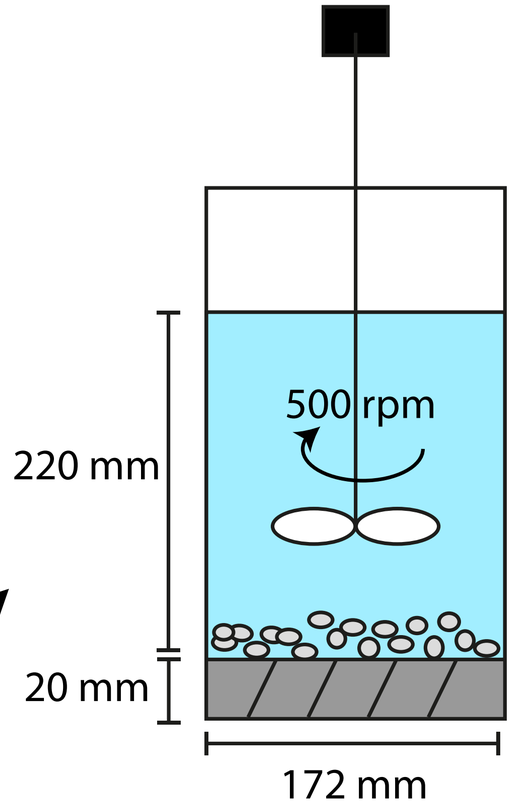
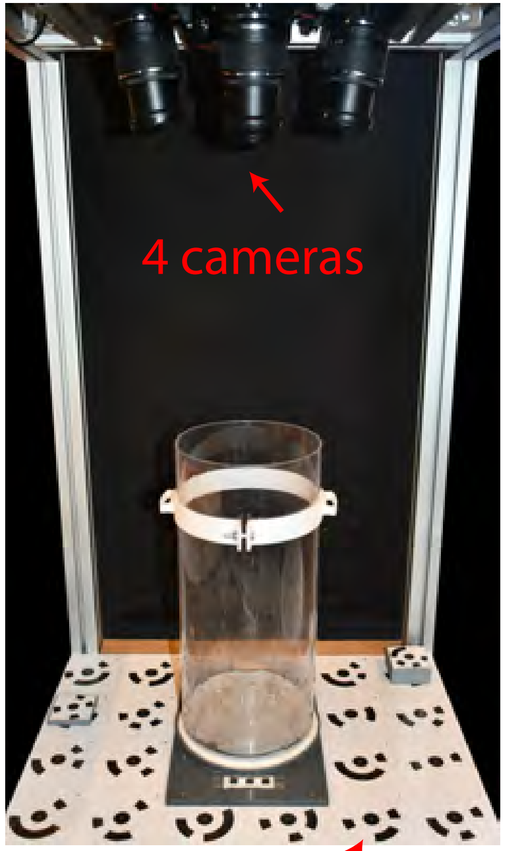
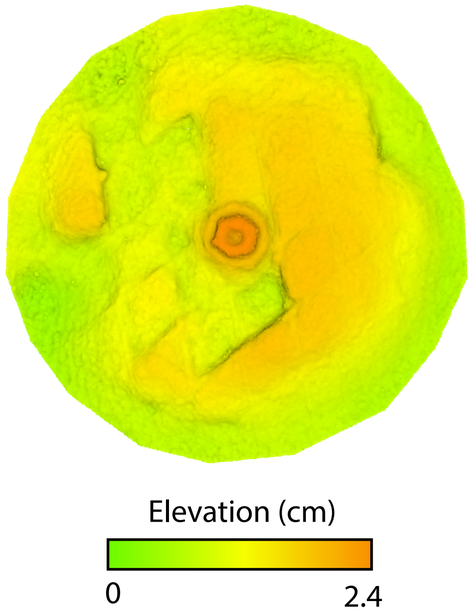




