Long-term hydro-mechanical analysis of the GED and GCS galleries using Second Gradient model

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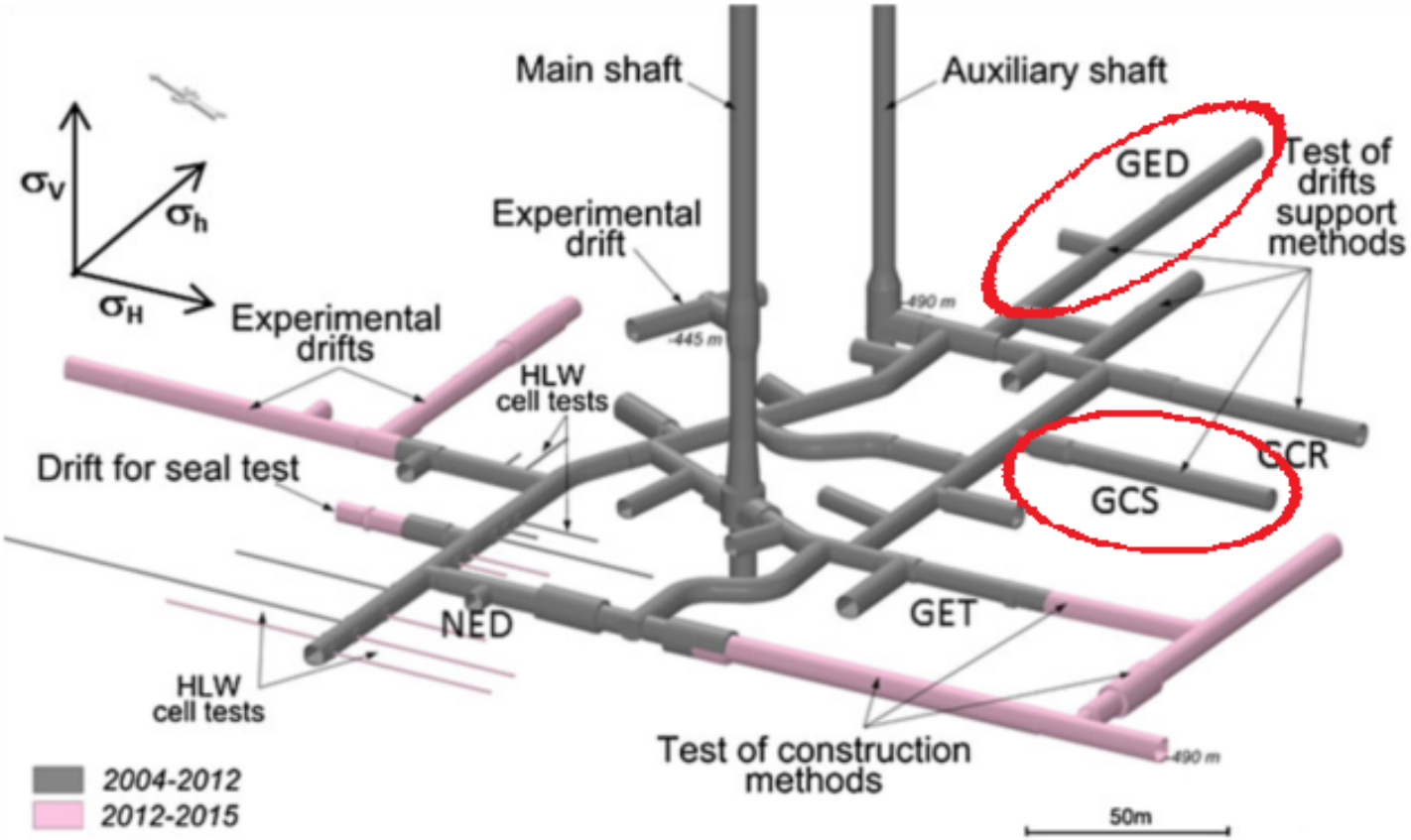
Outline

Outline

Meuse/Haute-Marne underground research laboratory



Objectives and strategy

- Strain localization modeling

Challenges

- Mesh dependency

Proposed solutions

- Second Gradient regularization

Objectives and strategy

- Strain localization modeling

Challenges
- Mesh dependency

Proposed solutions
- Second Gradient regularization

- Long-term modelization: 100years

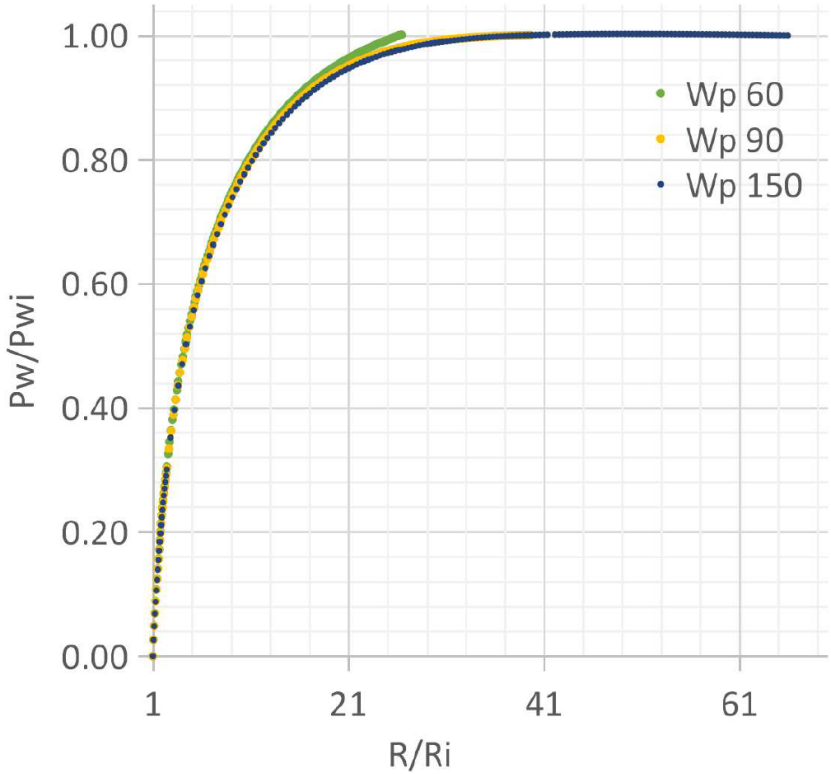
Challenges
1. Hydraulic influence
2. Creep deformation

