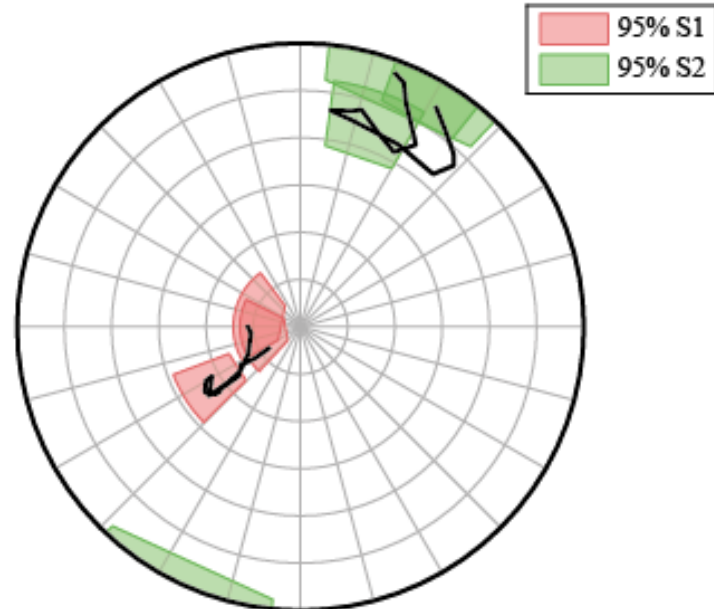
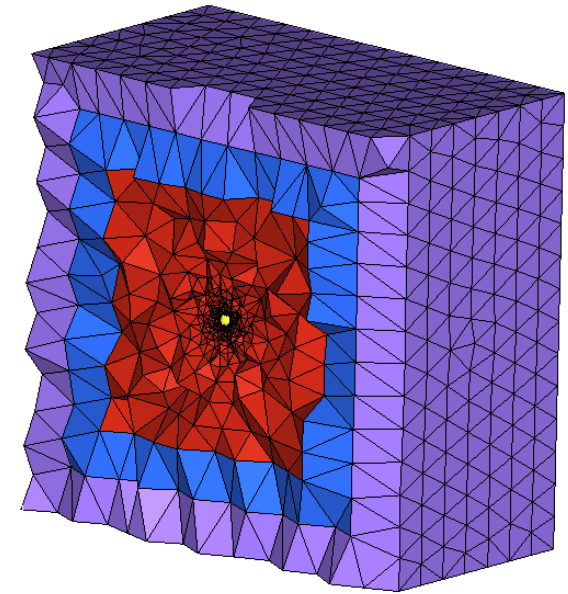


Injection induced stress rotations and their effect on induced seismicity



Martínez-Garzón et al. 2013



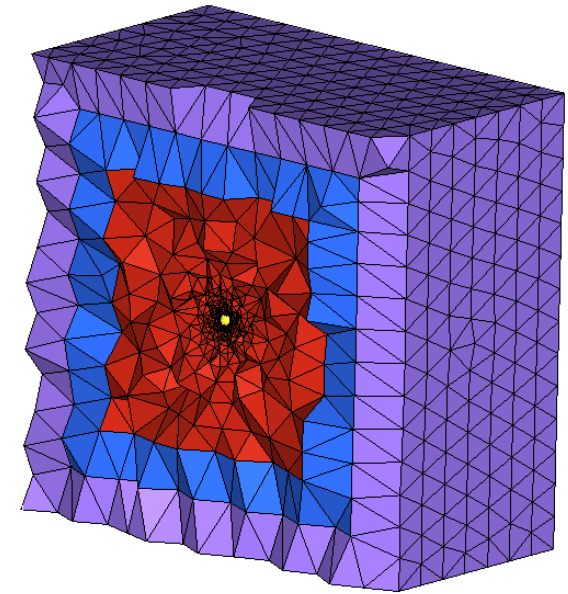
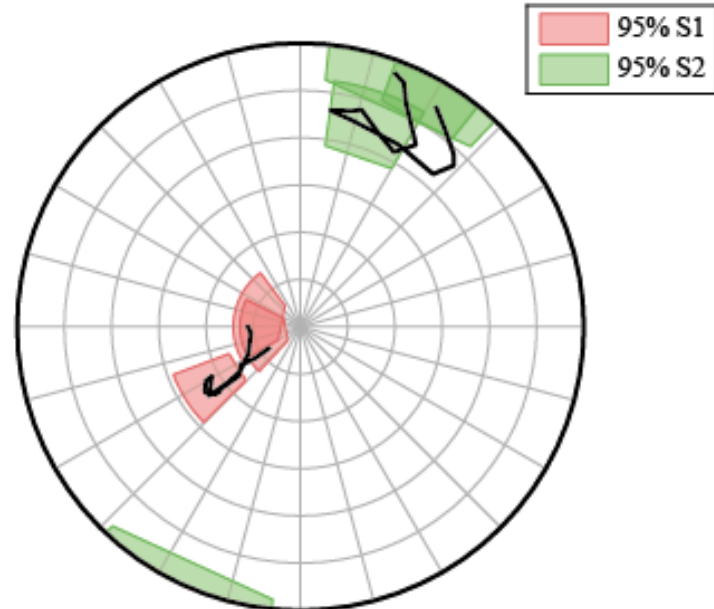
M. Ziegler^{1,2}, O. Heidbach¹, A. Zang^{1,2}