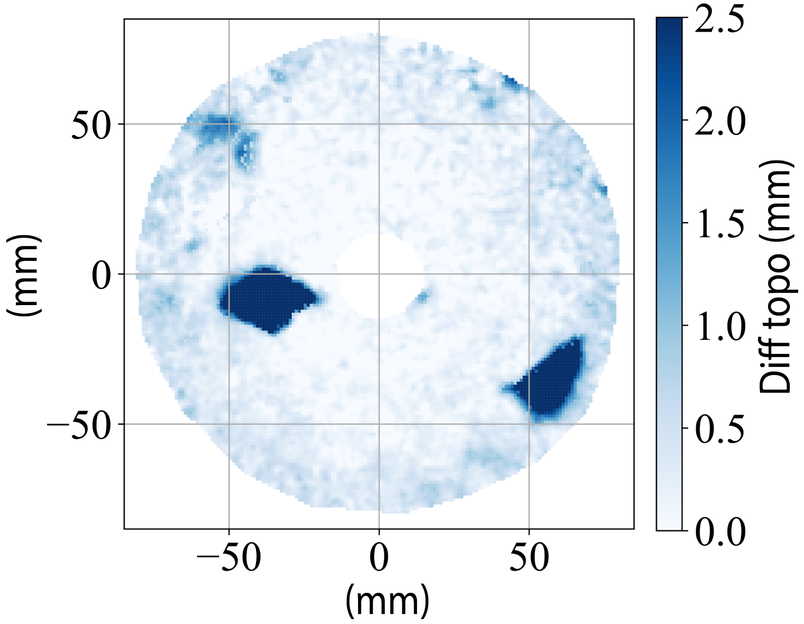
targets for SFM

DATA ANALYSIS

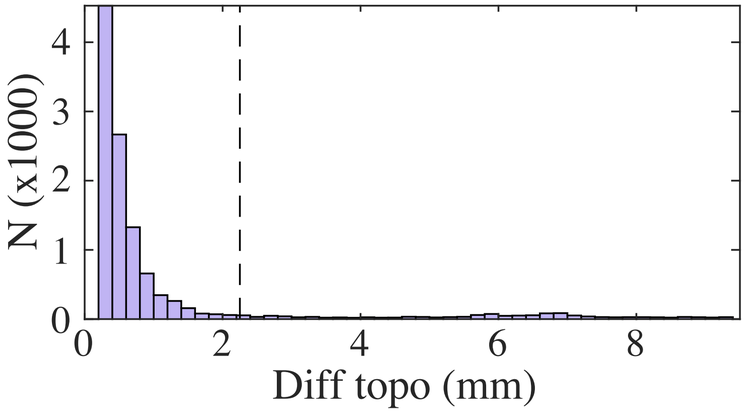
Topography from SFM



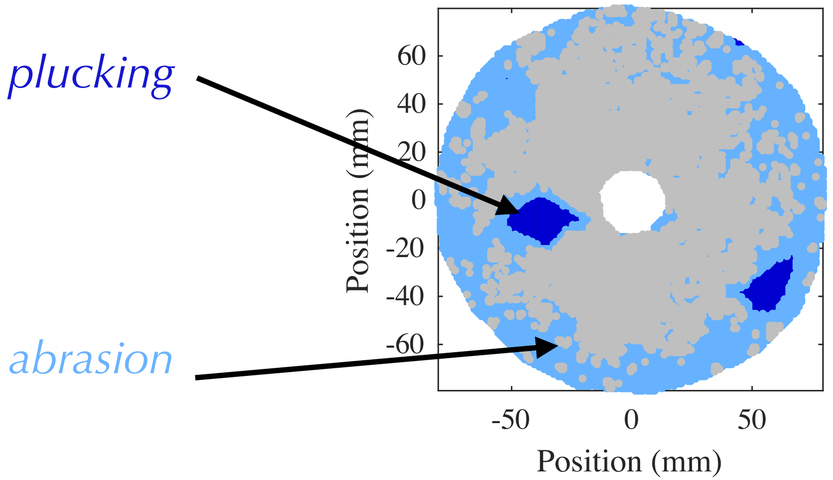
Difference of topography through time



Distribution of erosion