Proposed solutions
1. Study the external radius influence
2. Introduce viscosity to the model

Outline

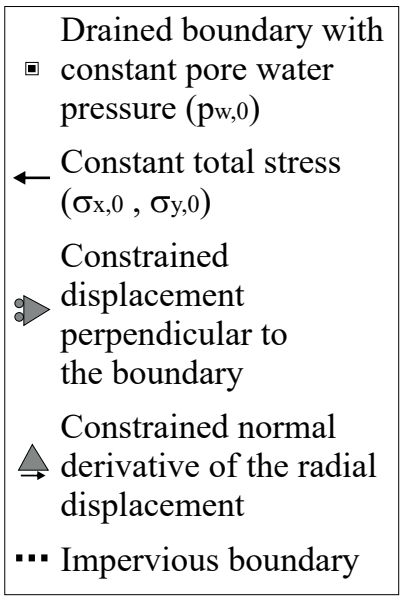
Influence of the outer boundary

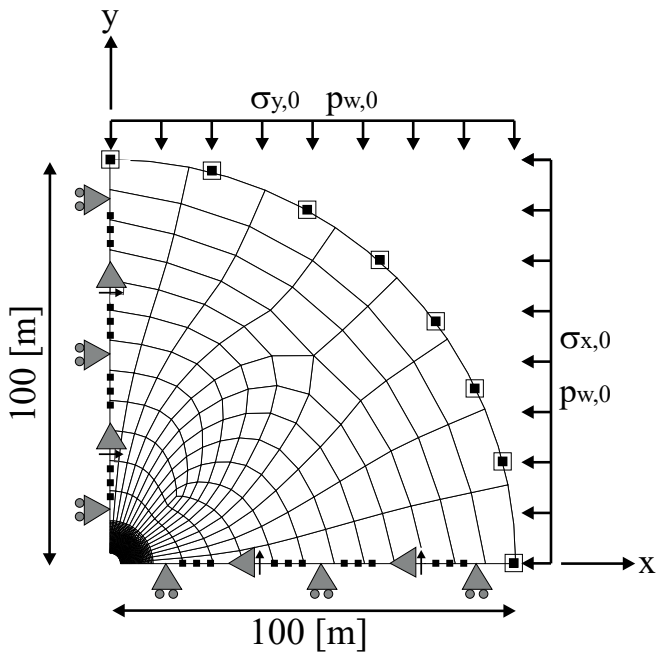
- In a 100 years period, the pore pressure will be further influenced
- 3 external radius considered in the sensitivity study
- No significative difference between 90m and 150m
- 100m is used in the following

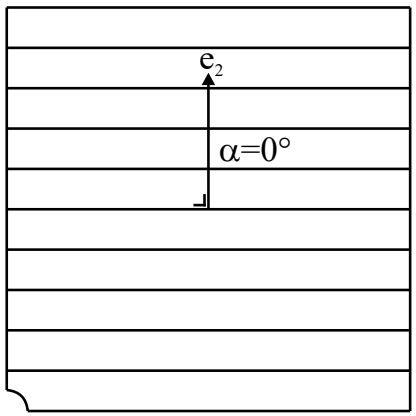


Geometry and initial conditions

A quarter of the gallery is used in order to decrease the numerical expenses:

