

# Localizing Signatures of Catastrophic Failure

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Stefano Zapperi  
CNR-IENI, Milano



# The consortium

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Stefano Zapperi  
**CNR, Milano, Italy**

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Michael Zaiser  
Ian Main  
Ian Butler  
**University of Edinburgh, UK**

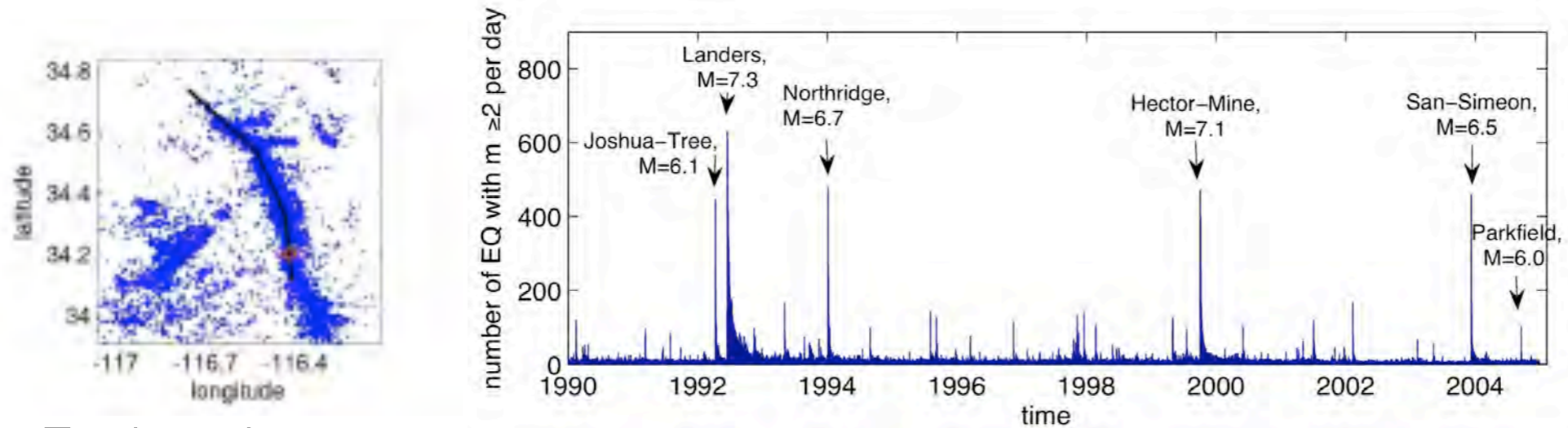
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Ferenc Kun  
**Debrecen University, Hungary**

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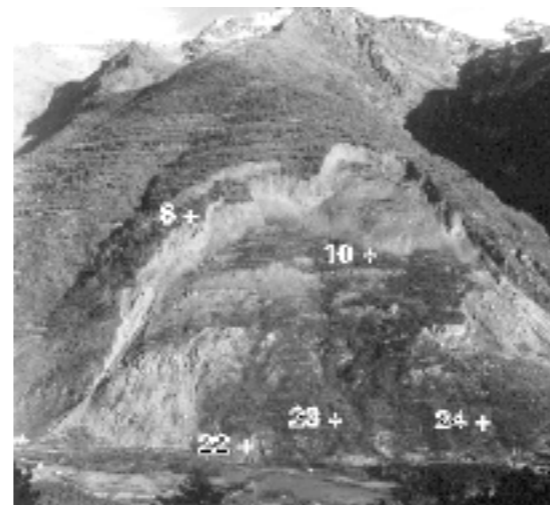
# Catastrophic failures: when and where?



