Impact of fracture sealing on their hydraulic and mechanical properties

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Background

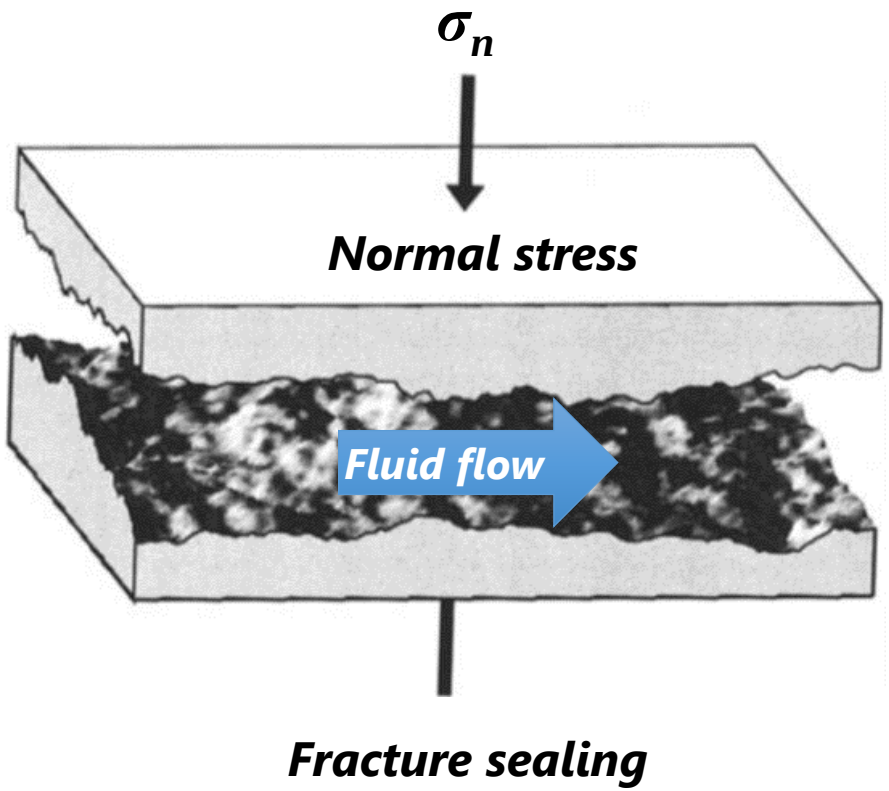


Fig.1 Concept sketch of fracture closure (Hansen et al, 2000)

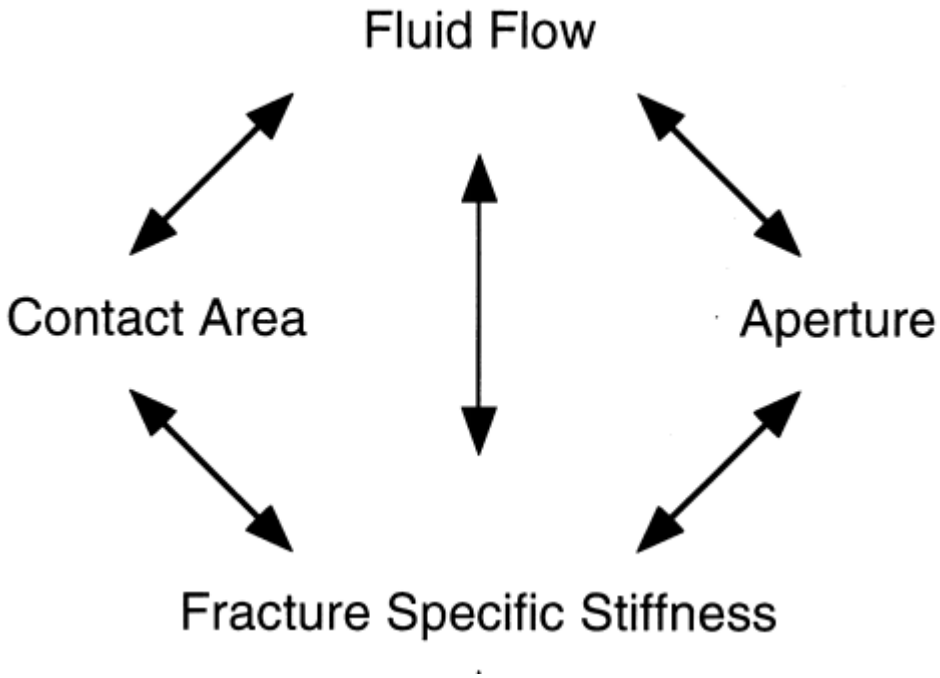


Fig.2 Interaction of fracture specific stiffness, fluid flow through Fracture geometry (Pyrak-Nolte & Morris, 2000)

