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Interpreting Geological Structures with Numerical Models: A Study on Rock-Melt Patterns

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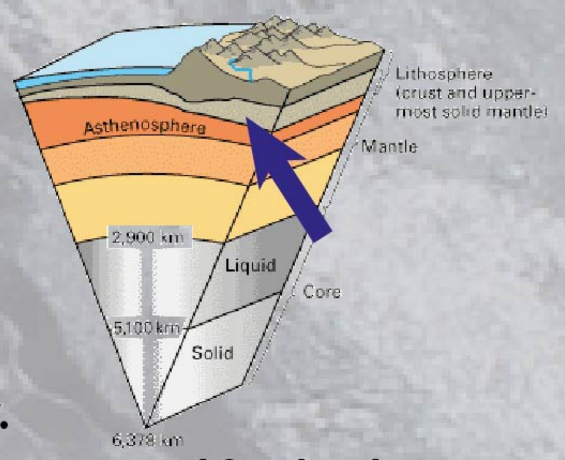
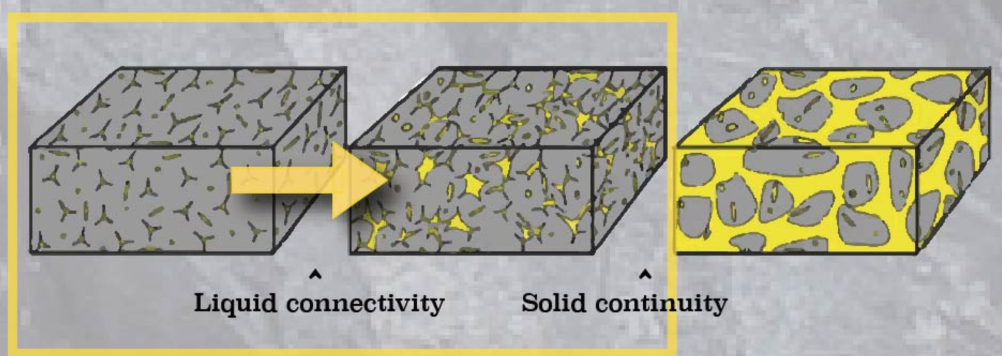
Background and Motivation



Melt in the Middle and Lower Crust

- Affects the structure, chemistry and mineralogy.
- Can remain where it forms (*in situ*) or migrate. This is crucial for rheology: stays in situ = weakens the rocks, migrates = residuum is strengthened[1].

Melt starts forming in segregated pockets. Then, the density contrast with the host rock will cause the fluid phase to migrate, merge and form structures[2]. This process is influenced by several mechanisms.



Aims of the PhD project:

- Perform regime analyses for the formation of patterns in melt-rock mixtures.
- Provide a 'tool' for the interpretation of structures observed in the field.
- Understand the conditions for migration or accumulation
- Quantify the role of mechanisms such as:
  - external deformation
  - rate of melt production
  - yield strength of solid
  - external melt influx
  - heterogeneity of the host rock

Future Work

- Solidification
- Improve flow in fractures: from porous to Stokes
- Influx of melt from an external source
- Fieldwork and comparison with simulations
- Ductile behaviour of the Host Rock

Values for the Simulations in this Poster

Timestep	10 years (1) / 100years(2)
Solid→Melt for each spot	0.01 %
Solid:	
Young's Modulus	20 GPa
Density	3000 kg/m³
Fluid:	
Viscosity	10^4 Pa s
Density	270 kg/m³