Earthquakes



Fractures

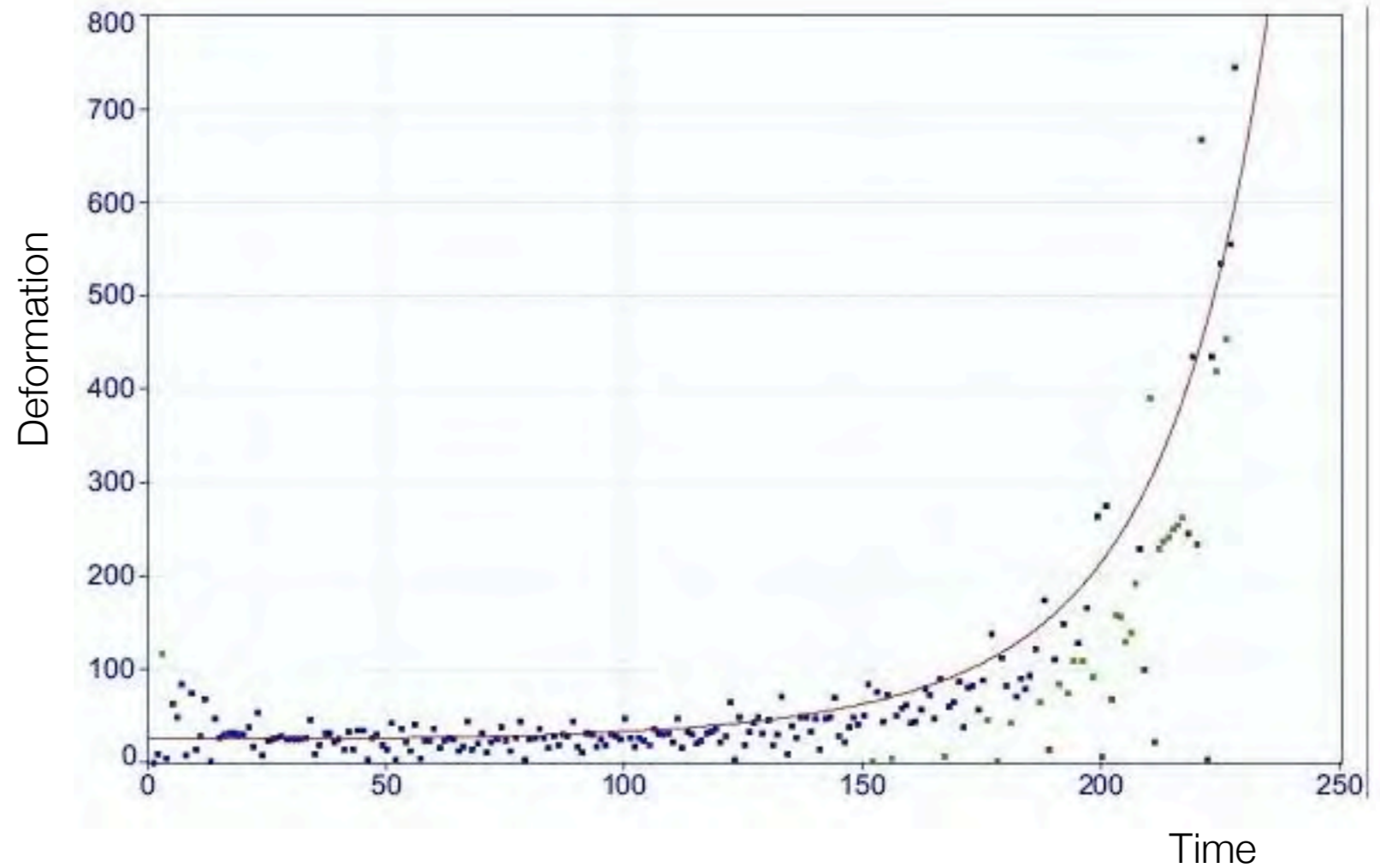
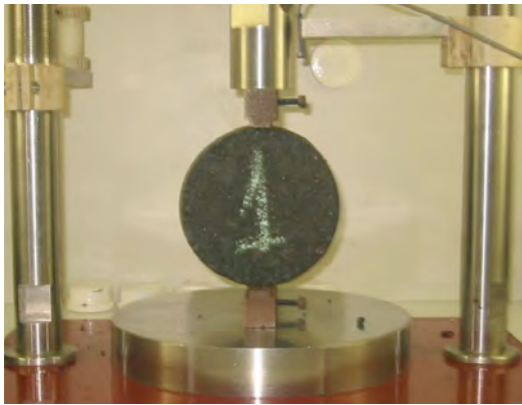