Synthetic fault generation

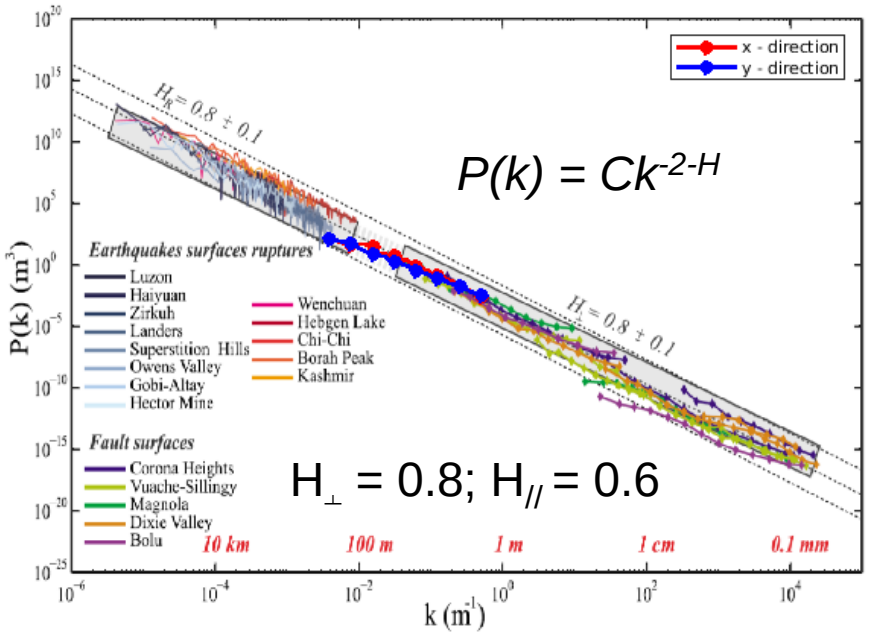


Fig.3 Self-affine fault surfaces generation following field measurements (Candela et al, 2012)

Two rough surfaces facing each other

Mechanical closure: plastic rheology (Ac < 20%)

Sealing closure: evenly mineral deposit (Ac > 20%)

