Influence of grains shapes on the slip regime.

Nathalie Casas[1,2], Ali Daouadji[2], Guilhem Mollon[1]
[1]LaMCoS, INSA-Lyon [2]GEOMAS, INSA-Lyon
nathalie.casas@insa-lyon.fr

3rd Induced Seismicity Workshop
5-8 March

CONTEXT

With recent climate changes and energetic transitions laws, research on Enhanced Geothermal Systems is increasingly relevant. Using hydraulic stimulation by fluid injections into the existing fractures increases the pore pressure into the gouge and may create some slip reactivations. These slips can be seismic or aseismic and they can create different kinds of micro-seismicity.

Hydraulic stimulation → **Seismic - Aseismic slips** → Induced seismicity ?

OBJECTIVES

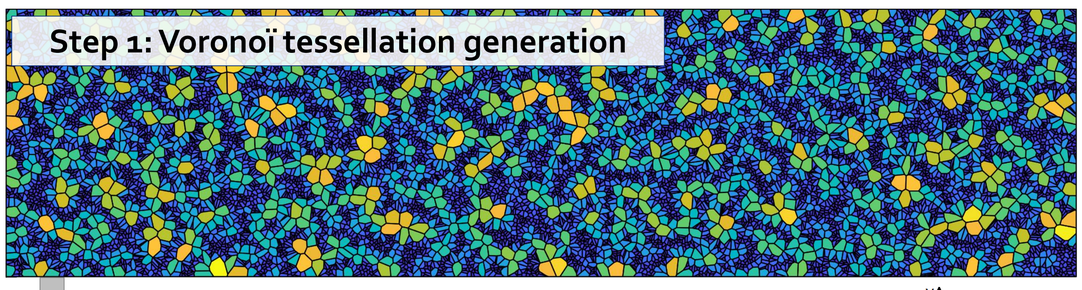
What is the influence of morphology of grains on the slip behavior and on the contact between the rock walls and a granular gouge ?

- To generate real grains shapes
- To simulate a 2D granular fault gouge with DEM: local simulation to bring to light the slip triggering
- To study the different behaviors of angular and circular grains within the contact

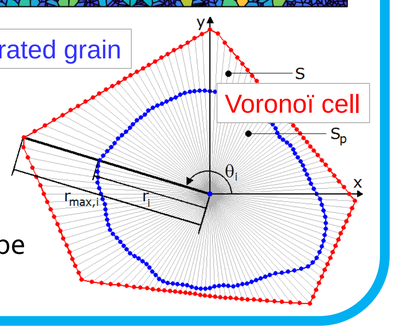
Geometry and gouge properties
Angular and faceted grains. → **DEM simulation**
Study of the slip mechanisms

GRAINS SAMPLE GENERATION

Code **Packing2D**: 2D grains generator employing a "**Fourier-Voronoï**" method to create a realistic packing. [1]