Landslides

# Traditional approach: signal analysis

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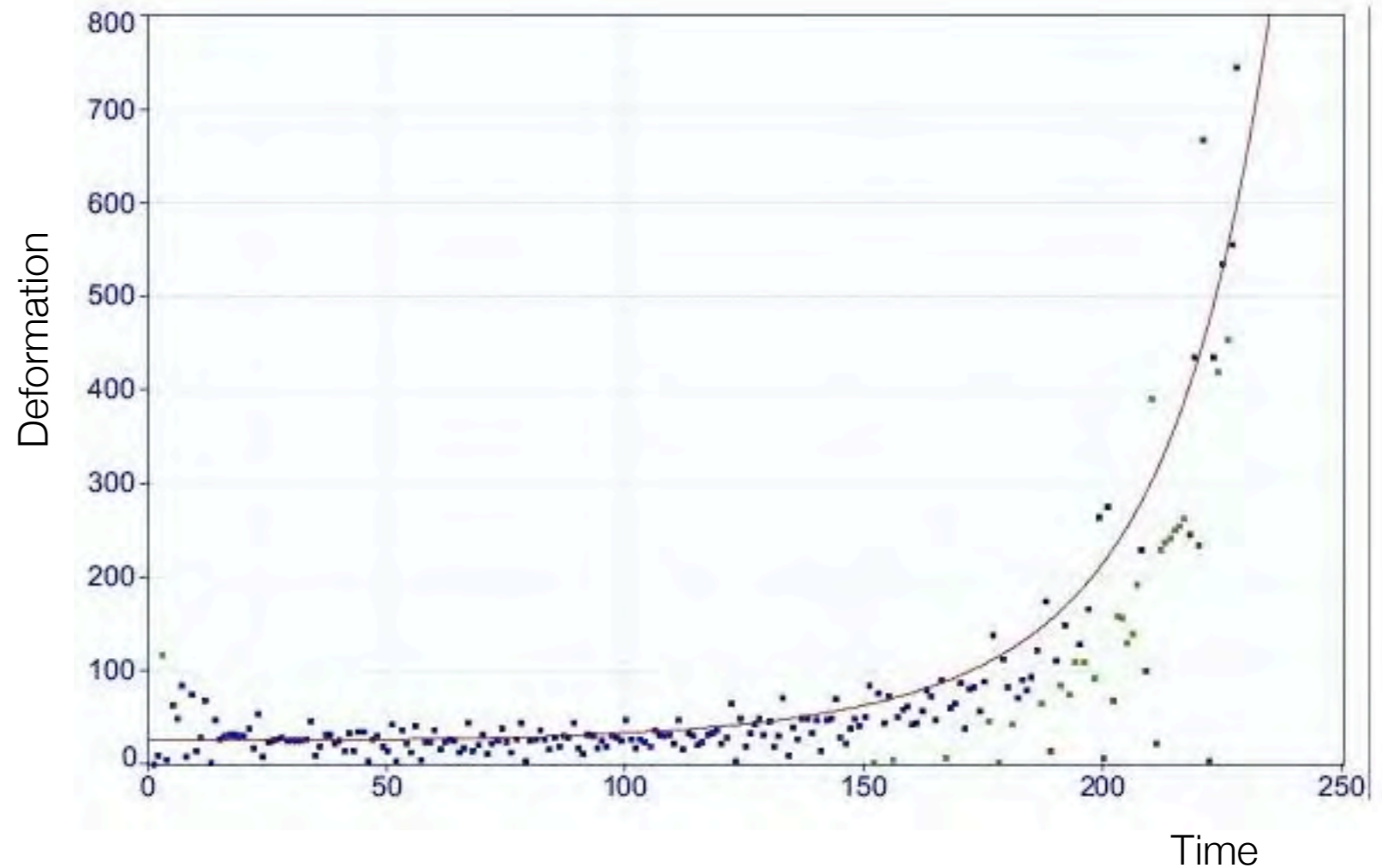
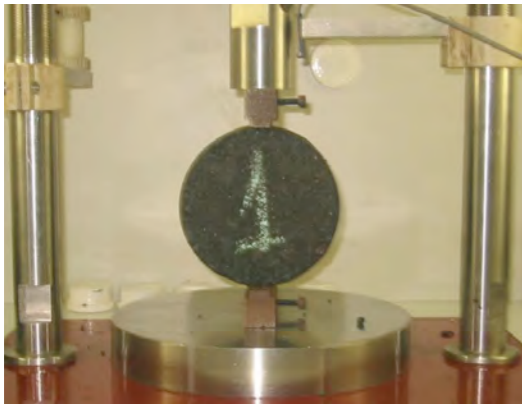
e.g. Fatigue failure of asphalt