1 GFZ German Research Centre for Geosciences

2 University of Potsdam

Schatzalp Workshop on Induced Seismicity – 14 to 17 March 2017

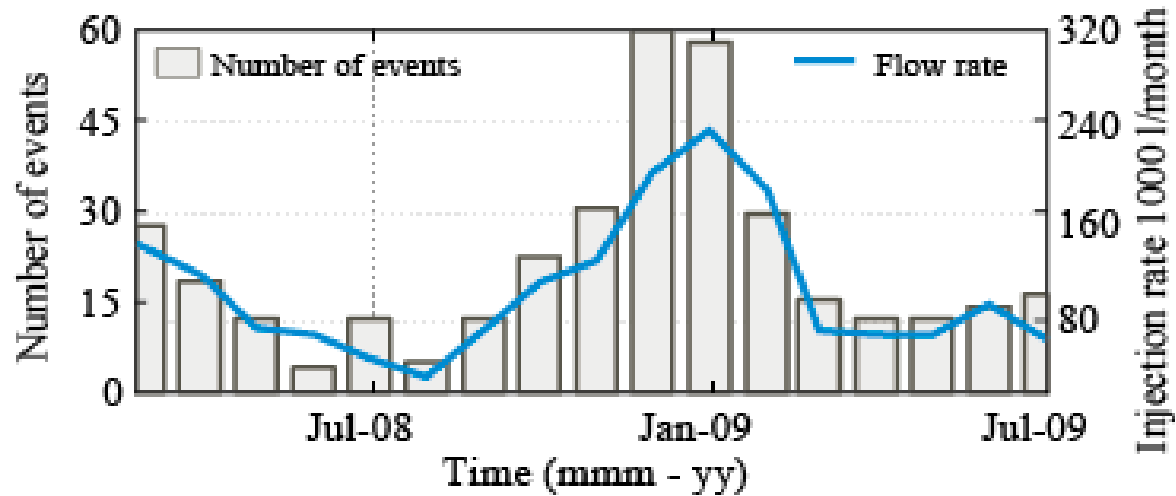
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Martínez-Garzón et al. 2013

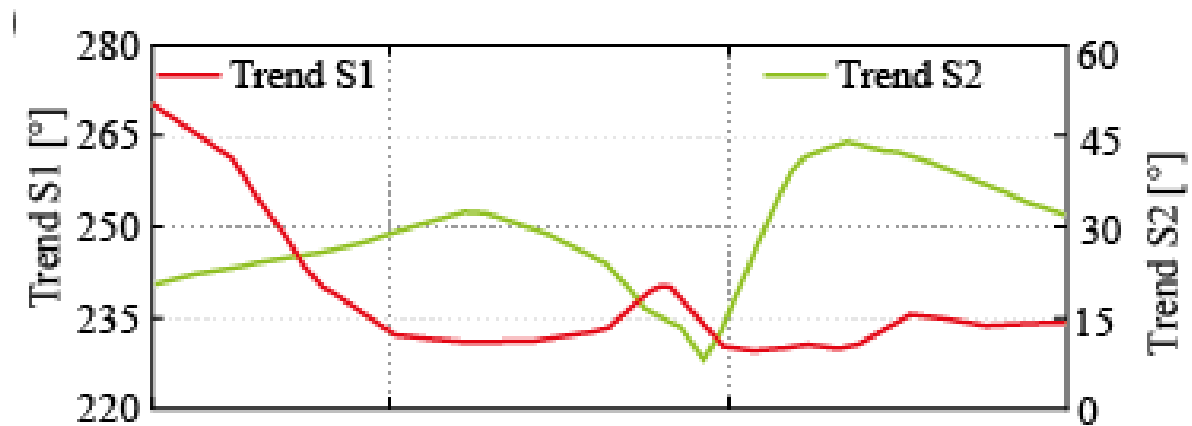
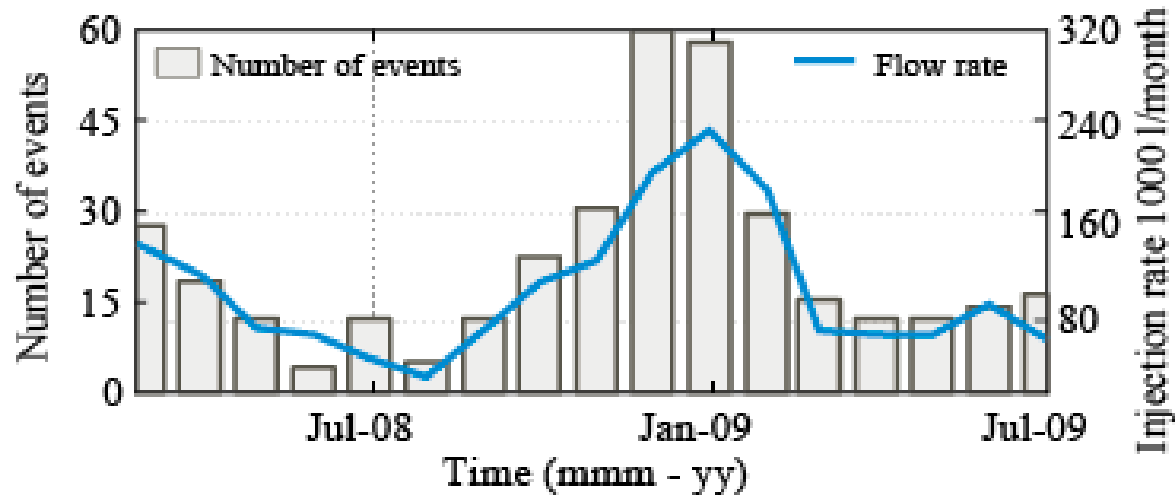
1. What are the key driving factors for a stress rotation?
2. What can we learn from stress rotations?