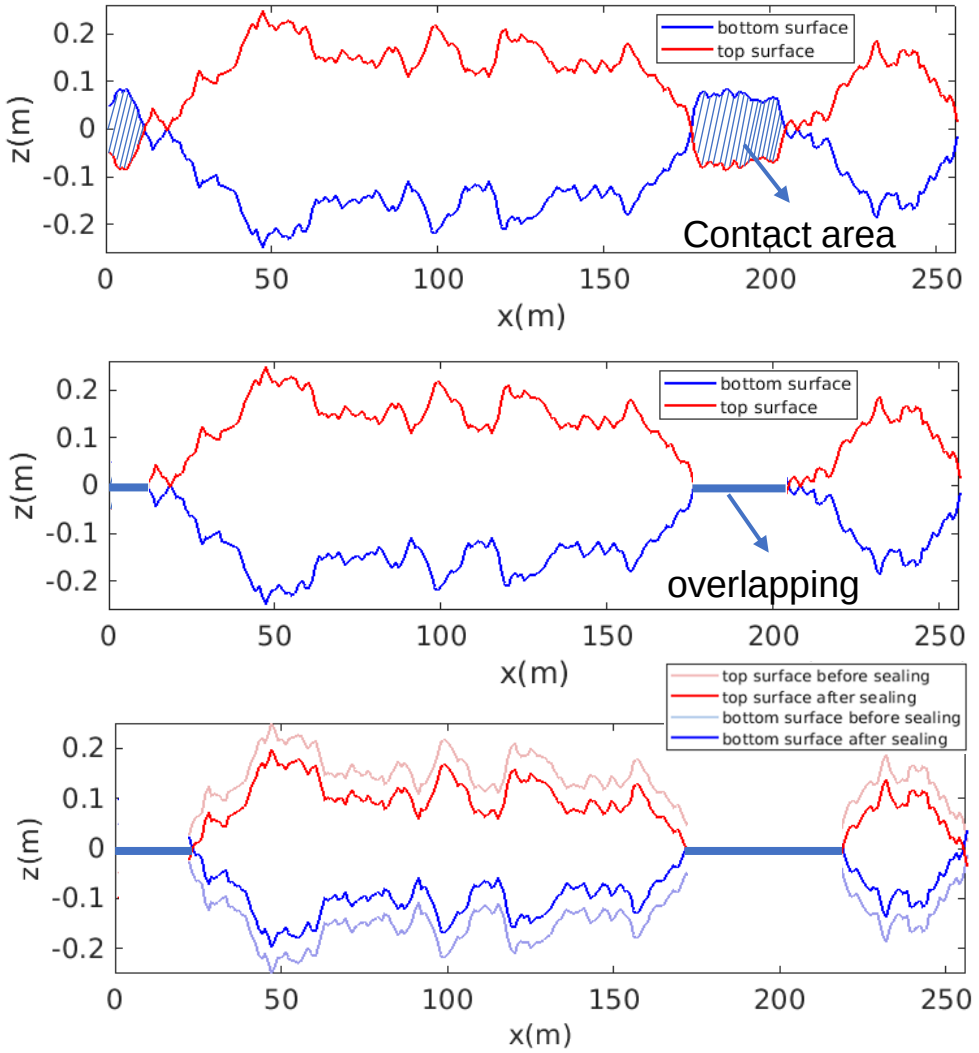


Fig.4 Sketch of constructing fracture geometry (side view facing y-direction)

Synthetic fault generation

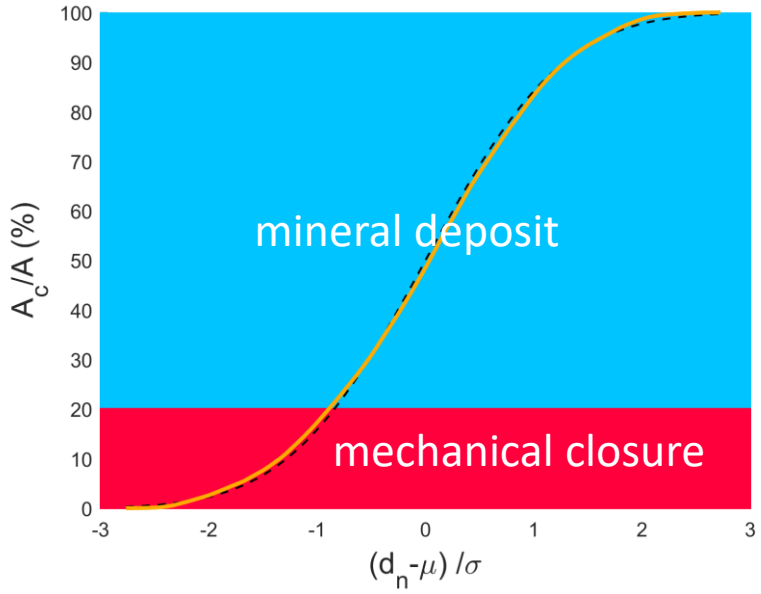


Fig.5 fracture closure process: contact area as a function of normalized imposed displacement

case	Contact area (%)	Average aperture (m)
c0	14.3	0.212
c1	20.0	0.189
c2	25.8	0.168
c3	32.2	0.144
c4	39.8	0.122
c5	47.9	0.102
c6	55.7	0.082
c7	65.0	0.063
c8	75.2	0.042
c9	85.1	0.024