# Traditional approach: signal analysis

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e.g. Fatigue failure of asphalt



Processes occur in space and in time: acceleration comes with localization!

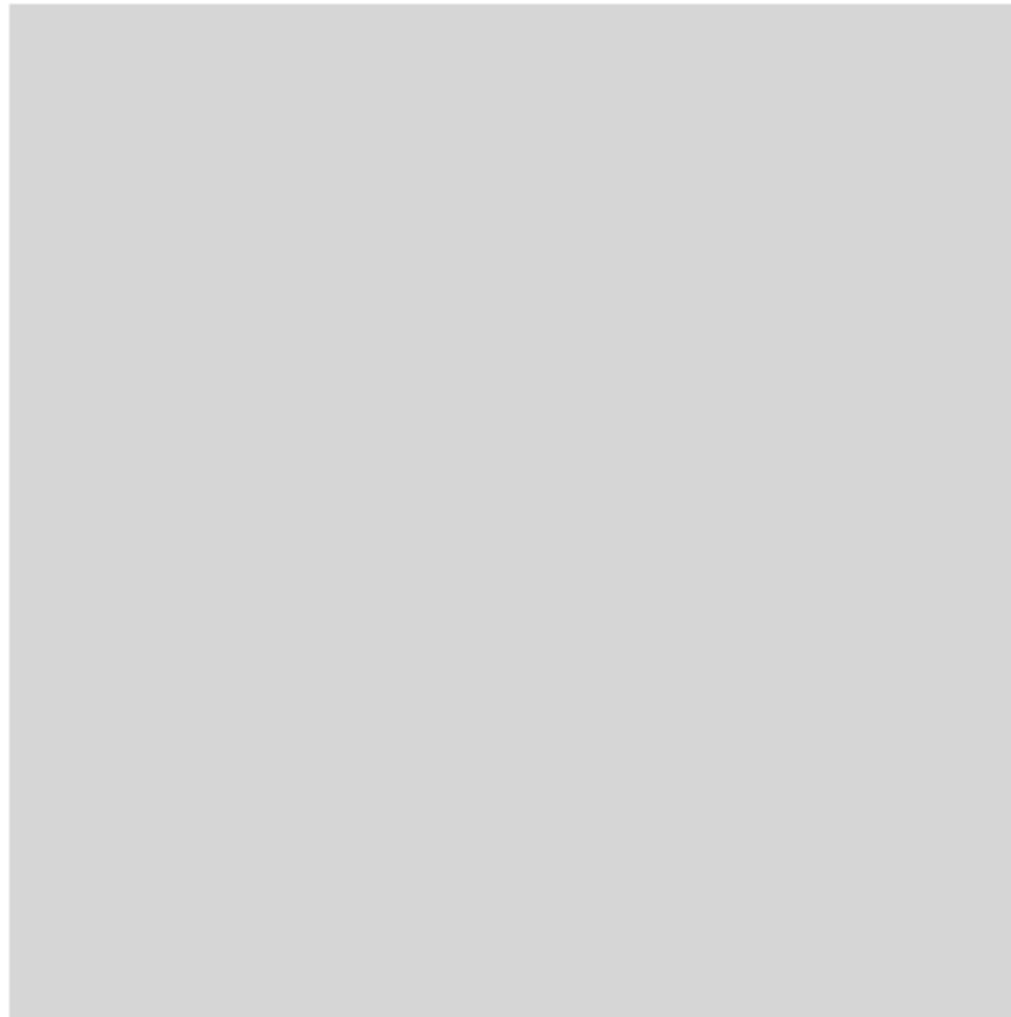
# Opening the black box

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# Opening the black box

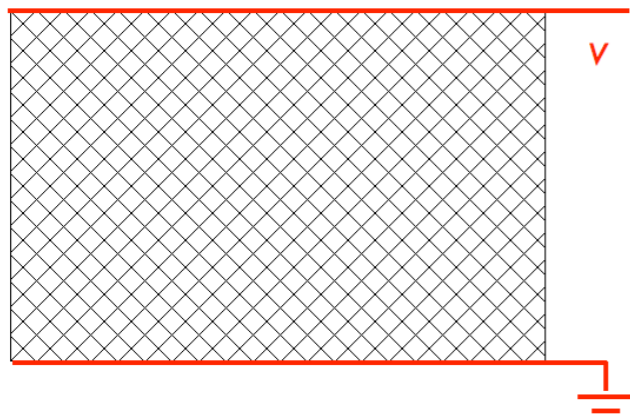