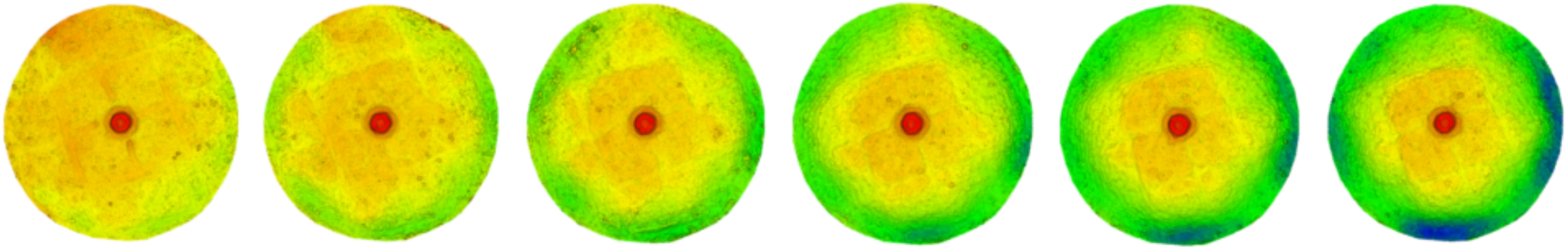
Identification of abrasion vs plucking

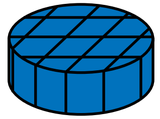


Erosion rates through time

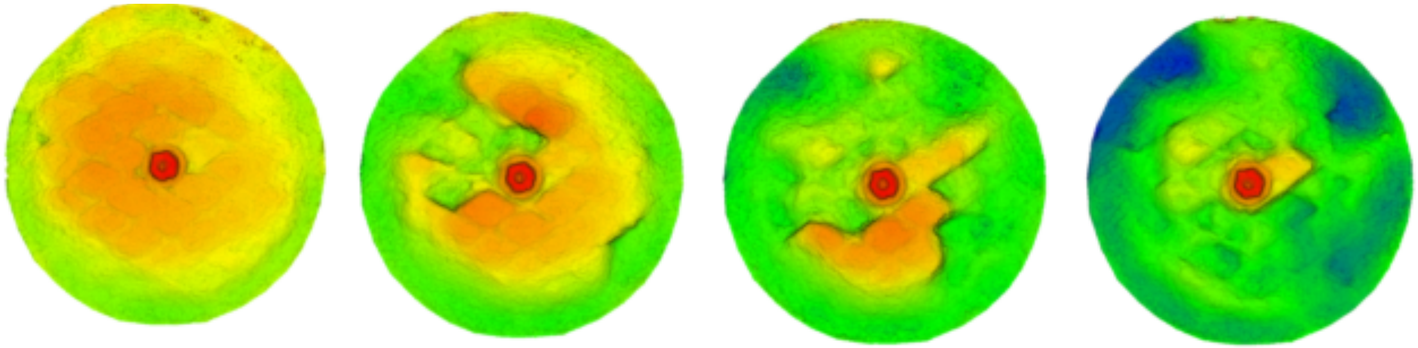
TYPICAL EXPERIMENT - TOPOGRAPHIC EVOLUTION