Stress rotations



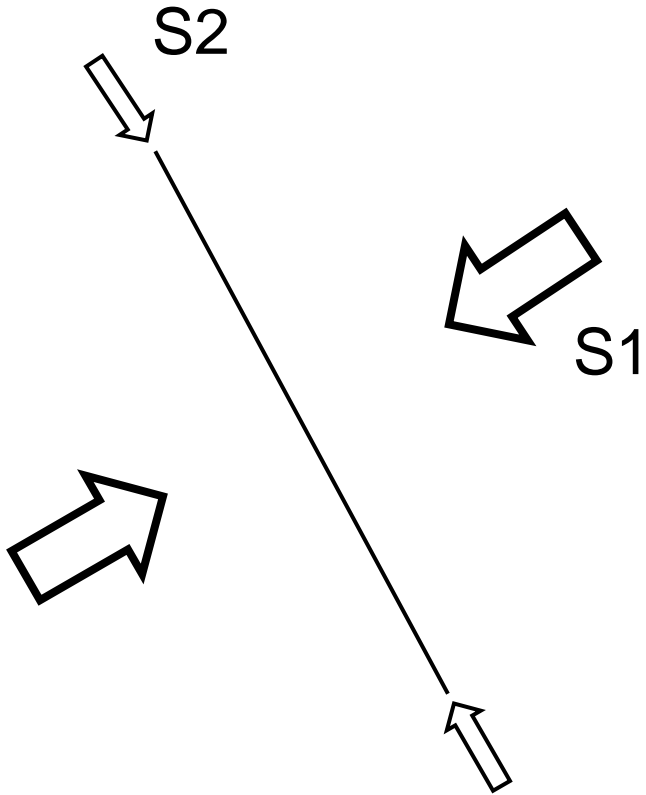
Martínez-Garzón et al. 2013

Stress rotations

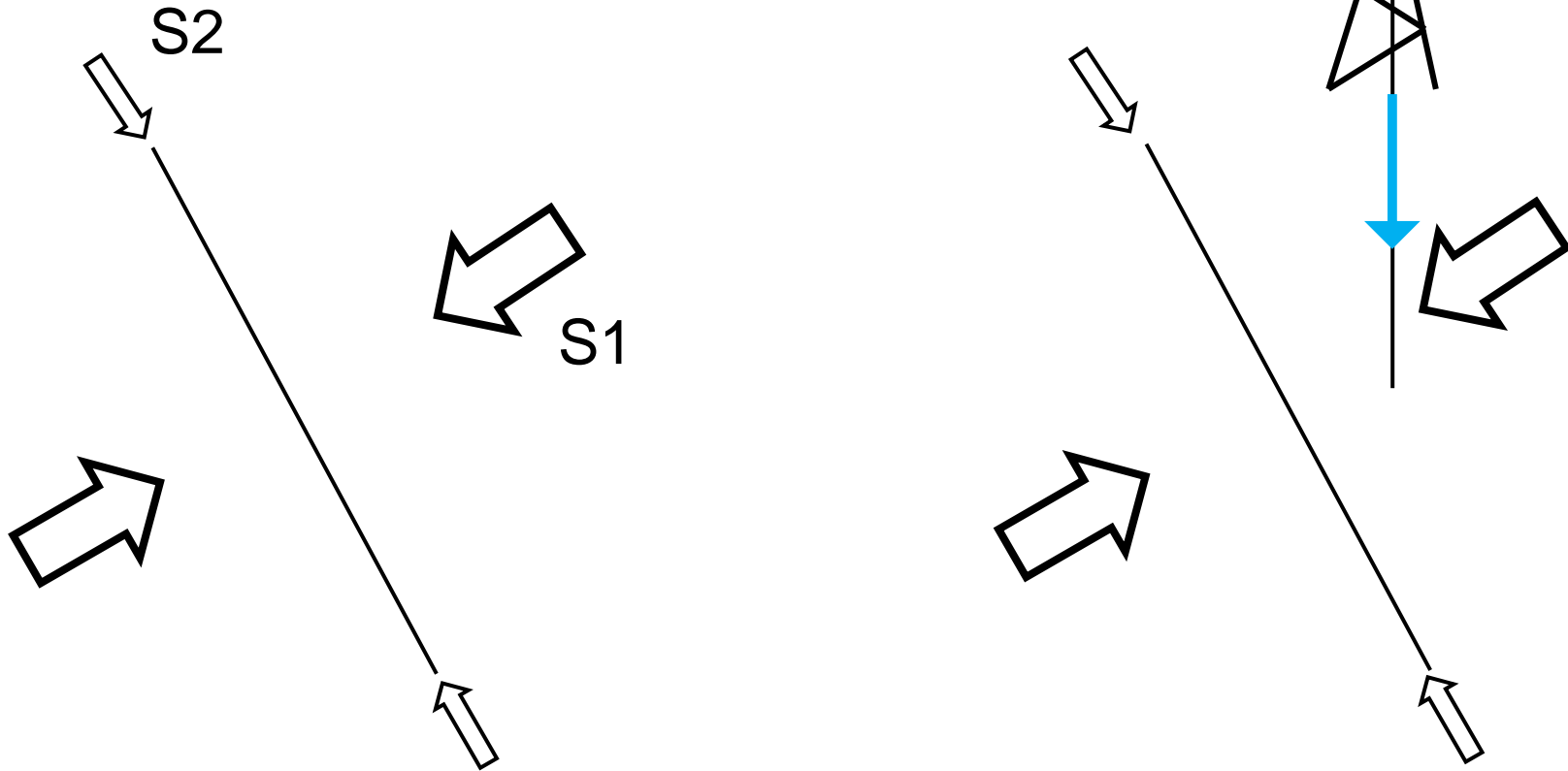