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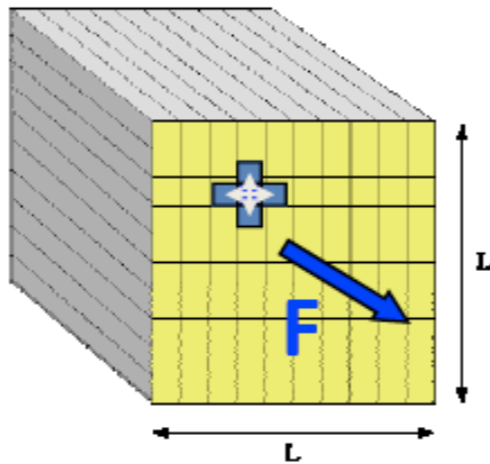
Identification and analysis of universal localization + acceleration patterns  
Identification of localized signatures  
Detection of localized patterns

# Conceptual models

Random Fuse model



Fiber bundle model



## Objectives

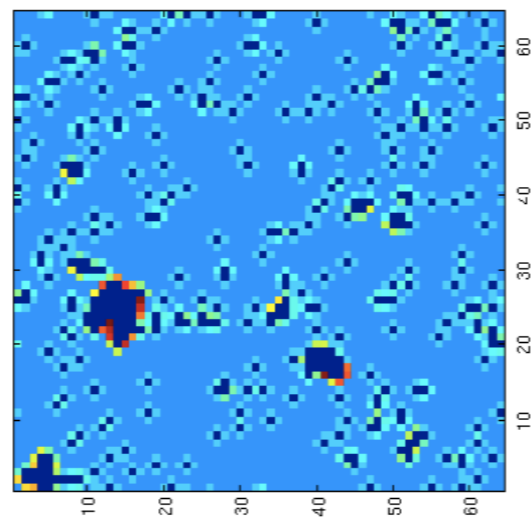
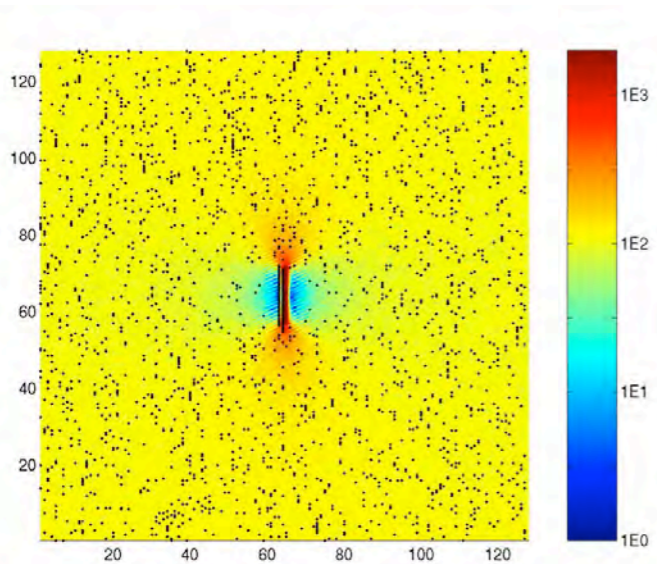
Relation of lifetime and other observables