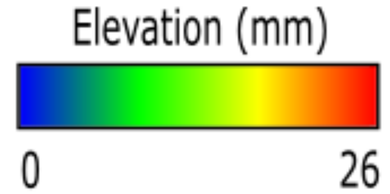
Abrasion dominated





Plucking dominated



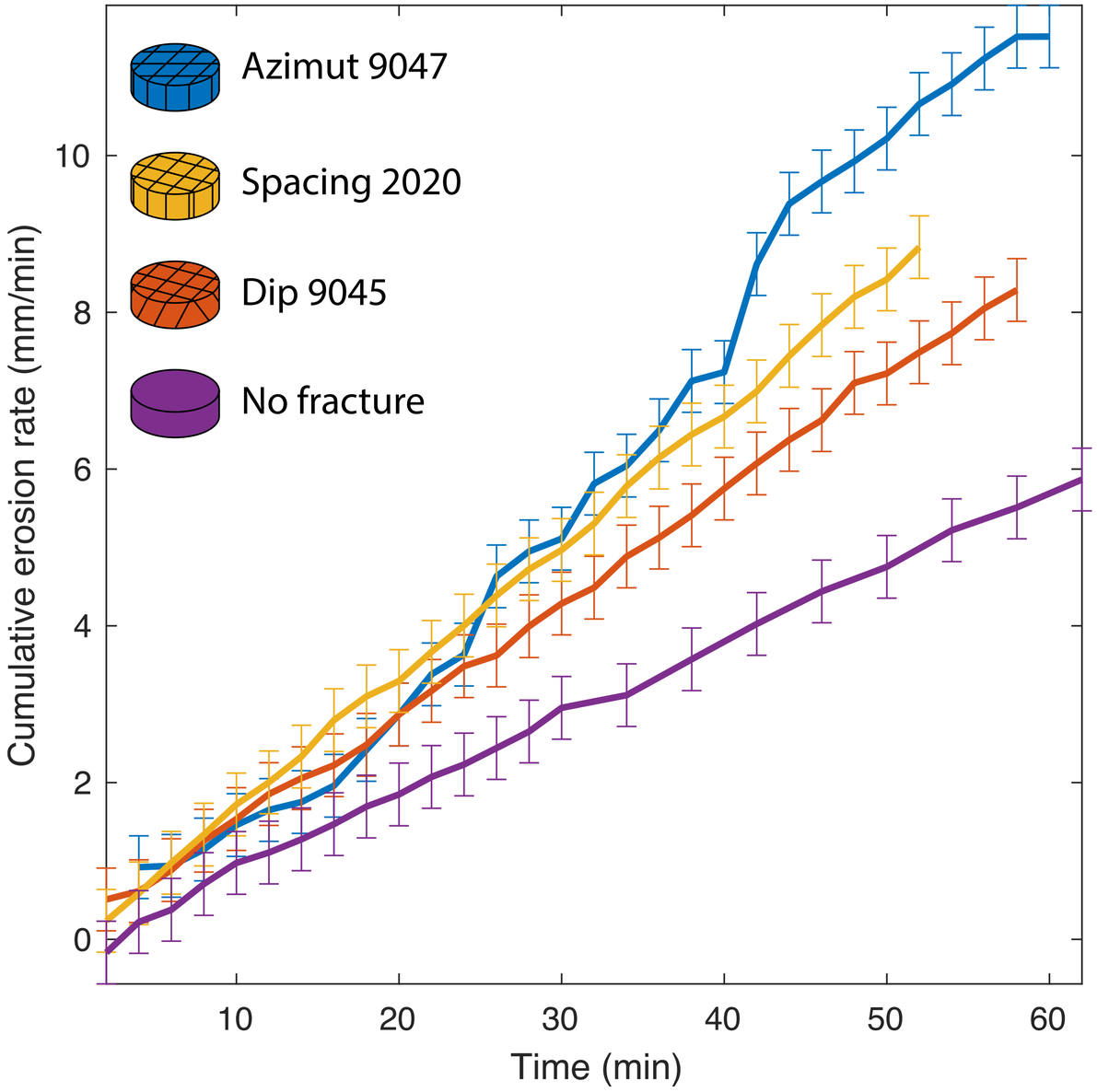


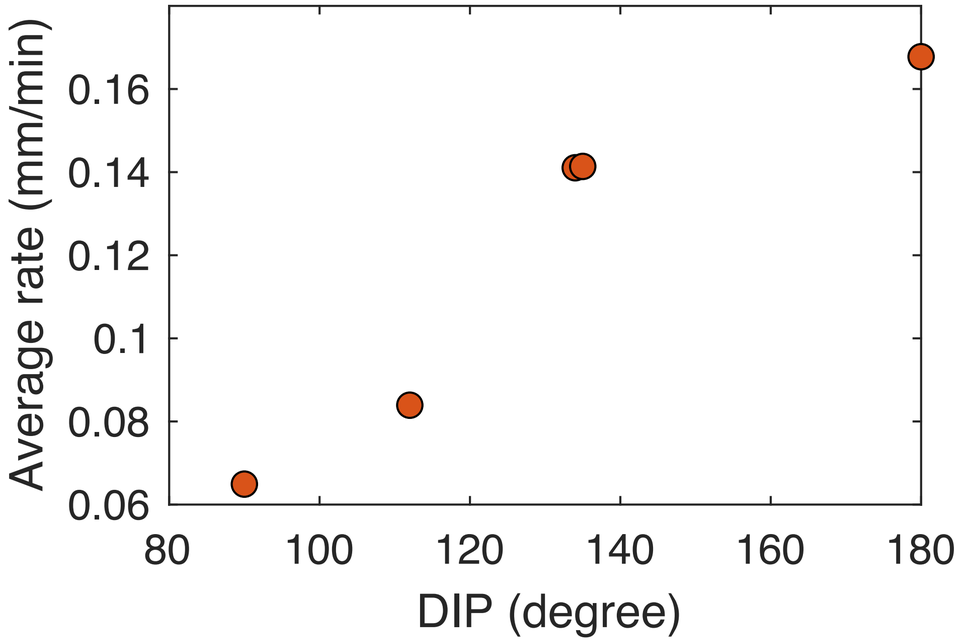
150 mm

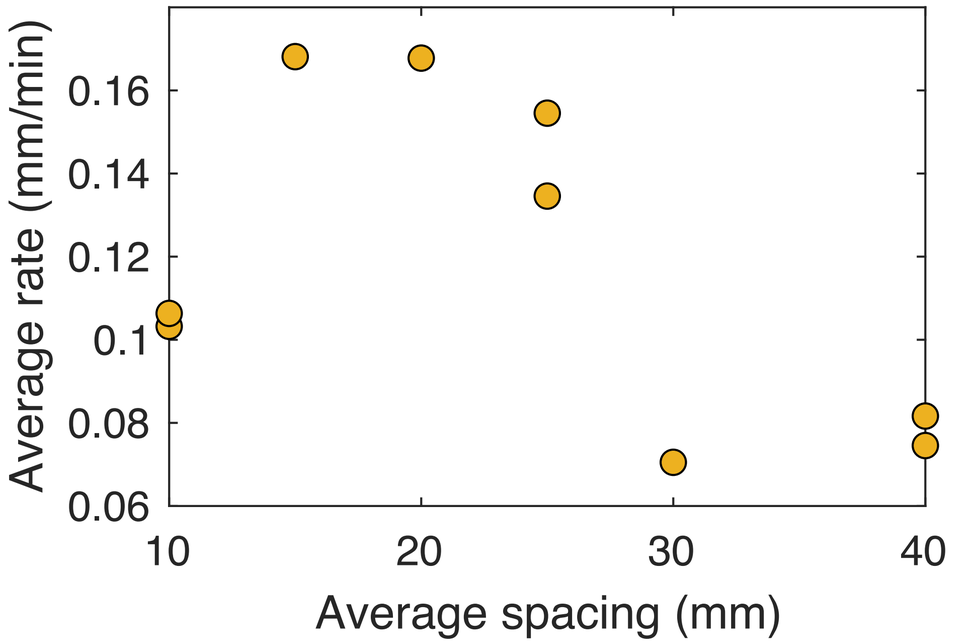
Temps (min)