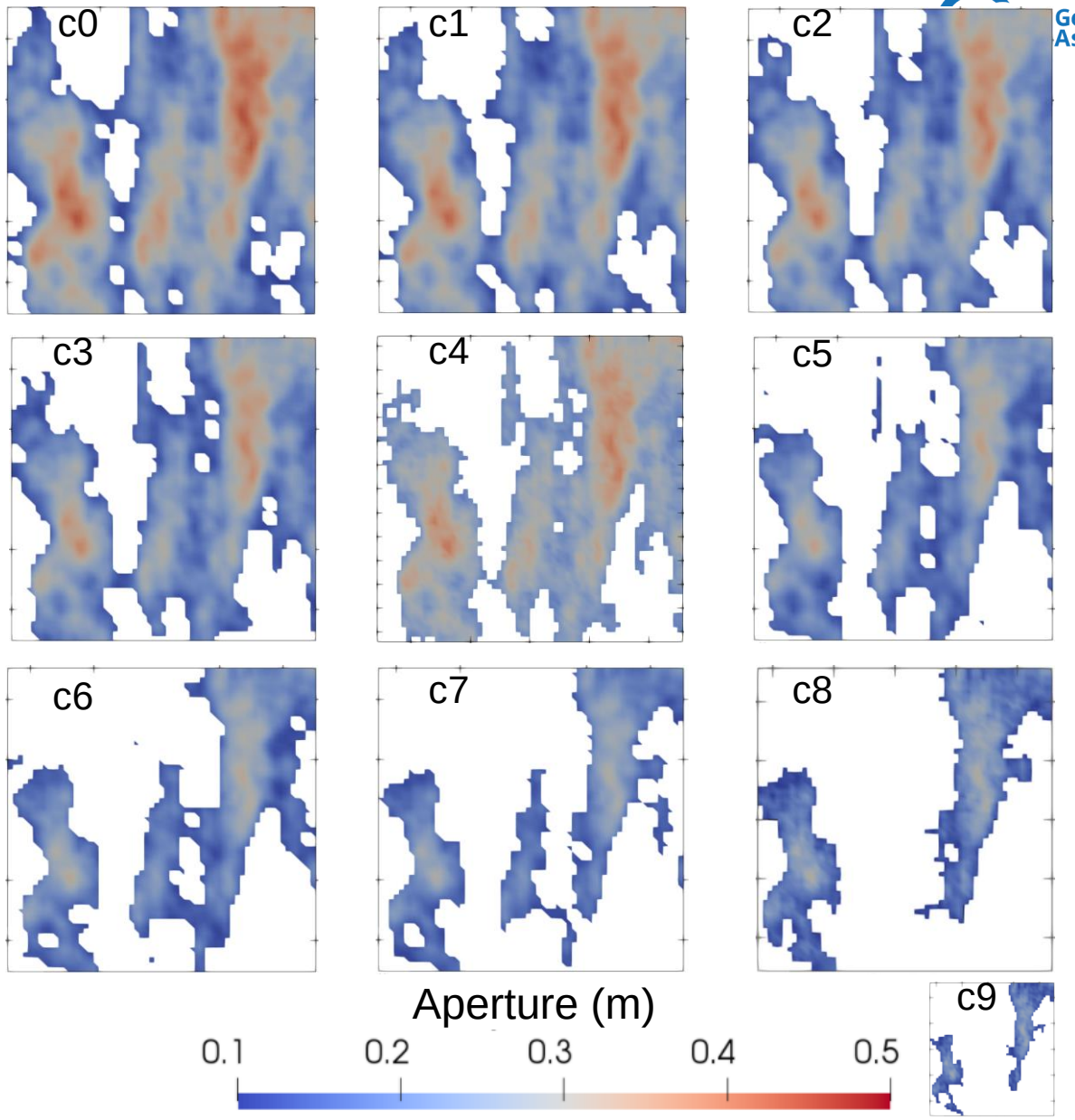


Fig.6 Stepwise closing the fracture owing to mechanical and sealing

Mesh generation and model setup

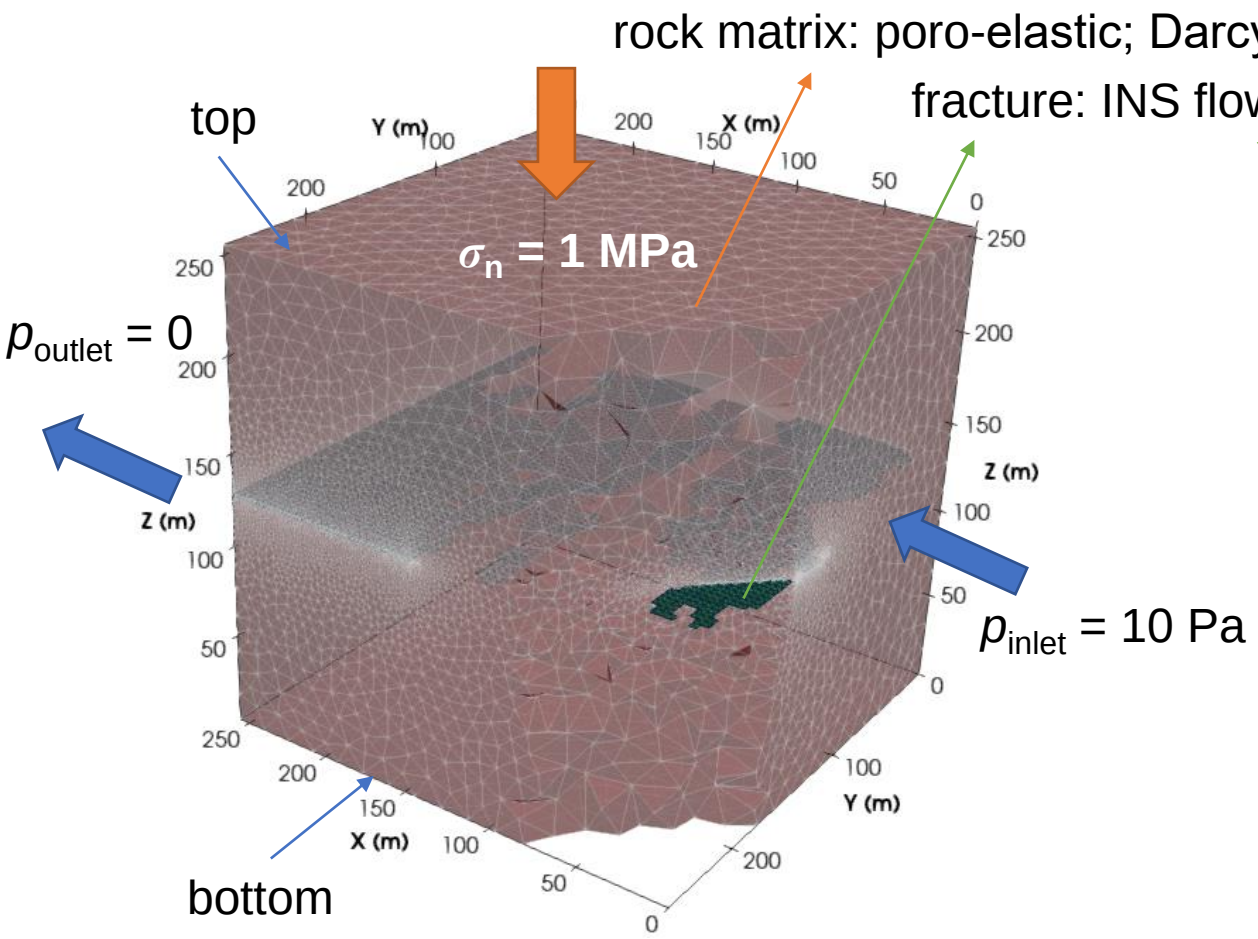
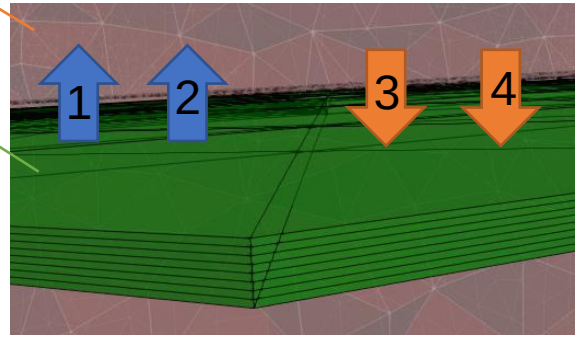


Fig.7 3D mesh of the fracture rock matrix system

Boundary conditions:
v = 0 for rock and fault except inlet and outlet
u = 0 for all lateral borders and the bottom



1: fluid pressure as flow boundary for rock
2: fluid pressure as stress boundary for rock
3: fluid velocity as flow boundary for fault
4: displacement as boundary for fault

Initial conditions:
$p_0 = 0$; $u_0 = 0$ for rock matrix
$p_0 = 0$; $v_0 = 0$ for fault