Interplay of disorder and local stress field

Distribution and size scaling of lifetime

Statistics of crackling noise, identifying precursors of imminent failure

Nature of epicenters, signatures of the acceleration phase



# Realistic models

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## **Development and validation of Discrete Element Models for geomaterials**

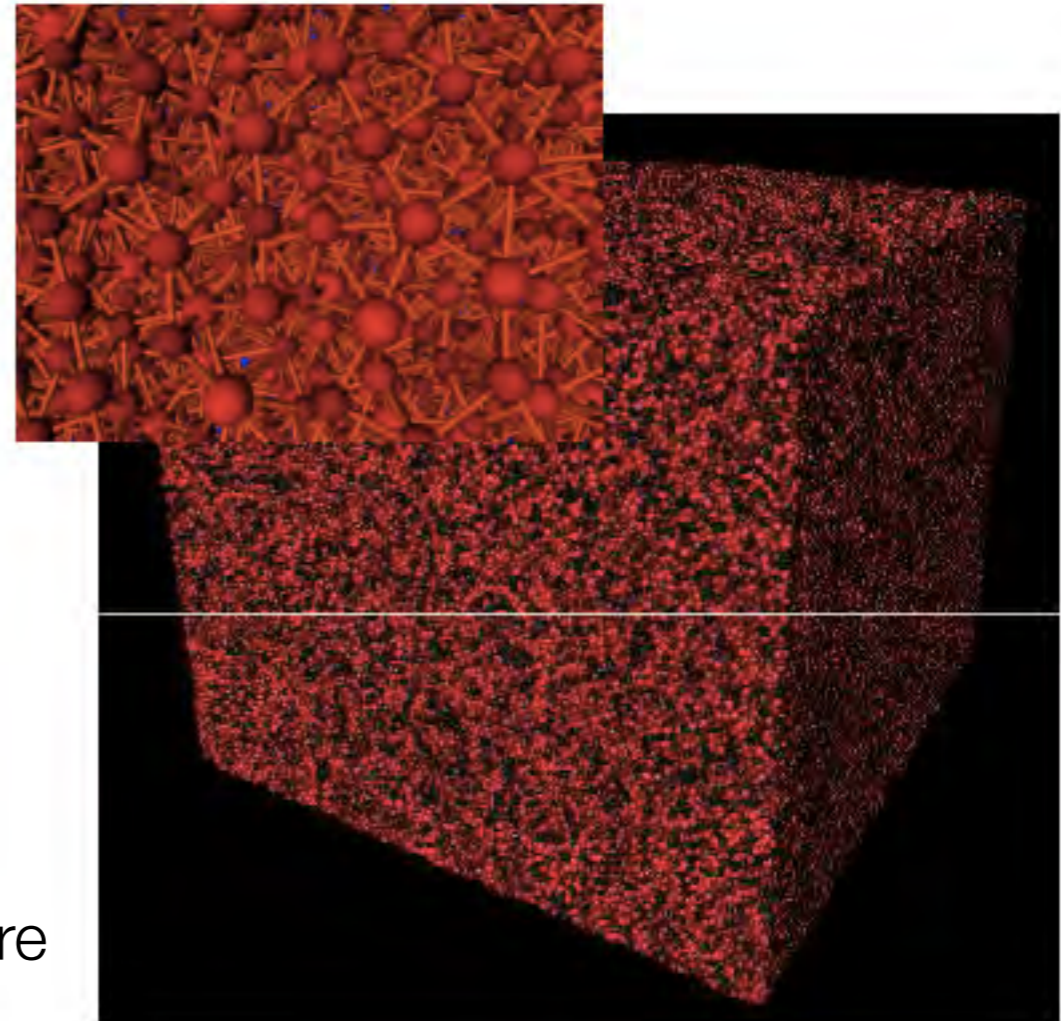
Random packing of polydisperse  
spheres connected by beams  
Mesoscopic description of shear failure