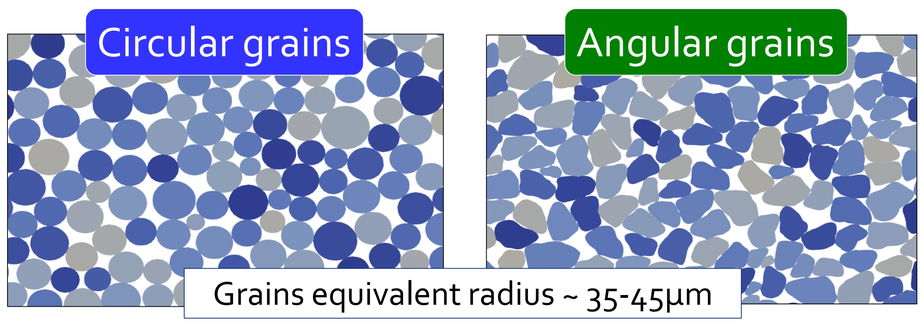


Step 2
Chose a spectrum of morphologic descriptors. → **Step 3**
Cell filling



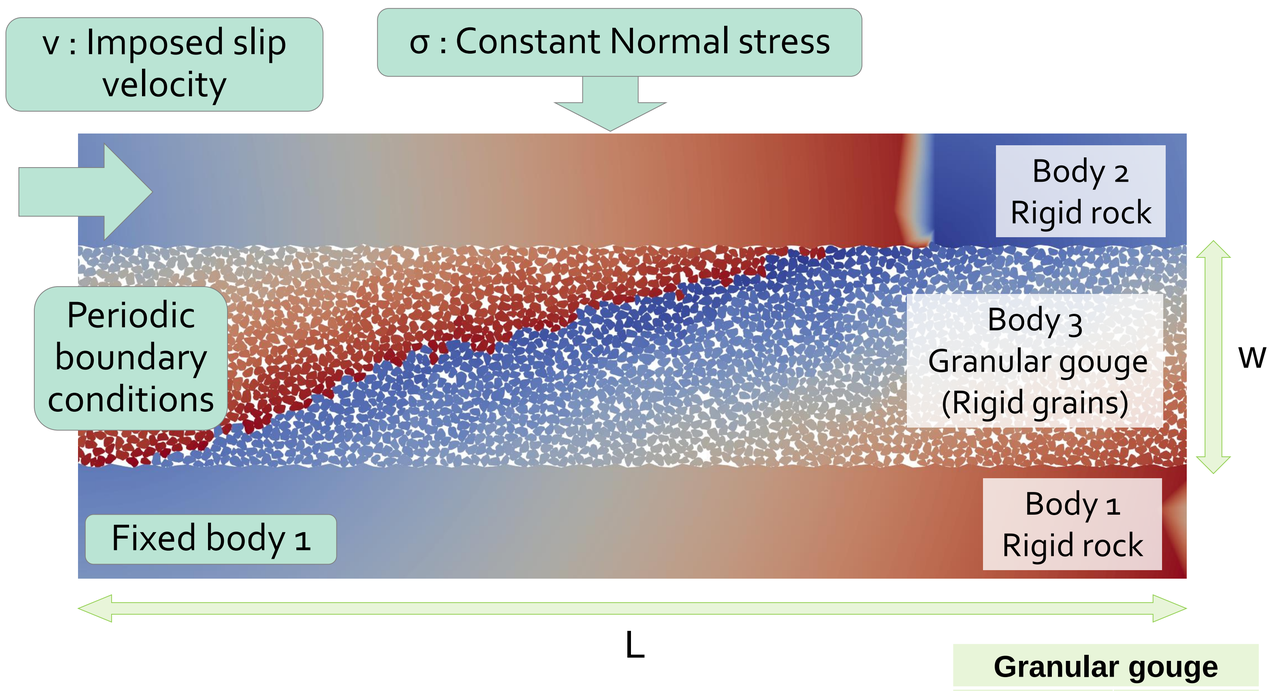
The main point of this code is that complex shapes can be implemented with an anisotropic orientation.

TWO TYPES OF SAMPLES GENERATED



DEM GOUGE SIMULATION

- **Discrete simulation** (multibody dynamic): code **MELODY** (Multibody ELement-free Open code for DYnamic simulation). [2]
- **Grain** (one body): discretized by a number of field nodes (like 2D FEM).
- Continuous displacement field: interpolated between these nodes using meshfree shape functions (**Moving Least Squares**)



Final position of the grains, color-coded by their initial position.

Granular gouge	
Width w	~ 2mm
Length L	10 mm

We include the grain sample generated by Packin2D[1] into the code MELODY[2] .

