An experimental study of fault growth in a 2D Biaxial apparatus

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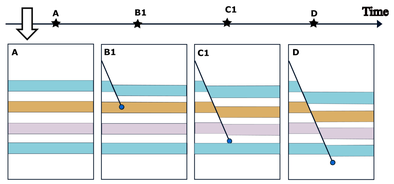
1) Why do we need to grow faults in lab?

There are many models for fault growth. The two widely accepted models are isolated and constant length fault growth model

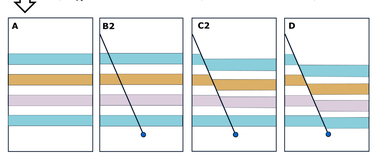
They agree on three stages of fault growth:
1) Propagation of fault segments
2) Displacement accumulation on fault segments
3) Fault segment interaction and linkage

They disagree on:

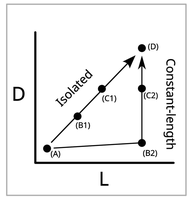
1) How displacement (D) vs length of fault (L) is established?



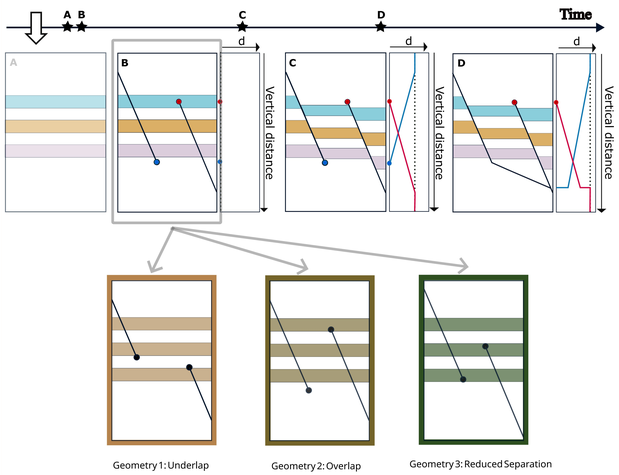
Isolated model of fault growth



Constant length model of fault growth



2) Are fault segments kinematically dependent and interact with each other?



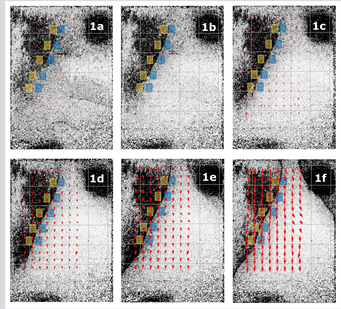
Geometry 1: Underlap | Geometry 2: Overlap | Geometry 3: Reduced Separation

d : Displacement
.....: Aggregate displacement

2) How displacement (D) vs length of fault (L) is established?



Sample at the end of experiment 1



Fault growth during experiment 1

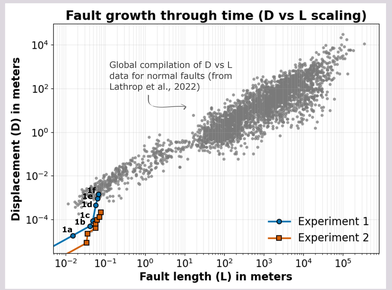
How do we calculate displacement (D) along a fault from the Digital Image correlation (DIC) data?

- Select frames corresponding to fault growth.
- Define paired regions on either side of the fault (blue and yellow boxes).
- Compute mean displacement vectors in each region.
- Calculate relative displacement between regions:

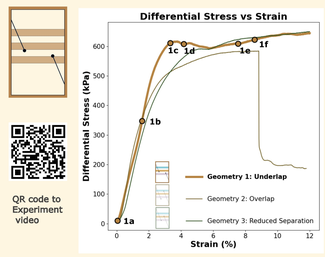
How do we calculate length (L) of a fault from the Diffusive wave Spectroscopy (DWS) data?

- Set the loss of correlation threshold to 80%
- Manually measure the length using ImageJ software

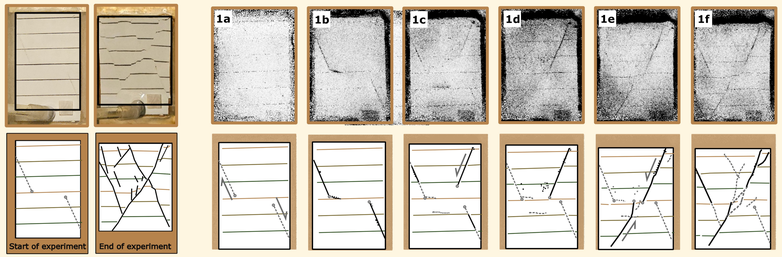
Preliminary results show that our samples favour the Constant length model of fault growth

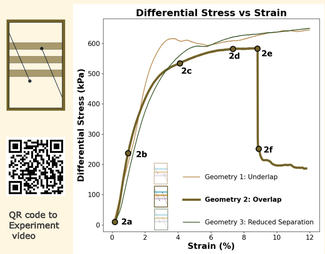


3) Are fault segments kinematically dependent and interact with each other? If yes, how does different fault segment geometry affect the displacement partitioning?