### **Objectives**

Realistic simulation of laboratory experiments  
on shear of rocks

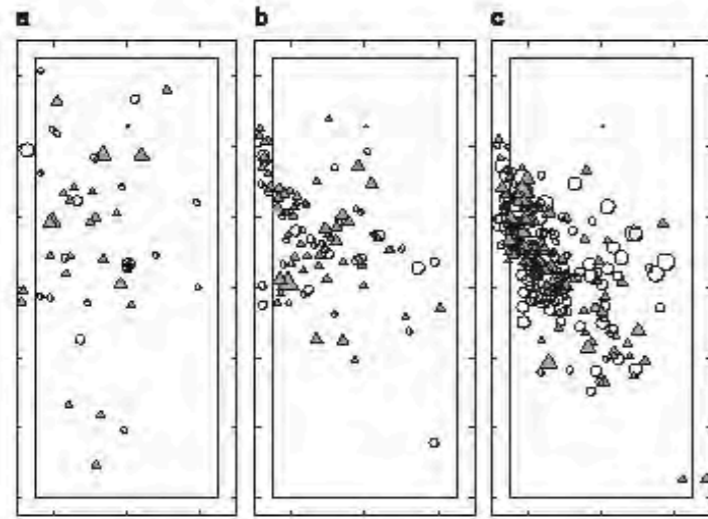
Spatial structure of damage, investigation  
of the nature of epicenters leading to macroscopic failure

Search for precursors of the acceleration phase investigating  
the spatio-temporal evolution of the sheared system