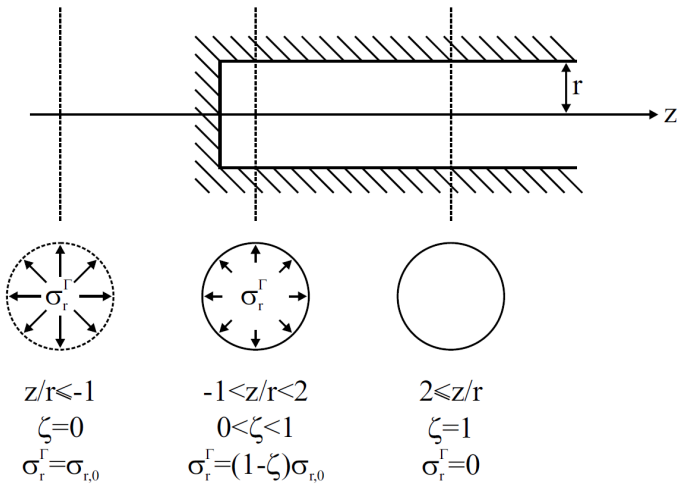




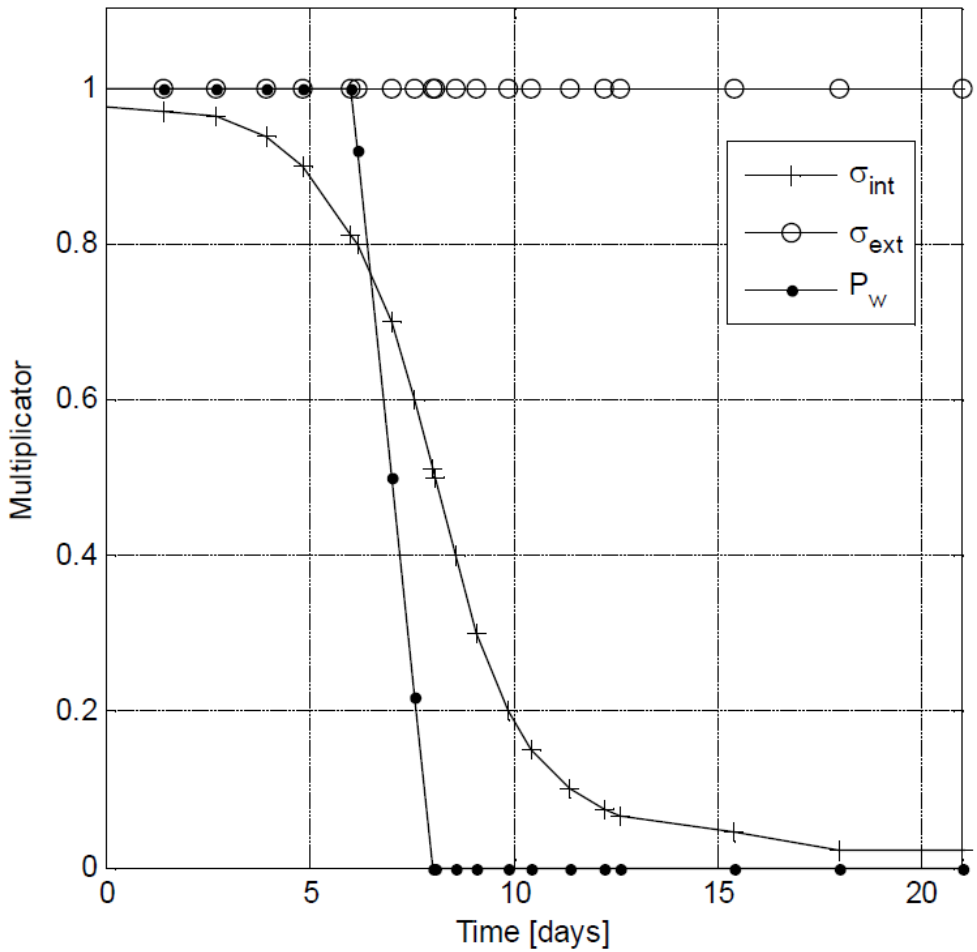


Excavation

Stress (MPa)	Condition 1	Condition 2
sigma v	12.0	12.7
sigma h	12.0	12.4
sigma H	15.6	16.1
pw	4.7	4.7



Excavation deconfining (Panet and Guenot, 1982)



Constitutive laws

Material laws with increasing complexity proposed:

1. Plasol: isotropic elastoplastic
2. Orthopla: anisotropic elastoplastic
3. Orthopla: anisotropic viscoplastic
4. Orthopla: +viscosity increase
5. Orthopla: +permeability evolution