Martínez-Garzón et al. 2013

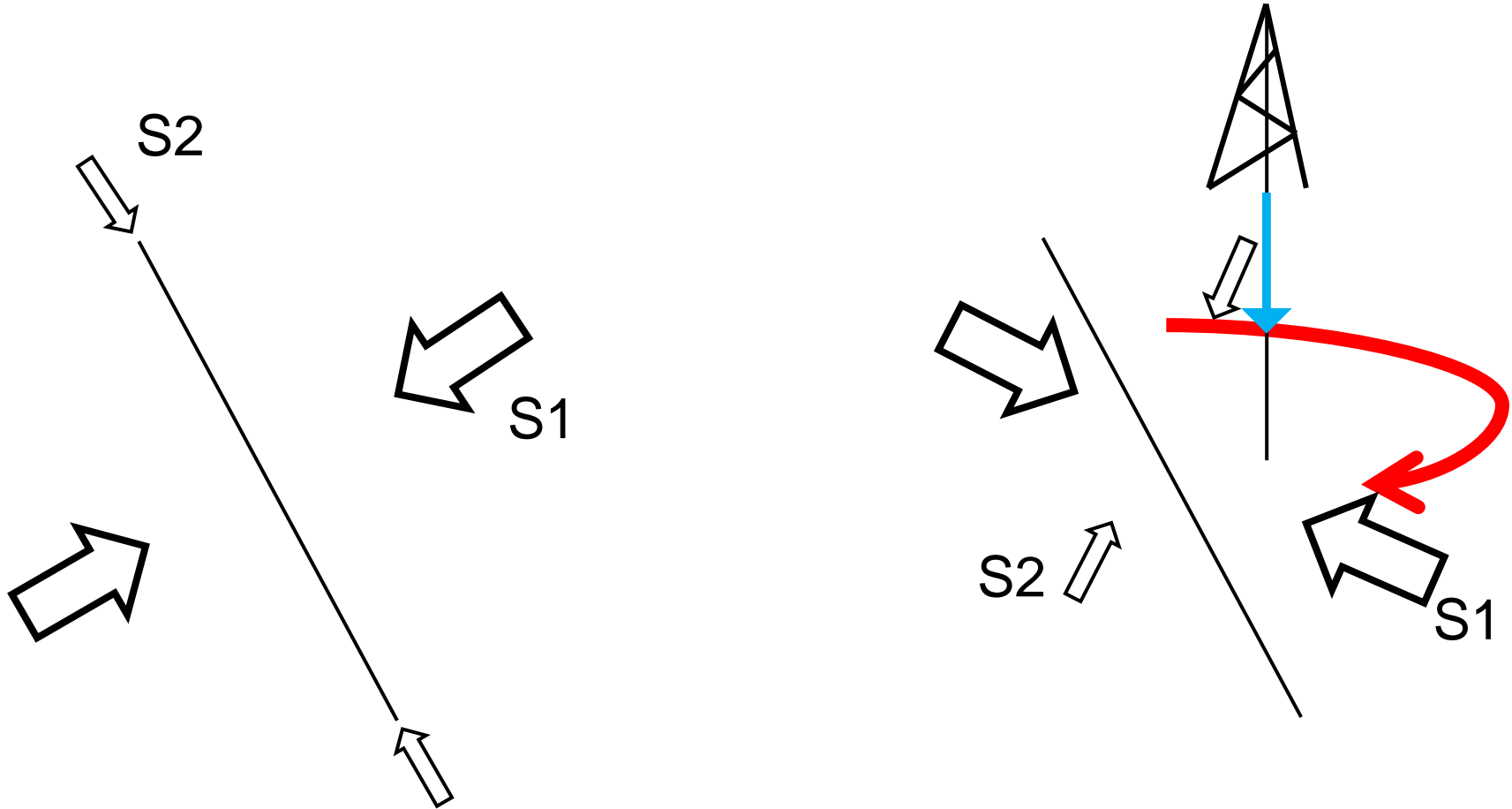
Stress rotation and faults



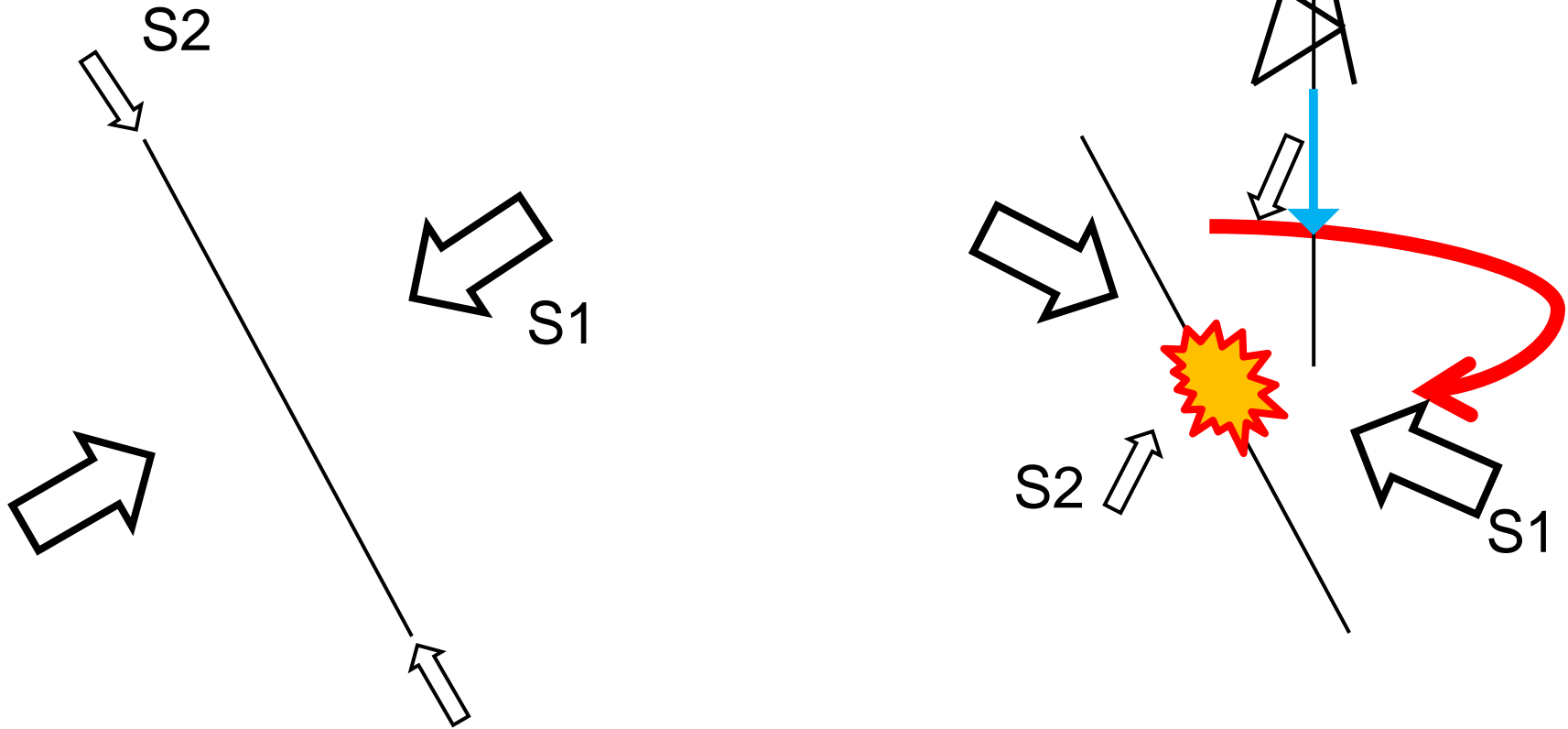