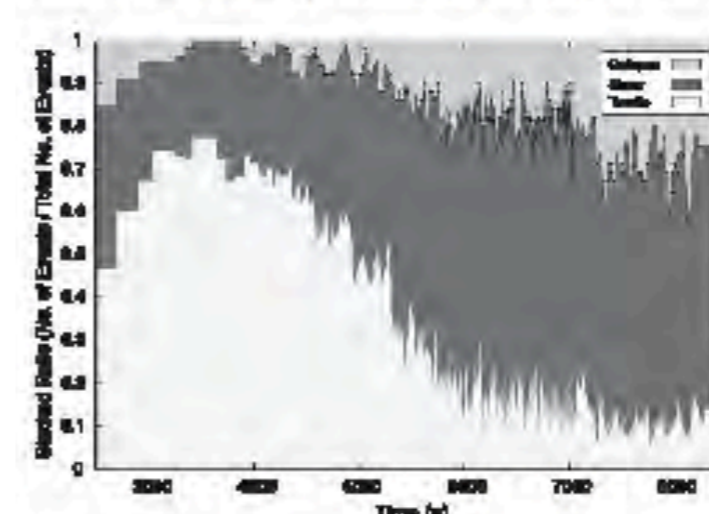


# Laboratory Experiments

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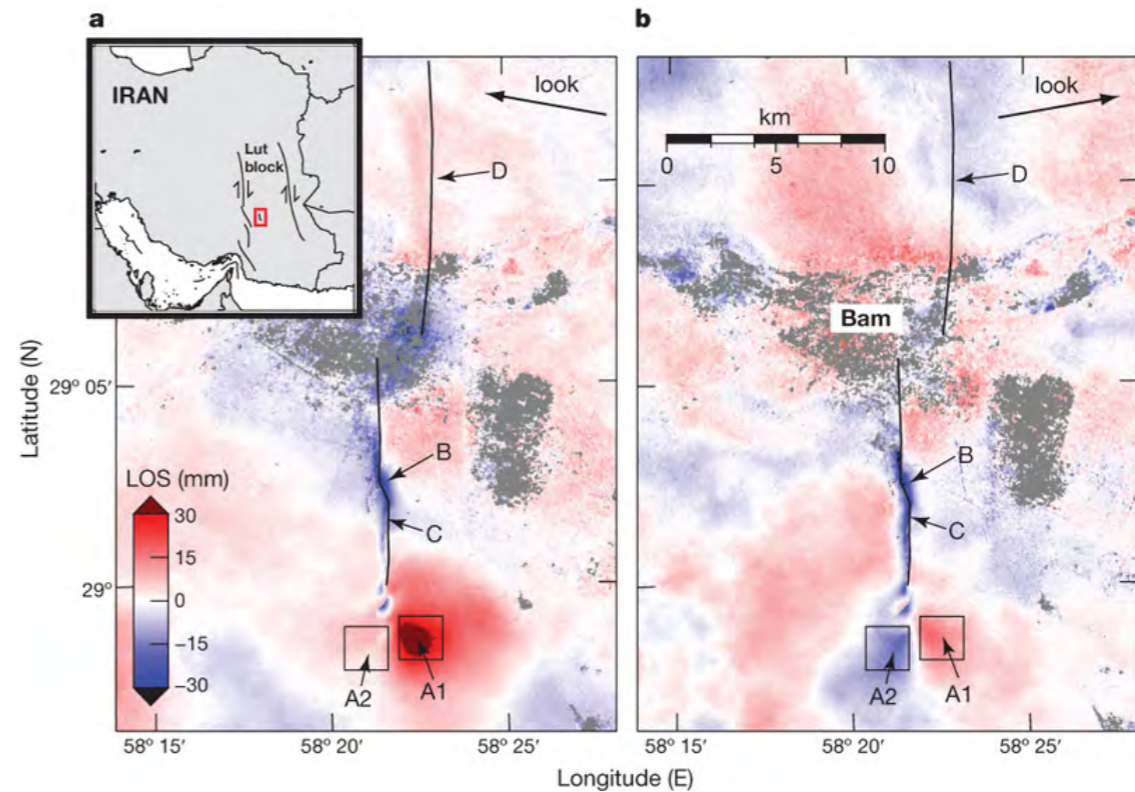
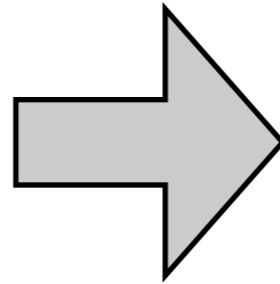
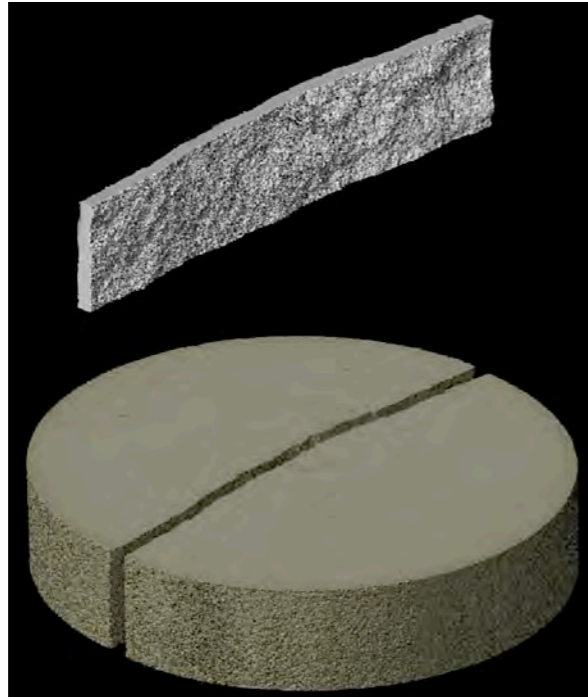


Laboratory test on Aue Granite:  
the location of acoustic emissions  
is becoming progressively more  
localised with time.



Localisation is accompanied by a  
change in source mechanism  
from predominantly tensile  
to predominantly shear failure  
(Graham et al., 2010, IJRM 47, 161–169)

# From the lab to the Earth



EJ Fielding *et al. Nature* **458**, 64-68 (2009) doi:10.1038/nature07817

High-resolution C-T image of a natural fracture, the detailed morphology being revealed in the upper image of the fracture aperture.

Postseismic surface deformation after the Bam, Iran, earthquake,

Thank you for your attention!