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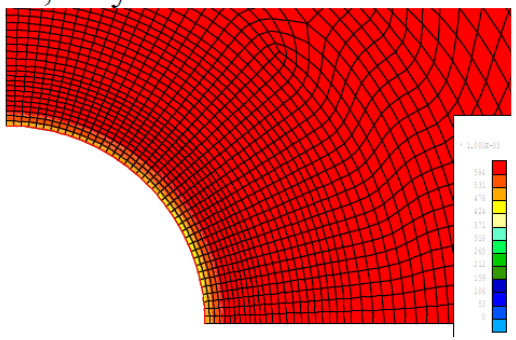
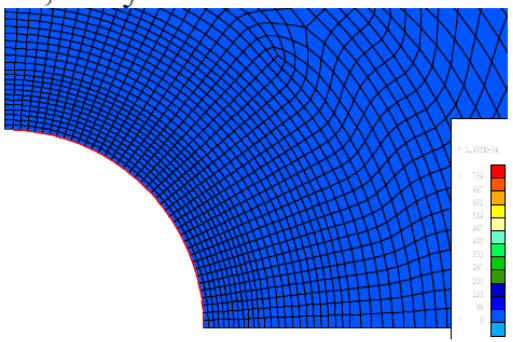
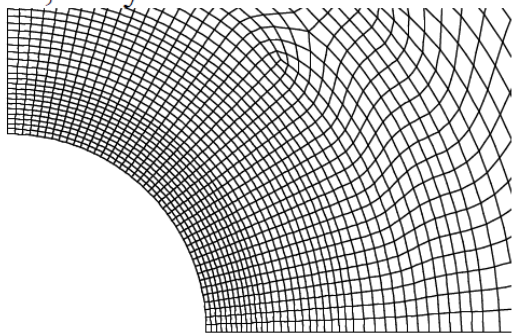
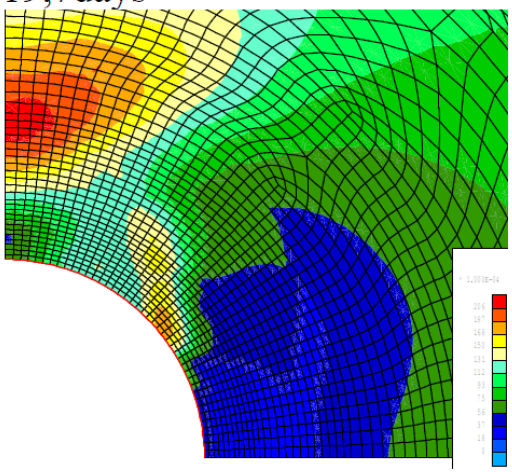
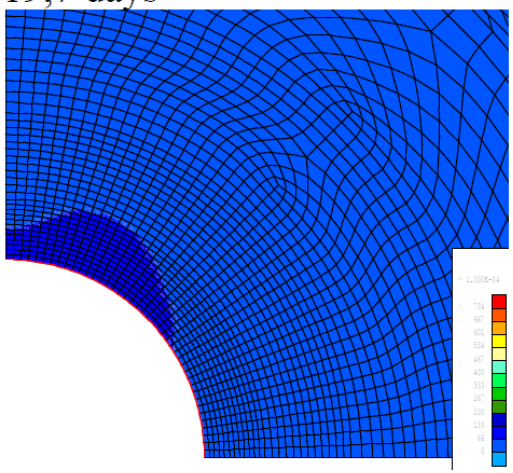
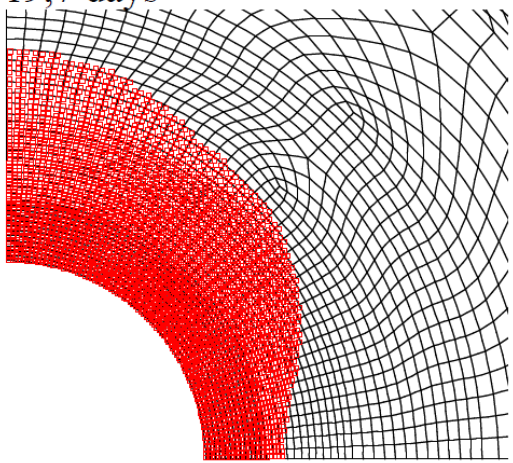
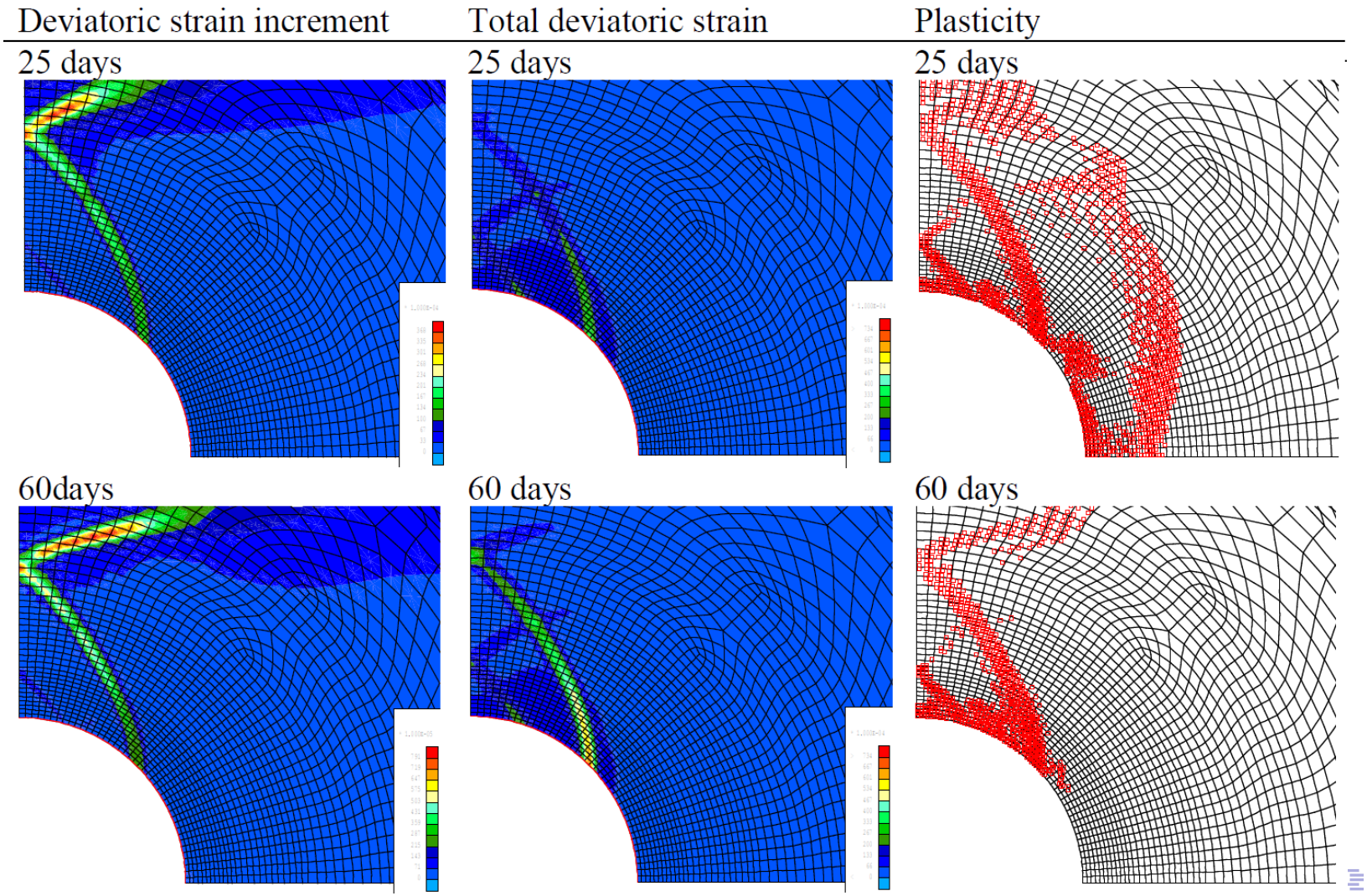
Results from laws 3 and 4 are presented in the next section