Stress rotation and faults



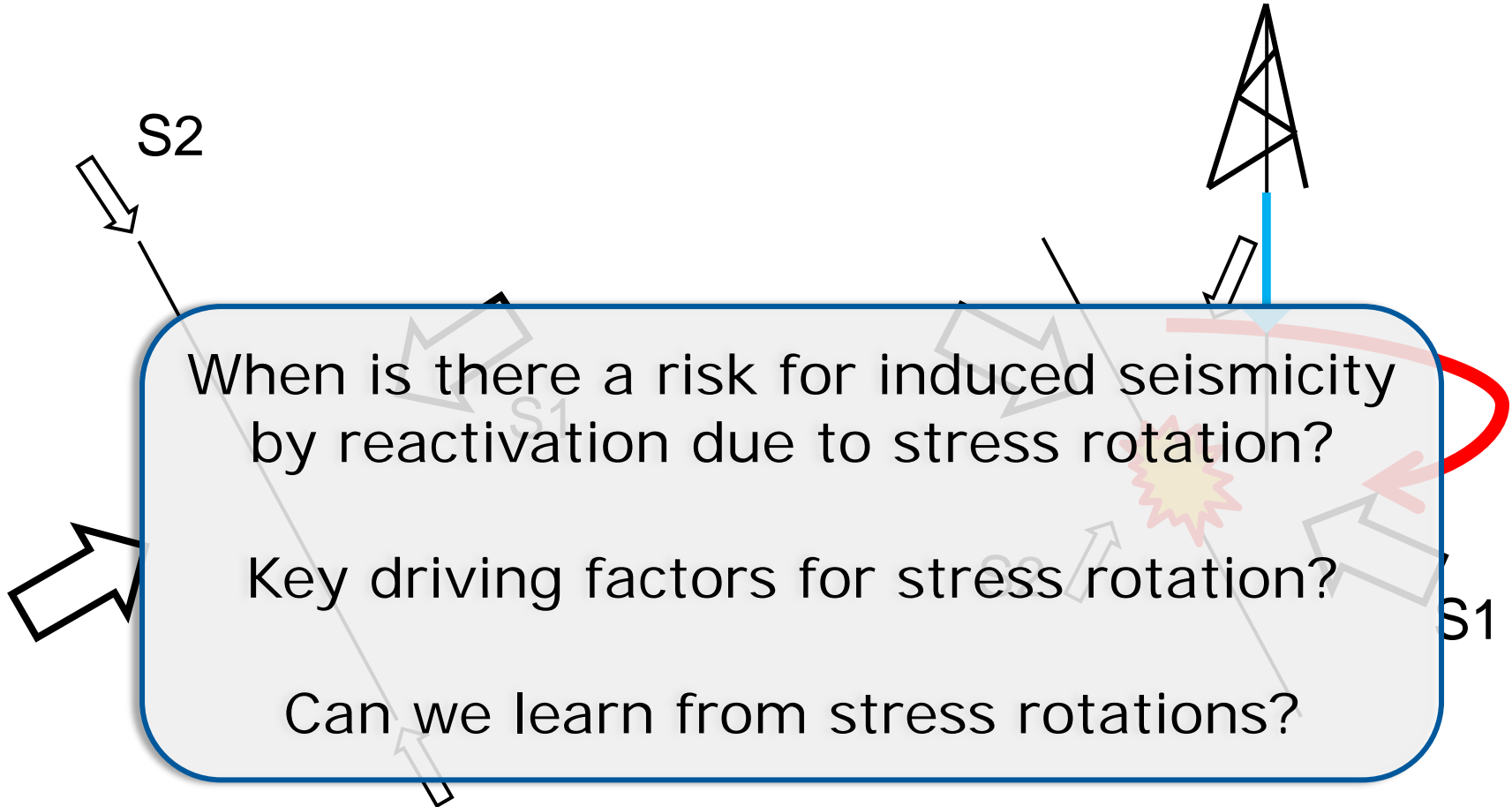
Stress rotation and faults



Stress rotation and faults