GOLEM
A MOOSE-based application
http://doi.org/10.5281/zenodo.999401

Results/Implications

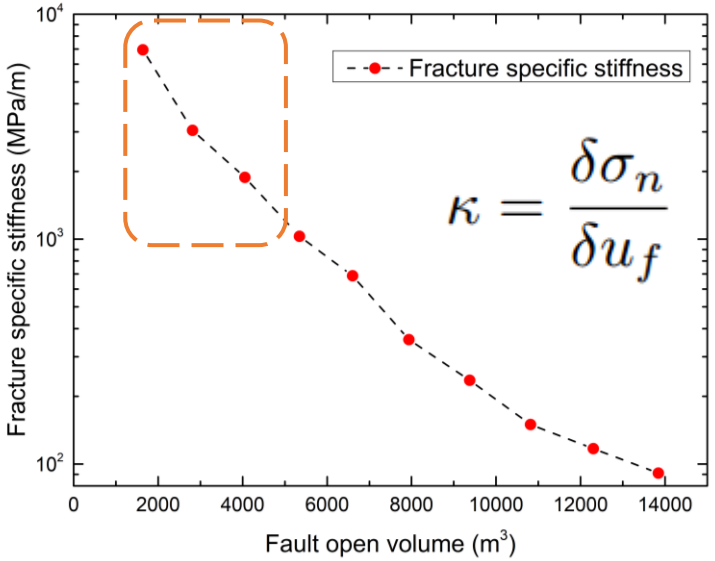


Fig.8 Fracture specific stiffness as a function of fault volume

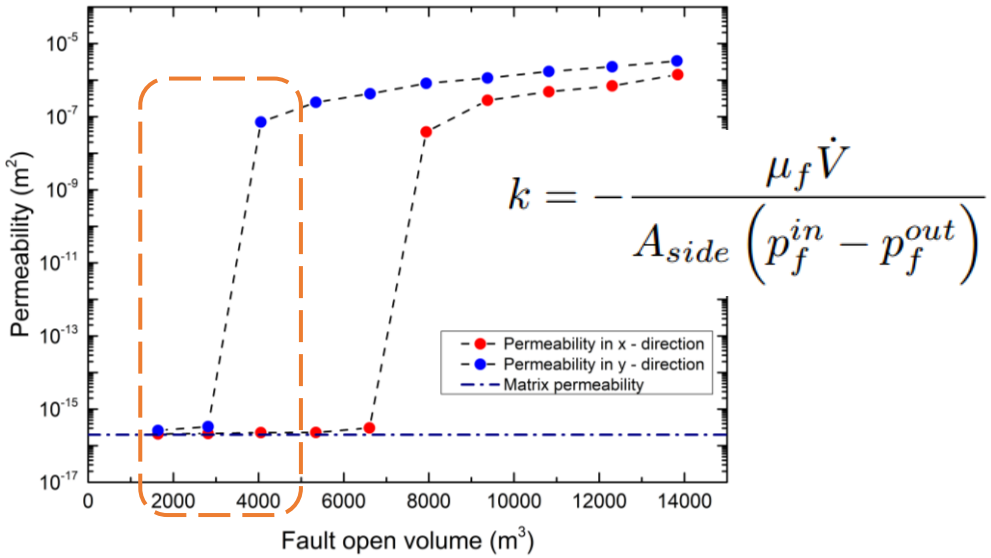


Fig.9 Permeability evolution as a function of fault volume

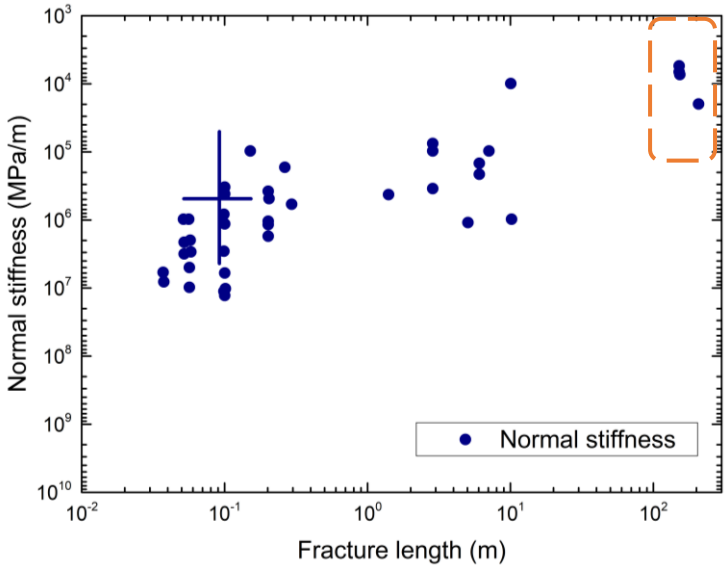


Fig.10 Fracture normal stiffness values taken from the literature (Hobby & Worthington, 2012)

- Fracture permeability and stiffness are strongly depends on the degree of sealing;
- Fracture specific stiffness can be used to quantify the degree of fracture sealing;
- Successful chemical treatment requires large fracture stiffness or high anisotropy permeability behavior.

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Thanks !

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