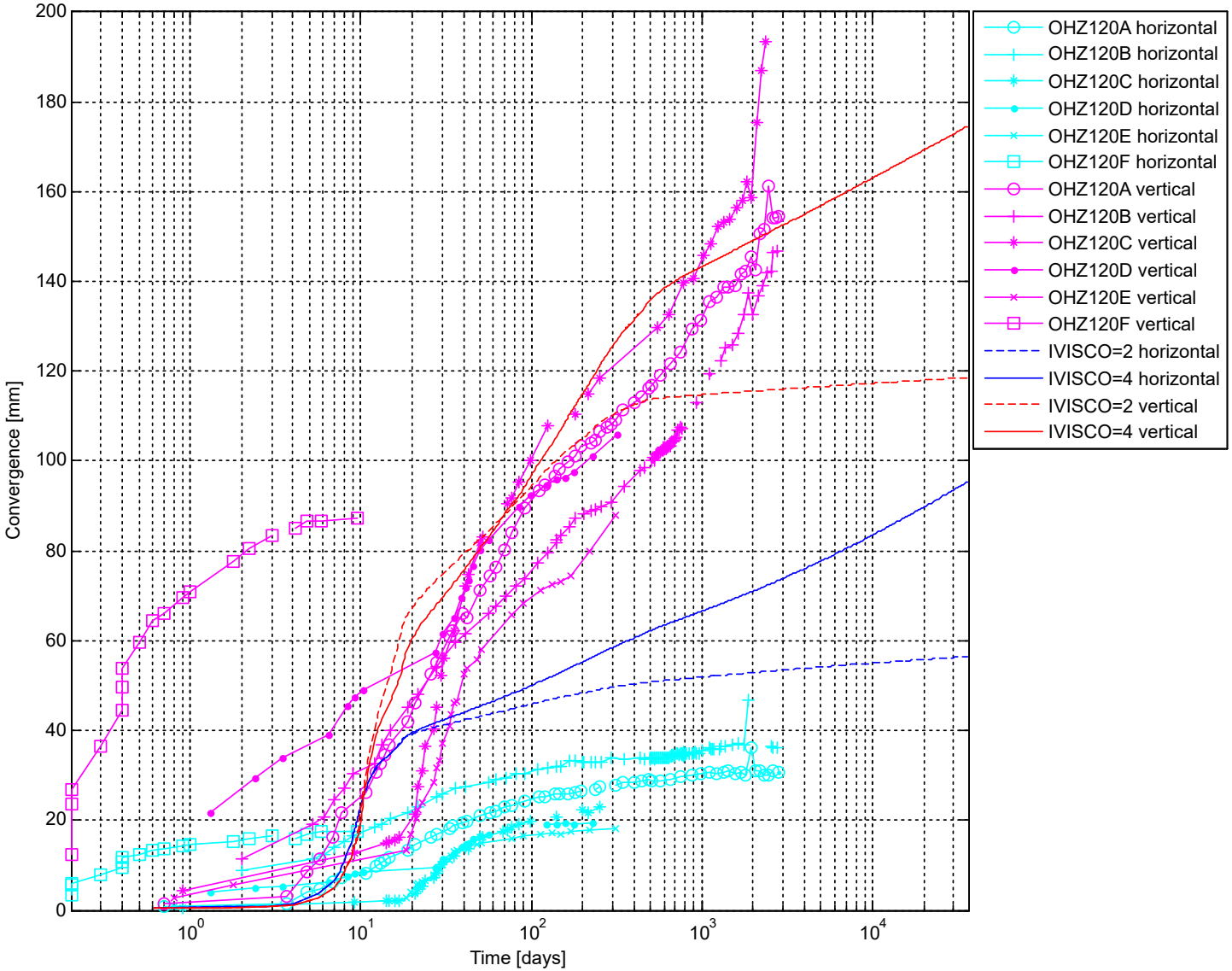
Outline

GED localization evolution: law 4 (+viscosity)

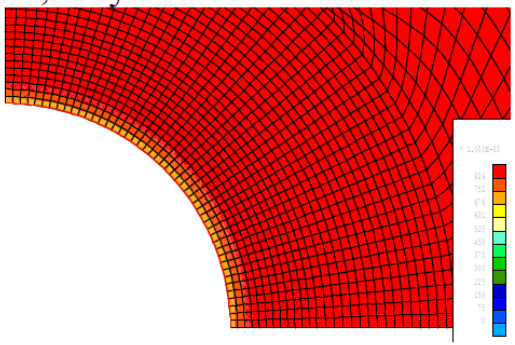
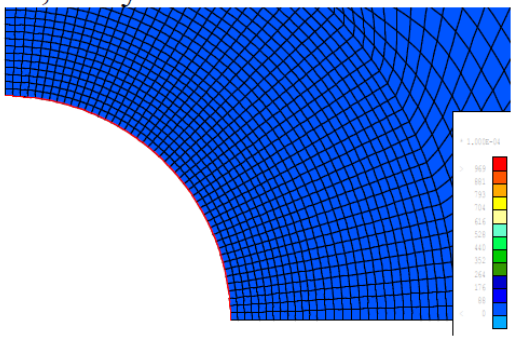
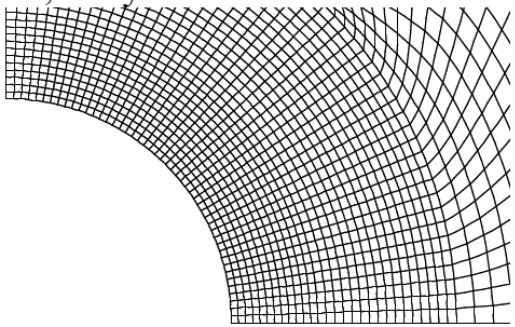
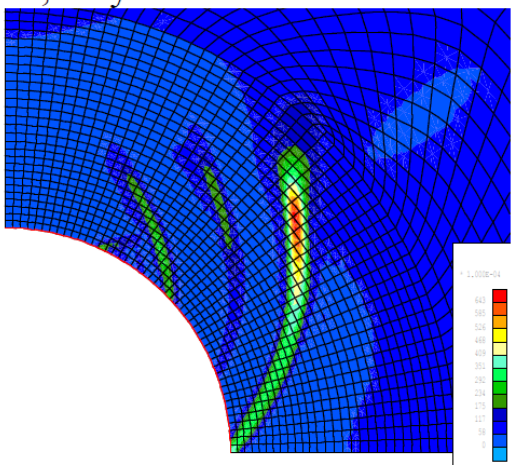
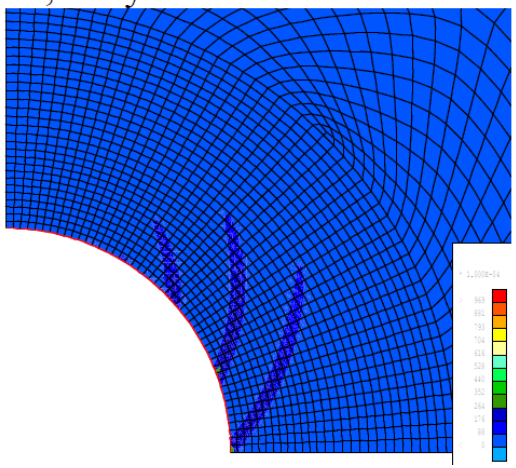
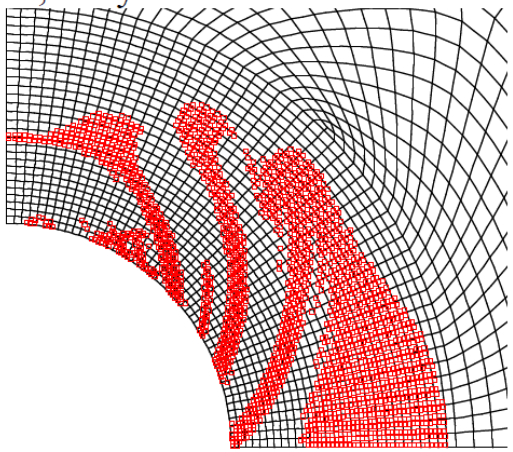
Deviatoric strain increment	Total deviatoric strain	Plasticity
13,8days	13,8 days	13,8 days
		