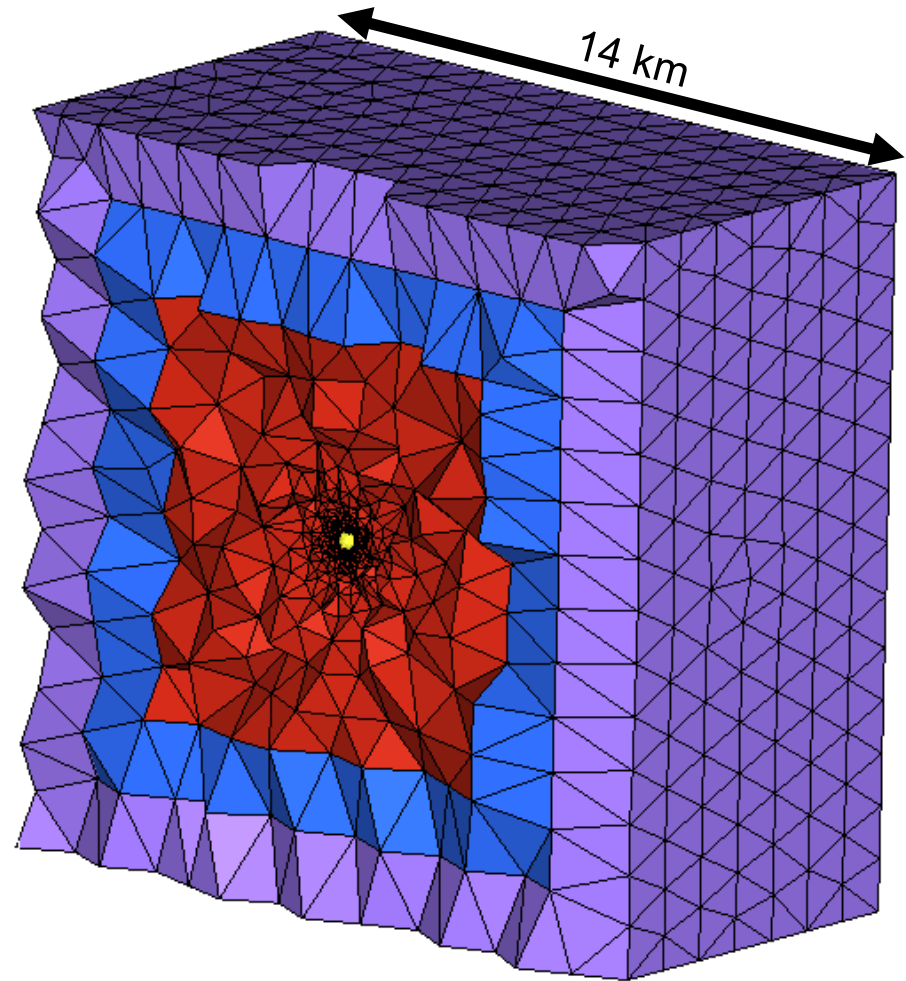


Stress rotation and faults



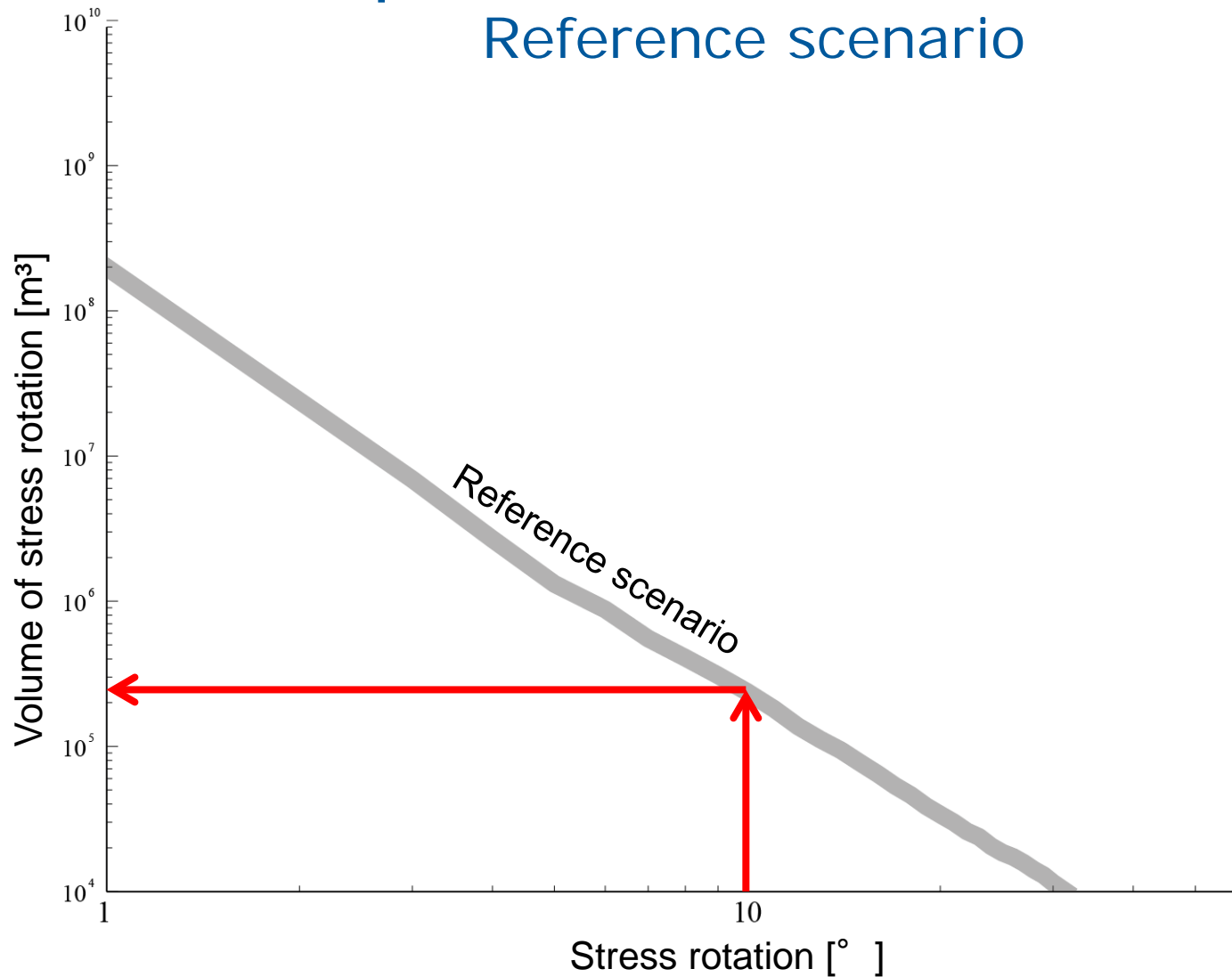
Thermo-Hydro-Mechanical Model

- Fully coupled