8 24 40 56 72 88

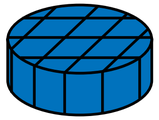
MAIN OUTCOMES: CONTROL OF THE GEOMETRY ON THE EROSION RATES



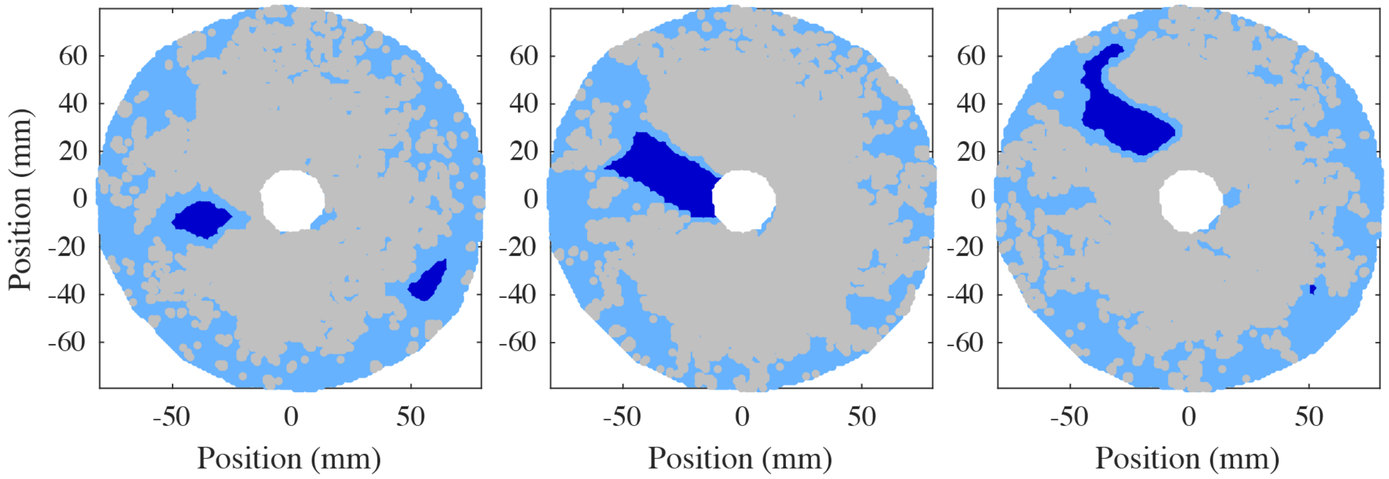




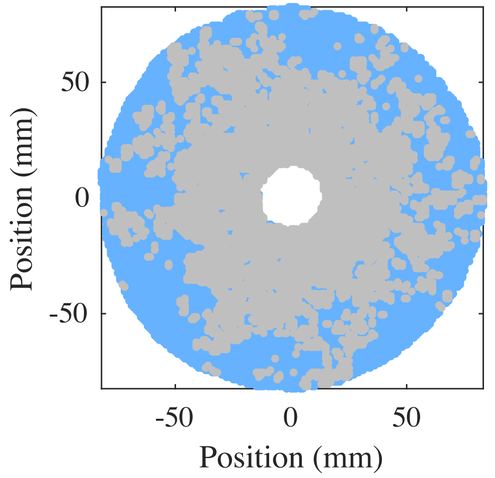
MAIN OUTCOMES: GEOMETRY, ABRASION AND PLUCKING



Plucking: anywhere on the disk



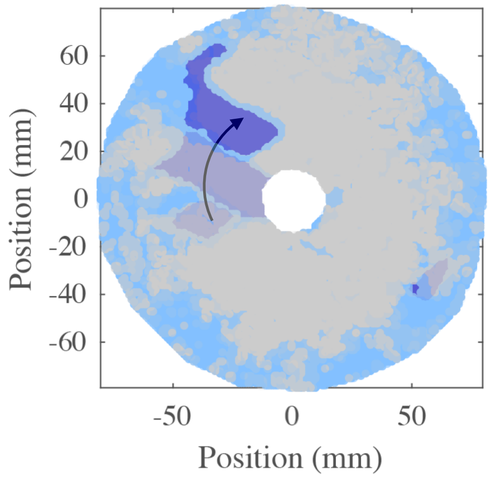
Abrasion: more on edges

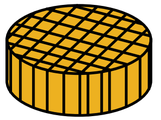


< 1.2 mm