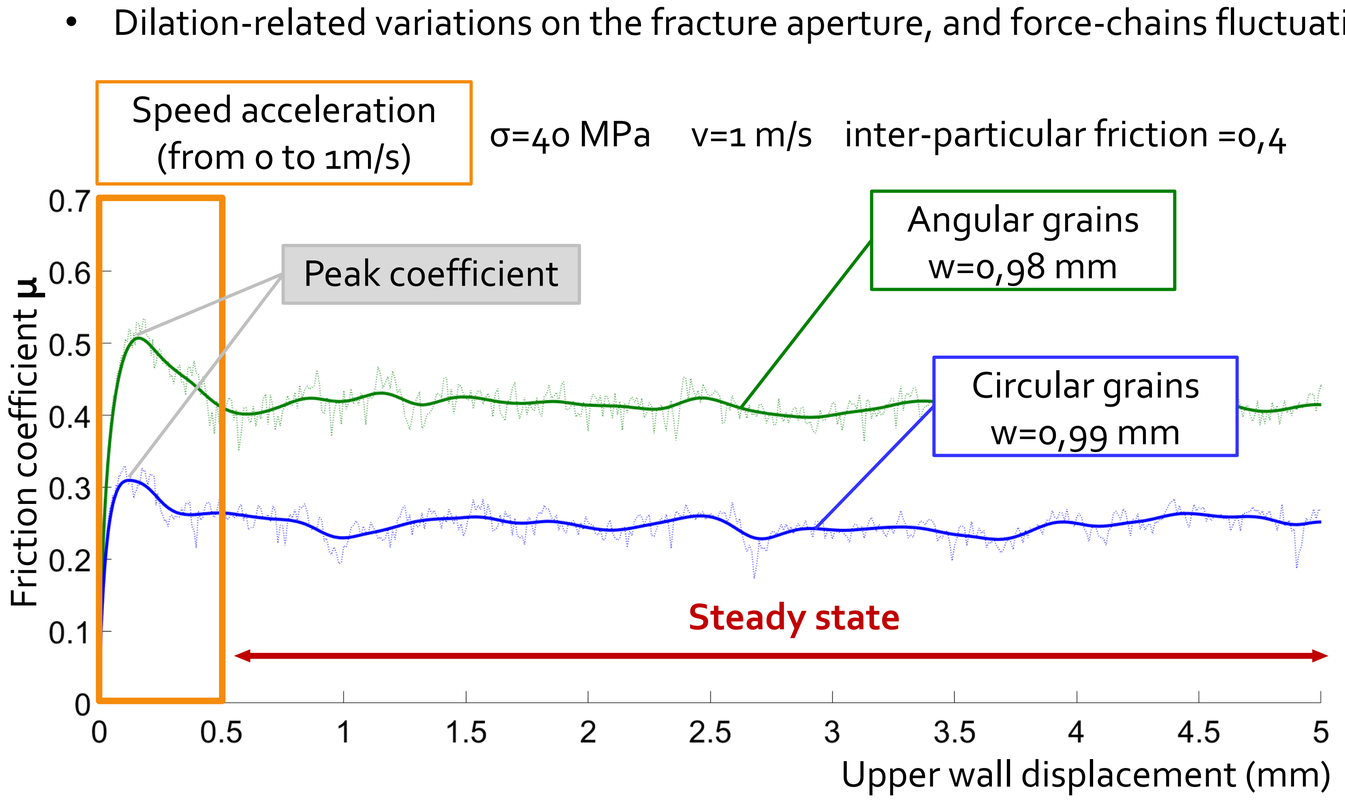
INFLUENCE OF GRAINS SHAPE

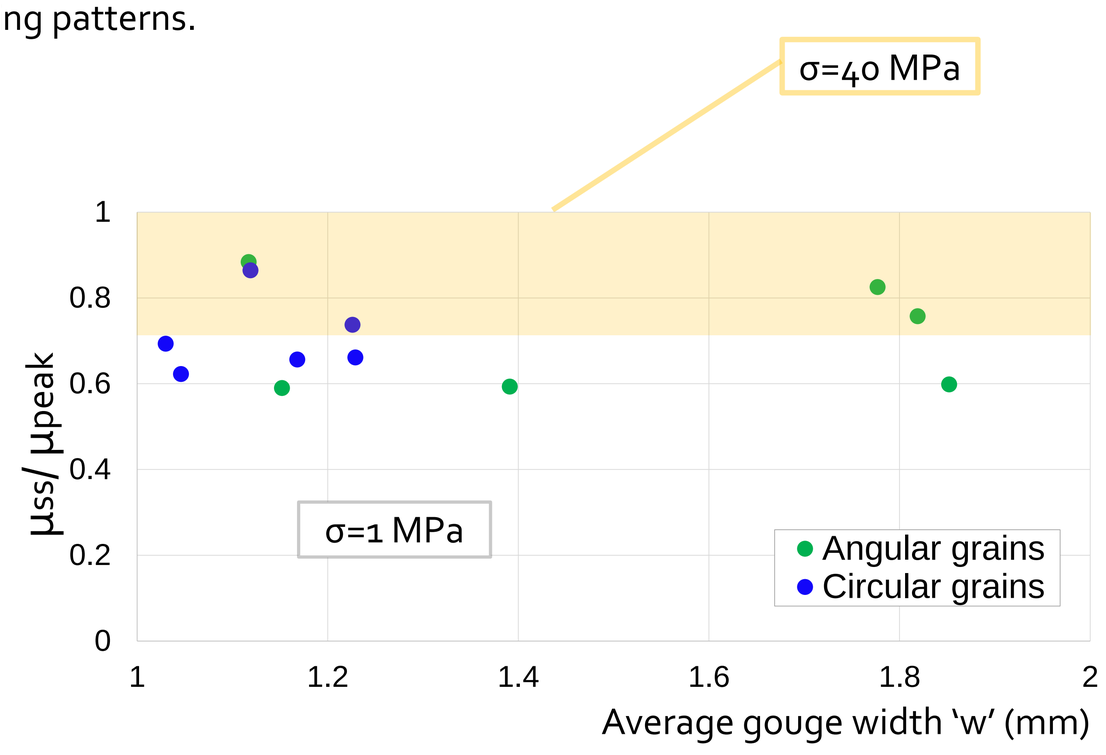
An improvement with respect to most of the existing simulations which use circular/spherical grains

Observations :

- Angular grains exhibit resisting forces and friction coefficients on the upper wall higher than those found for circular grains.
- Dilation-related variations on the fracture aperture, and force-chains fluctuating patterns.

Speed acceleration (from 0 to 1m/s) σ=40 MPa v=1 m/s inter-particular friction =0,4





Perspectives:

- To use fractal distributions and granular gradient with angular grains and different sizes of gouge, in order to investigate their influences on the slip mechanisms.
- To add cohesion and a pressure gradient in the model, we plan to simulate pore pressure effects into a real granular gouge.

[1] G. Mollon, J. Zhao, Fourier-Voronoï-based generation of realistic samples for discrete modelling of granular materials, Granul. Matter. (2012) 621–638. doi:10.1007/s10035-012-0356-x
[2] G. Mollon, A unified numerical framework for rigid and compliant granular materials, Comput. Part. Mech. (2018) 1–11. doi:10.1007/s40571-018-0187-6.