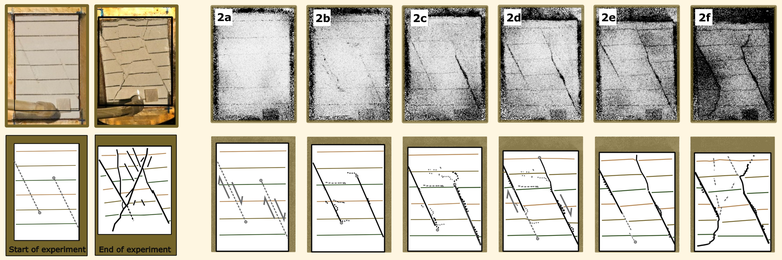


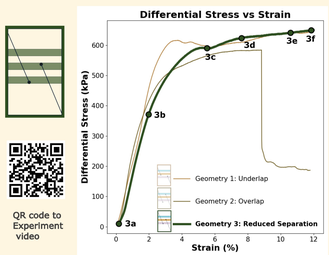
QR code to Experiment video



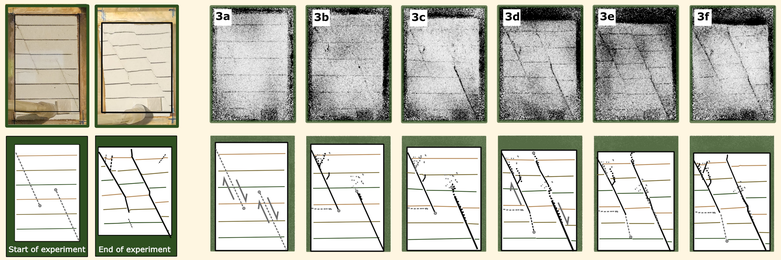


QR code to Experiment video





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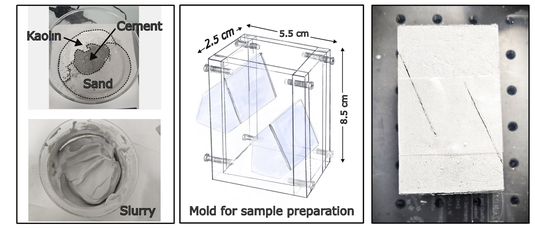


Tip point | In-active fault | Active fault | Layers | Active local events | In-active local events

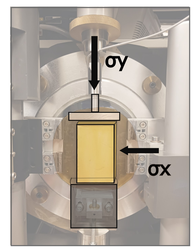
Preliminary results indicate that fault segments interact with one another, with overlap and separation emerging as key controlling parameters. Ongoing work applies Digital Image Correlation (DIC) to quantify strain distribution within the relay zone.

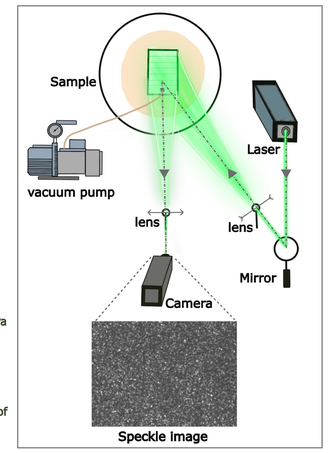
4) Methodology

A) Sample preparation using novel rock analogue material



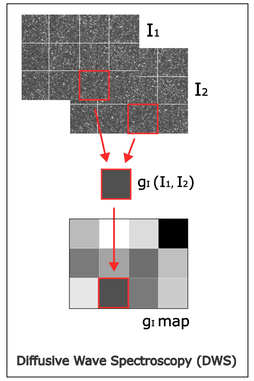
B) Slow loading using 2D Biaxial apparatus (Mathey et al., 2026)

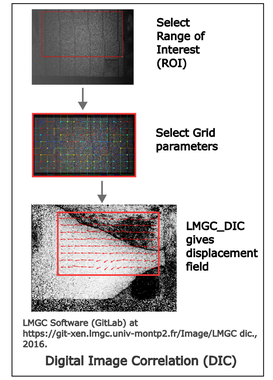




- Plane strain biaxial device
- Maximum Axial stress: 3500 kPa
- Maximum confining stress: 90 kPa
- Lowest strain rate: 0.1 µm/s
- 12mm of displacement lasts 33 hours
- Each experiment generates 1TB of data for 2 frames per second

C) Gathering information from Speckle Images





Optical Interferometry based DWS allows temporal resolution of 17-50 milliseconds. Correlation maps track deformation zones while DIC provides displacement field.

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