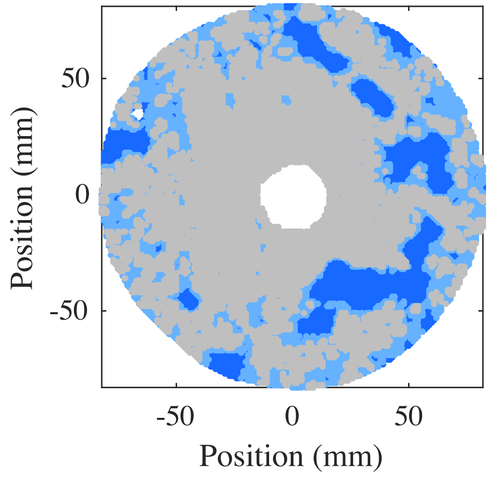
plucking > 2.5 mm

size and shape controlled by the fractures





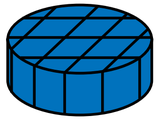
Mix: plucking of small blocks



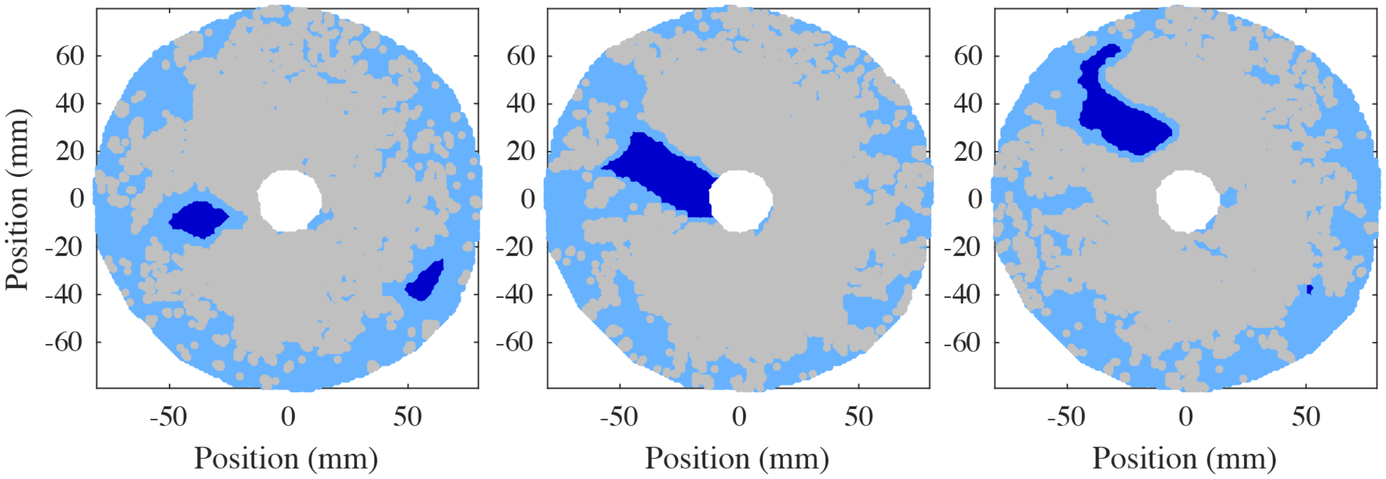
plucking: 1-2 mm

control of plucking events on the following ones

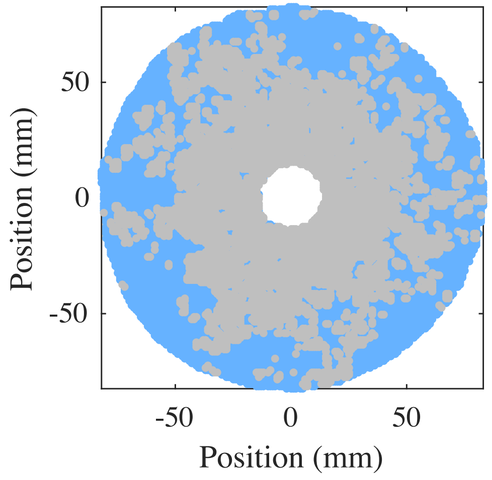
MAIN OUTCOMES: GEOMETRY, ABRASION AND PLUCKING



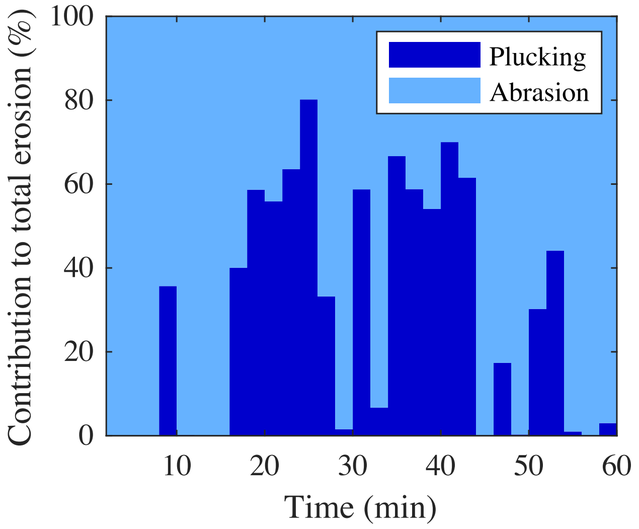