Acknowledgements

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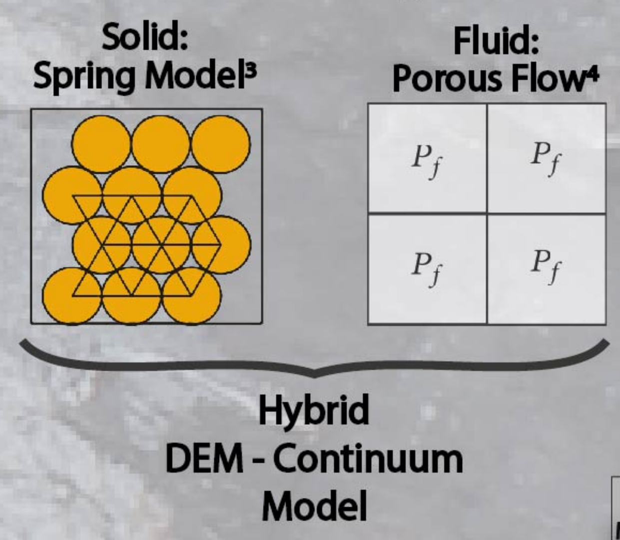
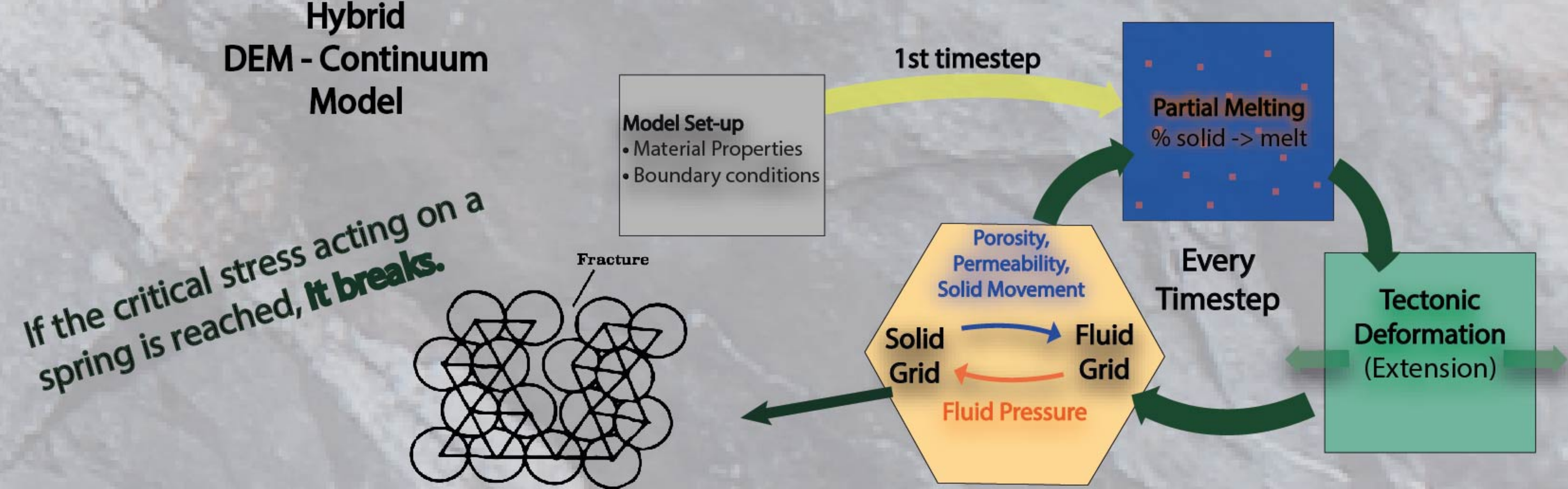
Numerical Methods

- We use the code Latte (part of the Elle framework).
- This 2D model uses two grids, one for the solid and one for the fluid.



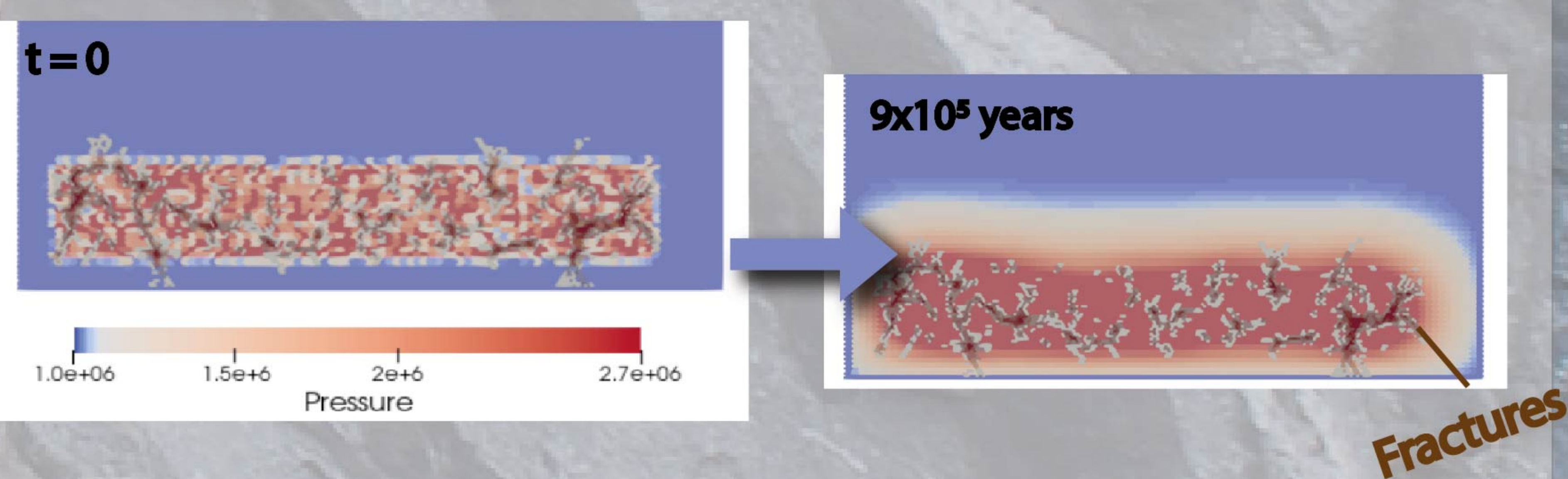
★ The **solid** part is a Discrete Element Model with springs connecting the particles.
★ The **fluid** part is a continuum model that simulates Darcy flow.