19,7days	19,7 days	19,7 days
		

GED localization evolution: law 4 (+viscosity)

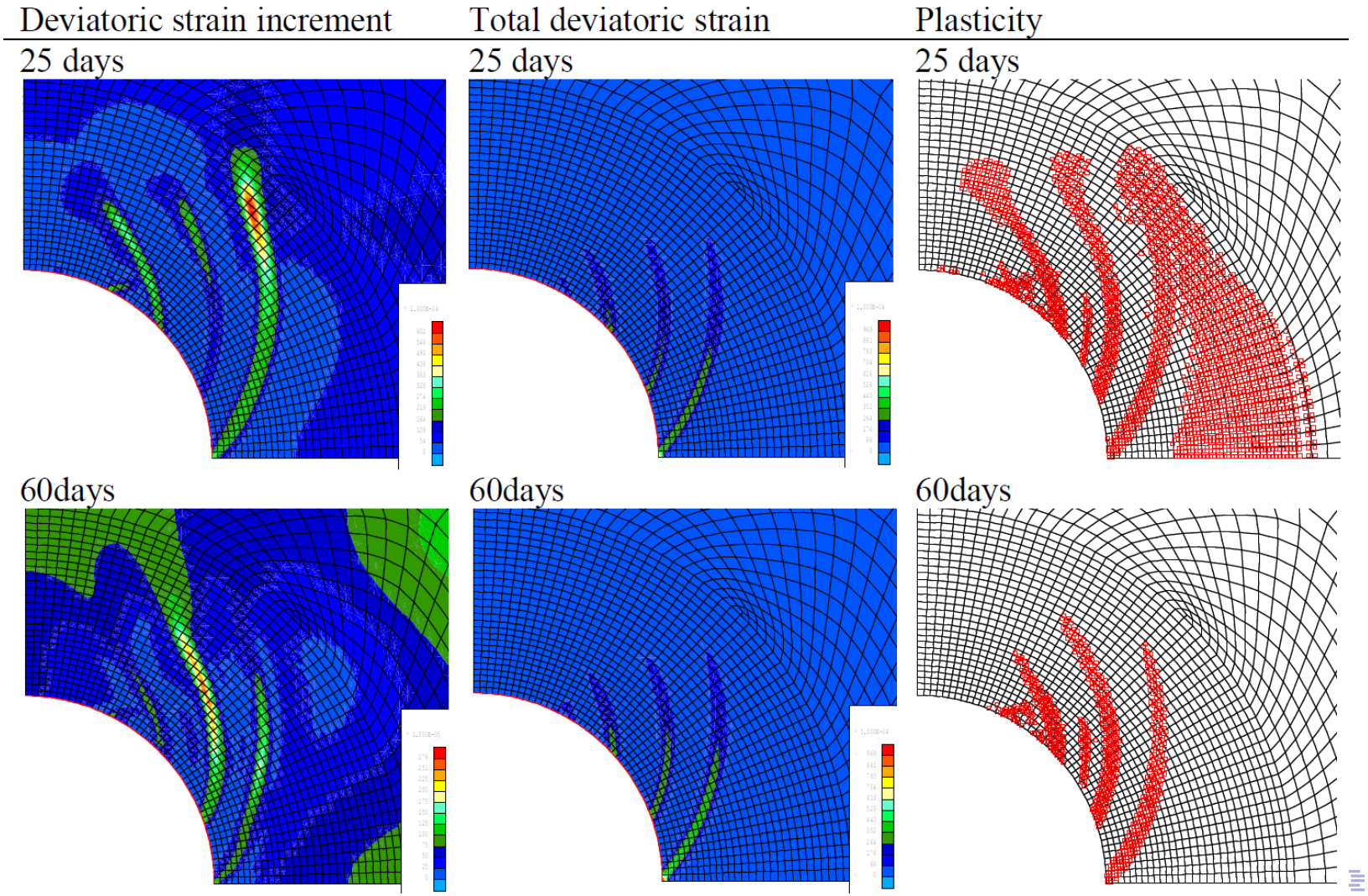


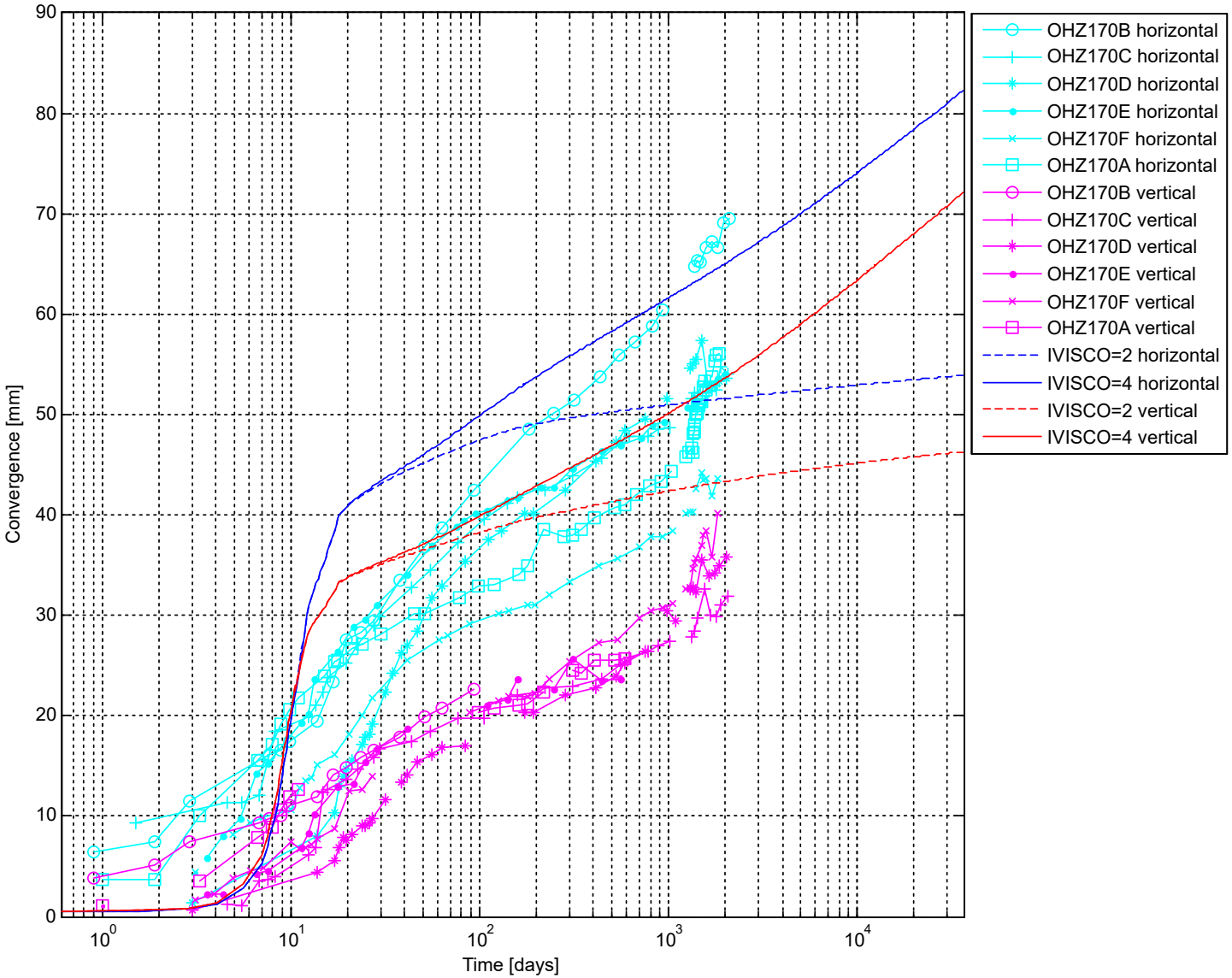

Convergence [mm]
Time [days]
OHZ120A horizontal
OHZ120B horizontal
OHZ120C horizontal
OHZ120D horizontal
OHZ120E horizontal
OHZ120F horizontal
OHZ120A vertical
OHZ120B vertical
OHZ120C vertical
OHZ120D vertical
OHZ120E vertical
OHZ120F vertical
IVISCO=2 horizontal
IVISCO=4 horizontal
IVISCO=2 vertical
IVISCO=4 vertical

GCS localization evolution: law 4 (+viscosity)