Plucking: anywhere on the disk

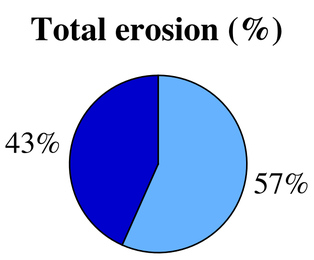


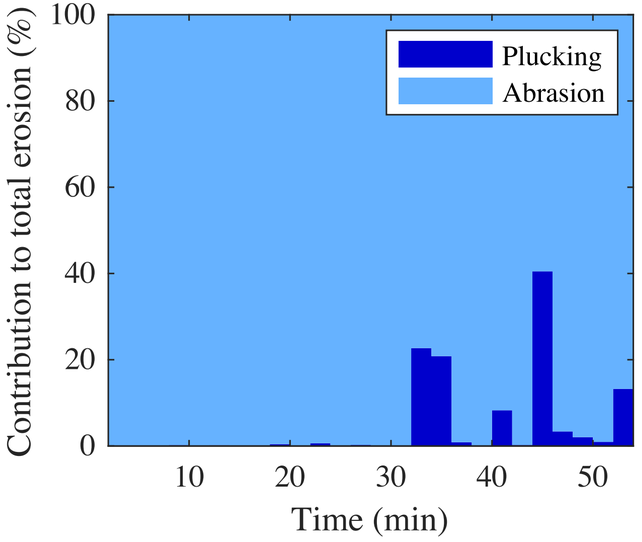
Abrasion: more on edges

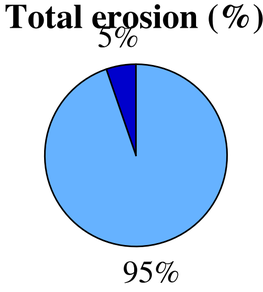


< 1.2 mm









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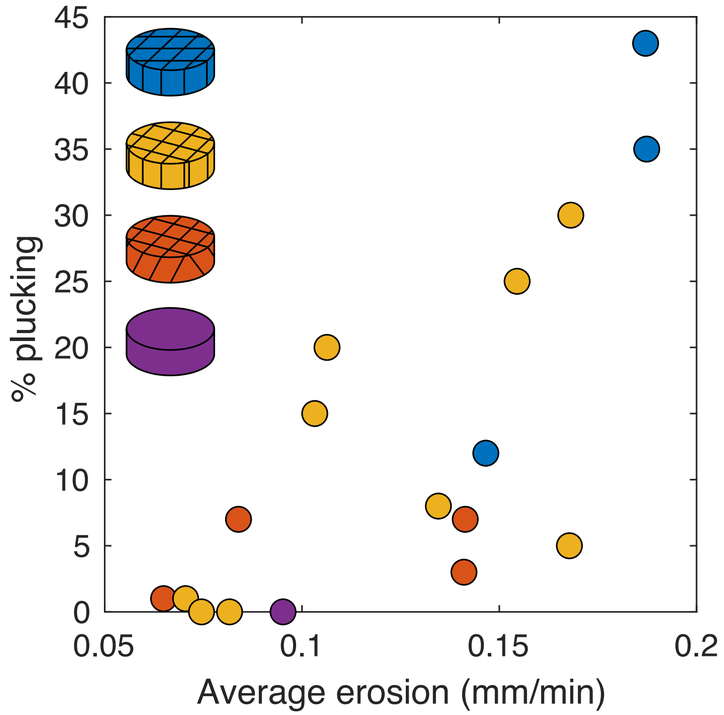
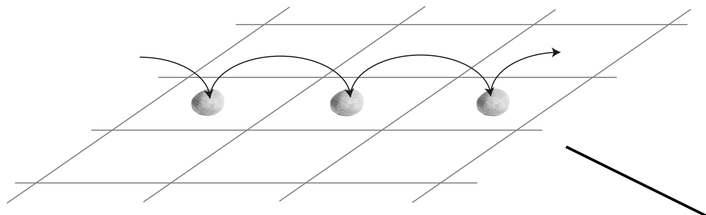
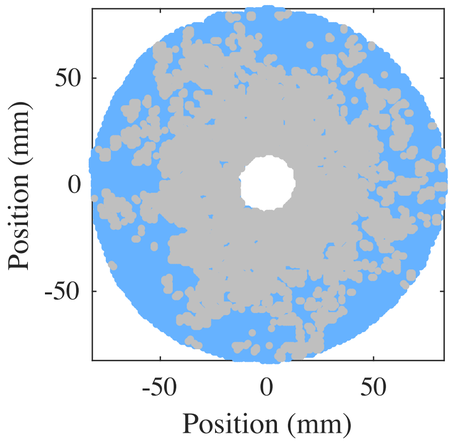
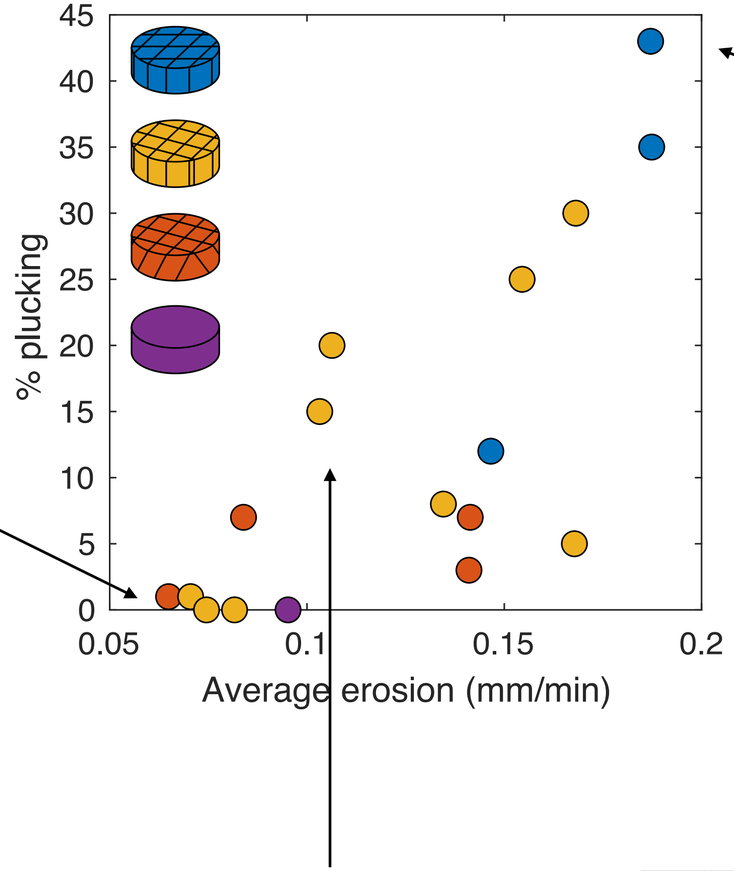