Results

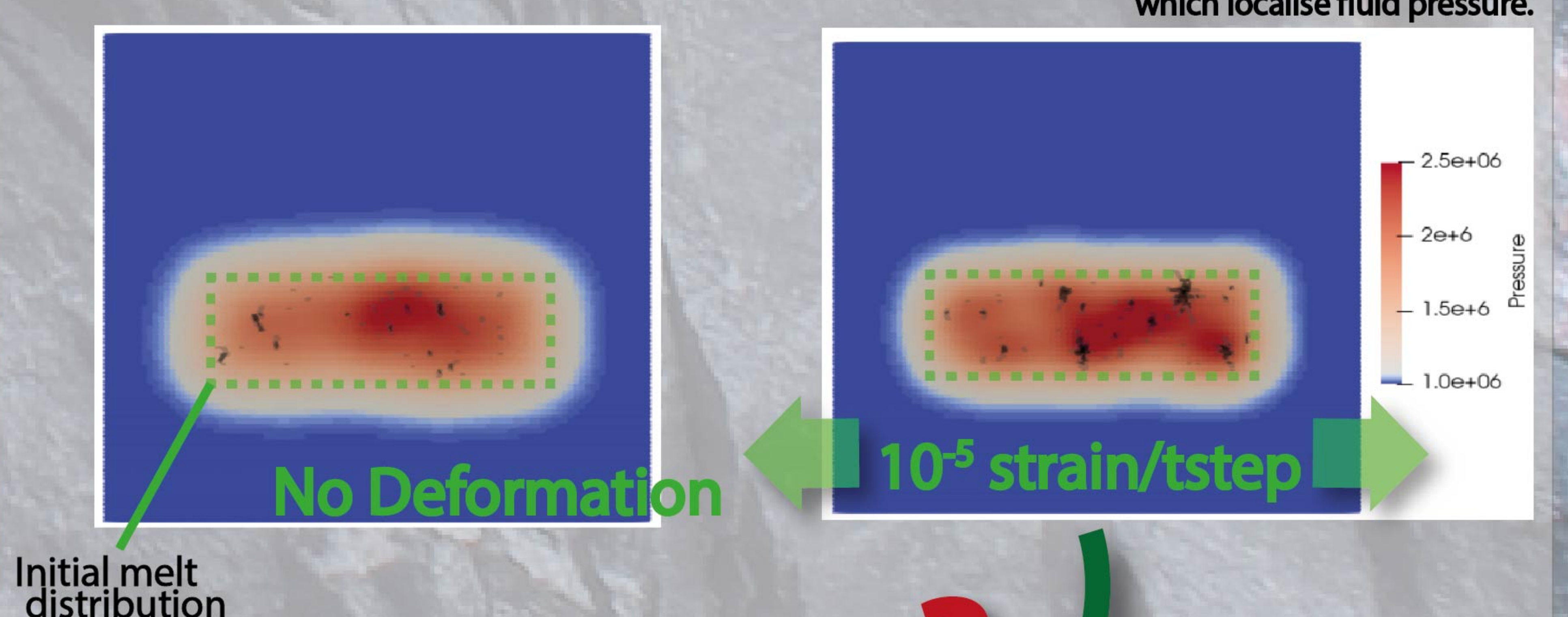
(1) Melt is generated in 3000 random spots inside a horizontal layer. Then the system is left to equilibrate. Melt is represented by the fluid pressure.

The extra fluid pressure generated by the phase change breaks some of the springs. This creates a fracture network that enhances permeability.



(2) Effect of **external deformation**: No deformation (left) or extension (right).

External deformation contributes to the formation of fractures, which localise fluid pressure.



Goal: **Identify** and **quantify** the processes that caused the **formation** of these **structures**.

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