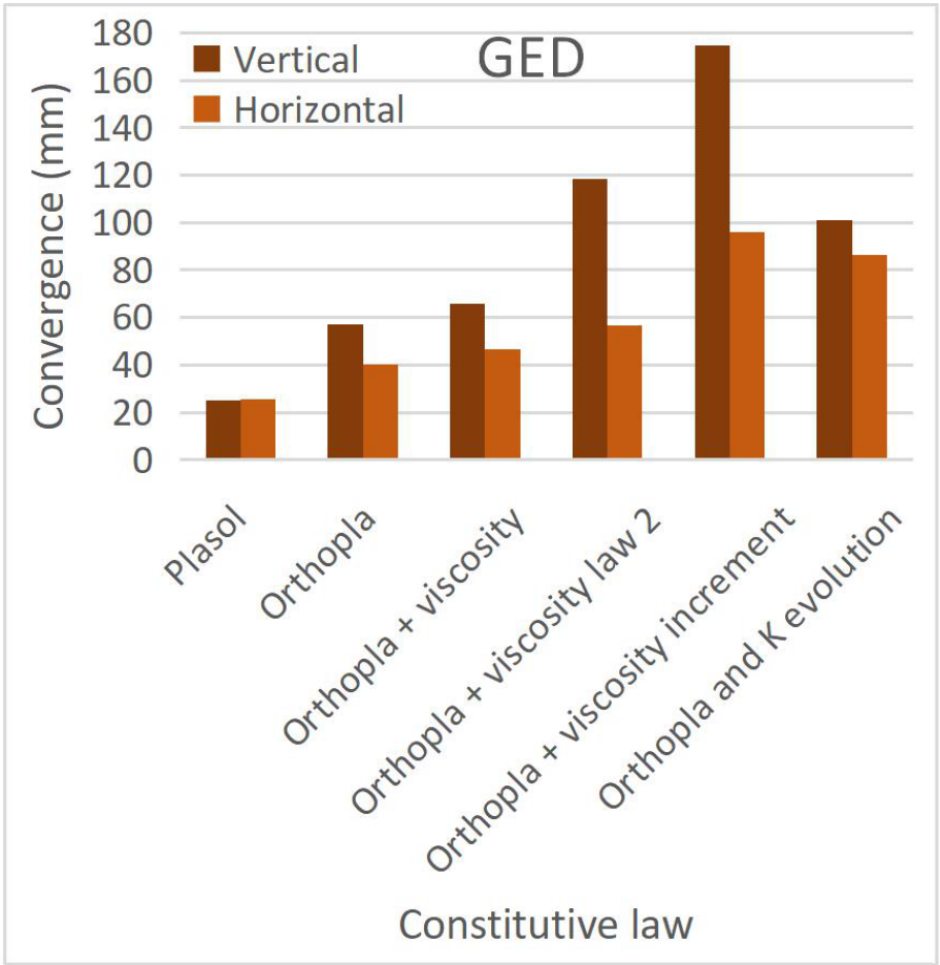
Deviatoric strain increment	Total deviatoric strain	Plasticity
13,8days	13,8 days	13,8 days
		
19,7days	19,7 days	19,7 days
		

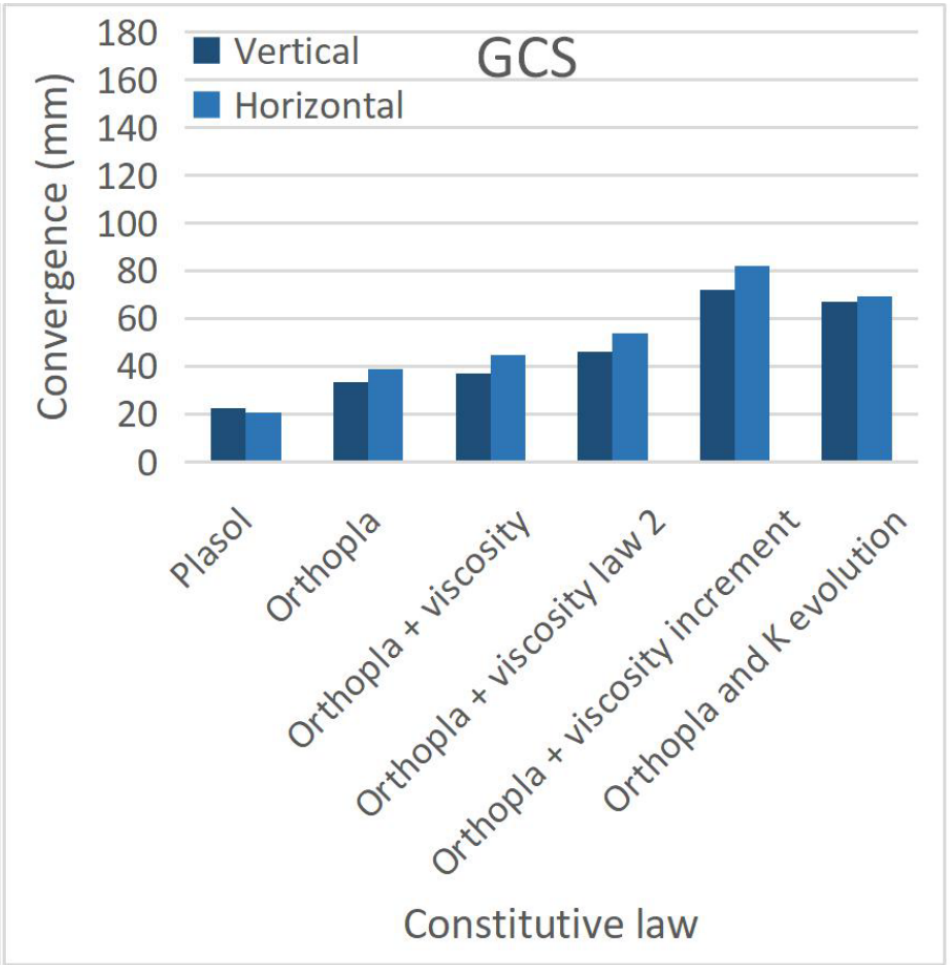
GCS localization evolution: law 4 (+viscosity)




Convergence [mm]
Time [days]
OHZ170B horizontal
OHZ170C horizontal
OHZ170D horizontal
OHZ170E horizontal
OHZ170F horizontal
OHZ170A horizontal
OHZ170B vertical
OHZ170C vertical
OHZ170D vertical
OHZ170E vertical
OHZ170F vertical
OHZ170A vertical
IVISCO=2 horizontal
IVISCO=4 horizontal
IVISCO=2 vertical
IVISCO=4 vertical

Convergence summary for 100 years





Outline

Conclusions

- The galleries are stable for a period of 100 years
- Convergences up to 174mm (GED) and 82mm (GCS)
- The constitutive law 4 (+ viscosity) gives the best fit
- Different localizations modes give important differences

Thanks !