MAIN OUTCOMES: FRACTURE, GRAIN SIZE AND EROSION

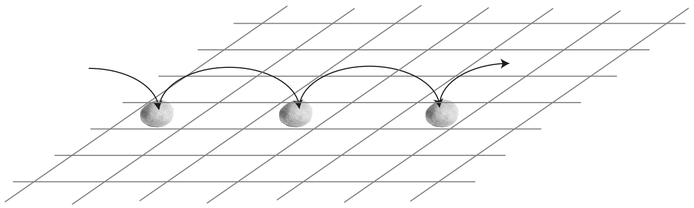
Abrasion dominated

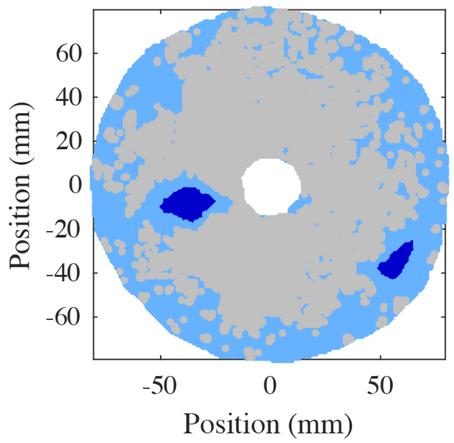




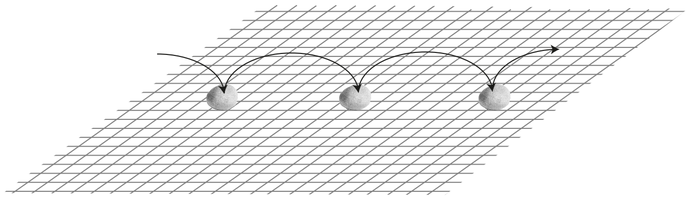


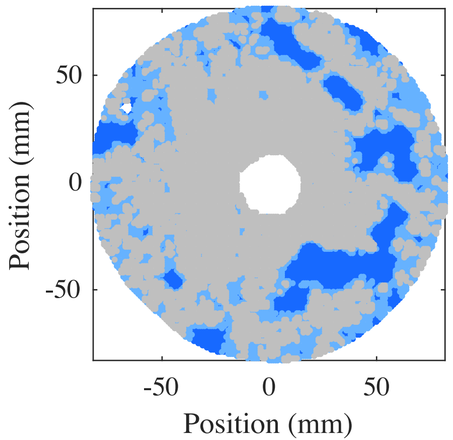
Plucking dominated





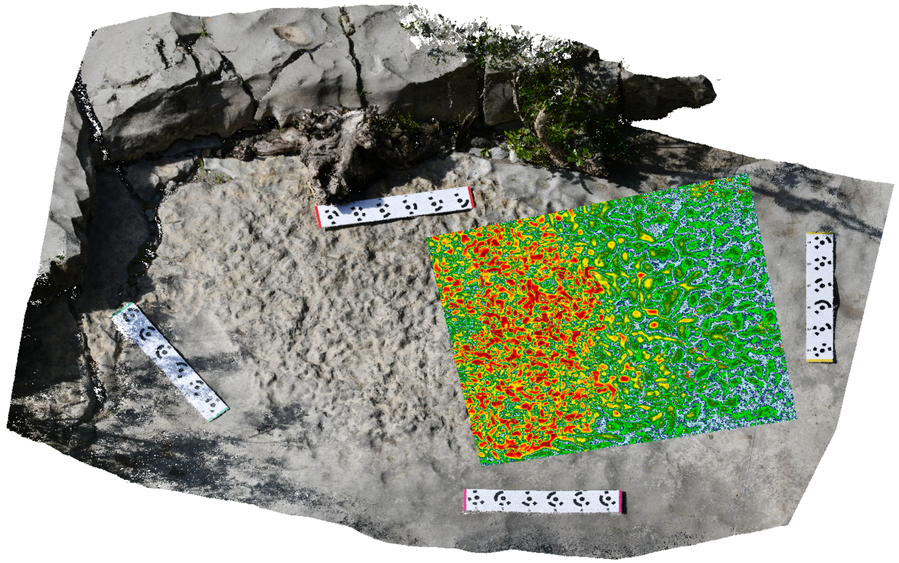
Abrasion-like plucking



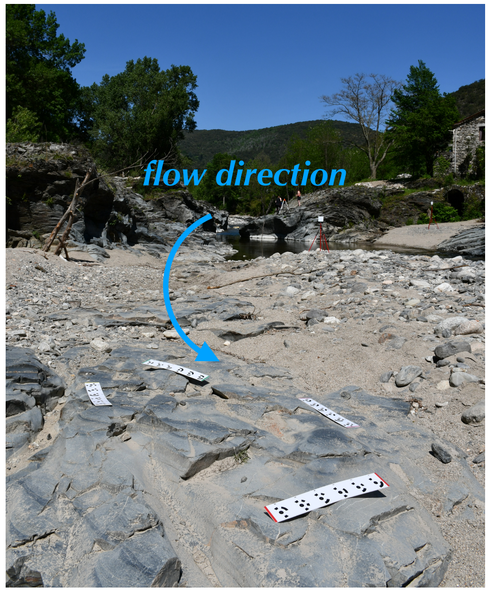


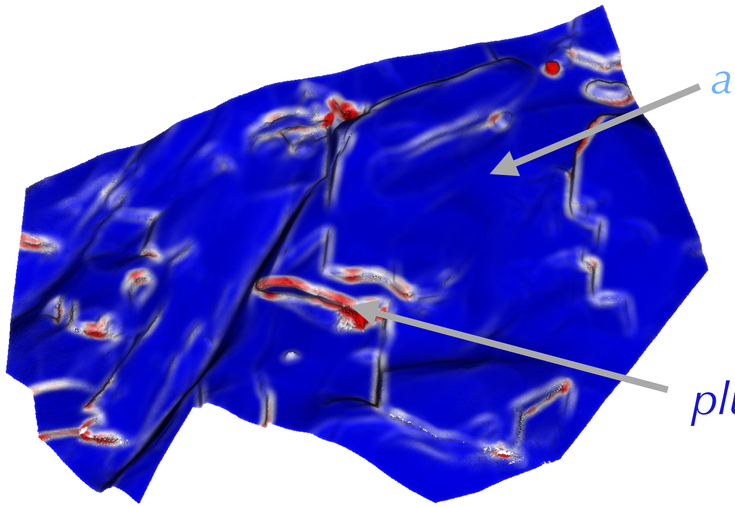
TOWARD NATURAL SYSTEMS

Roughness analysis

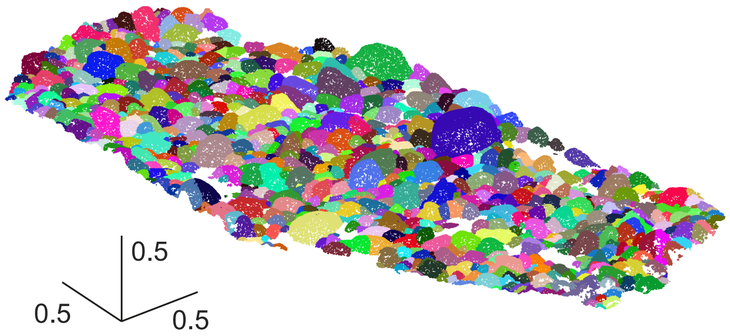


3D normal orientation





Grain-size measurements



(Steer, Guerit et al., in review for Esurf)