- Reference scenario:
 - 100 l/s injection at a single point
 - 12 months injection
 - $\Delta T = 50\text{K}$
 - $S_1\text{-}S_3 = 2.8\text{ MPa}$
 - Porosity: 2%
 - Permeability: 10^{-14} m^2



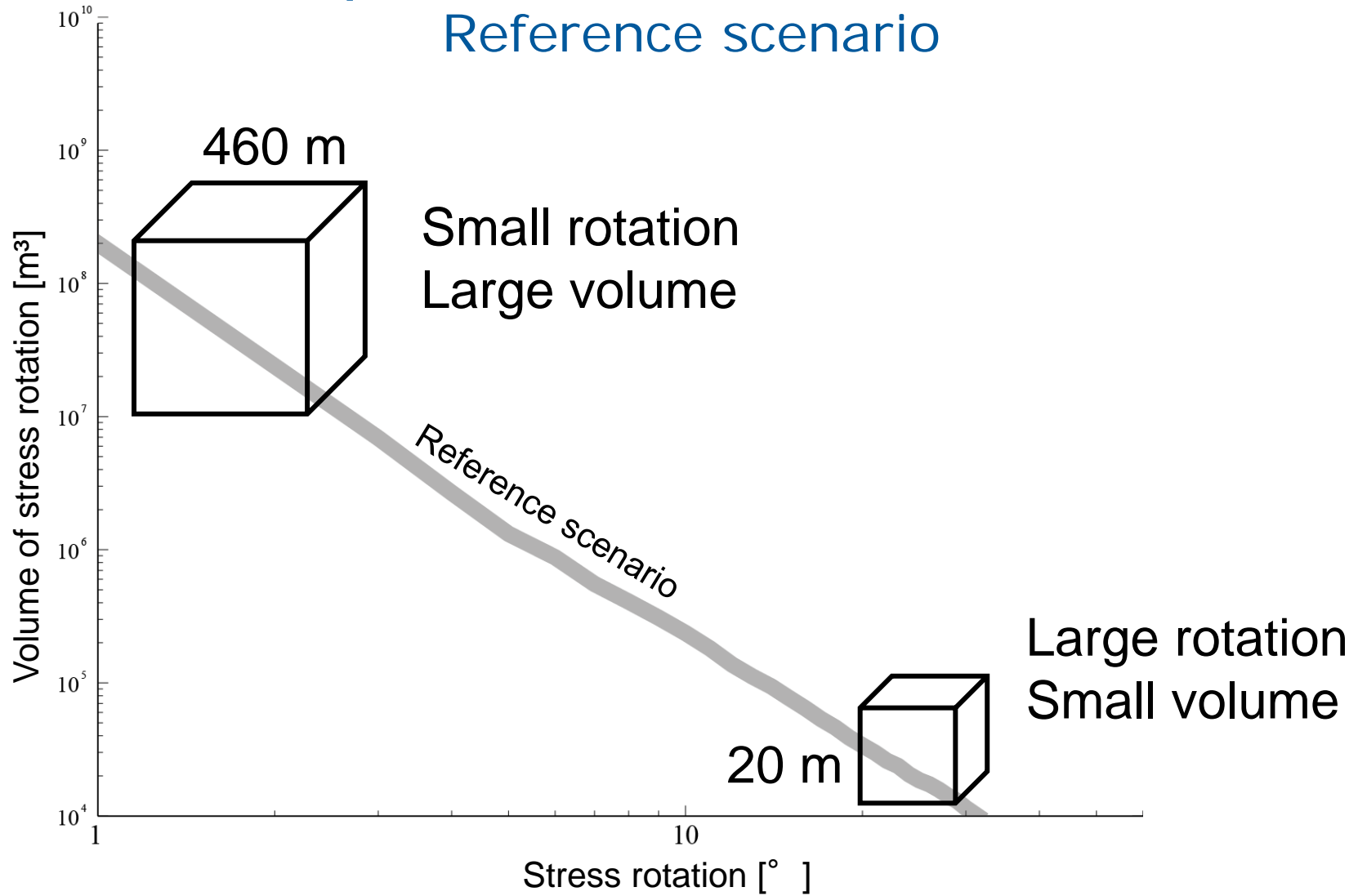
Representation of results

Reference scenario

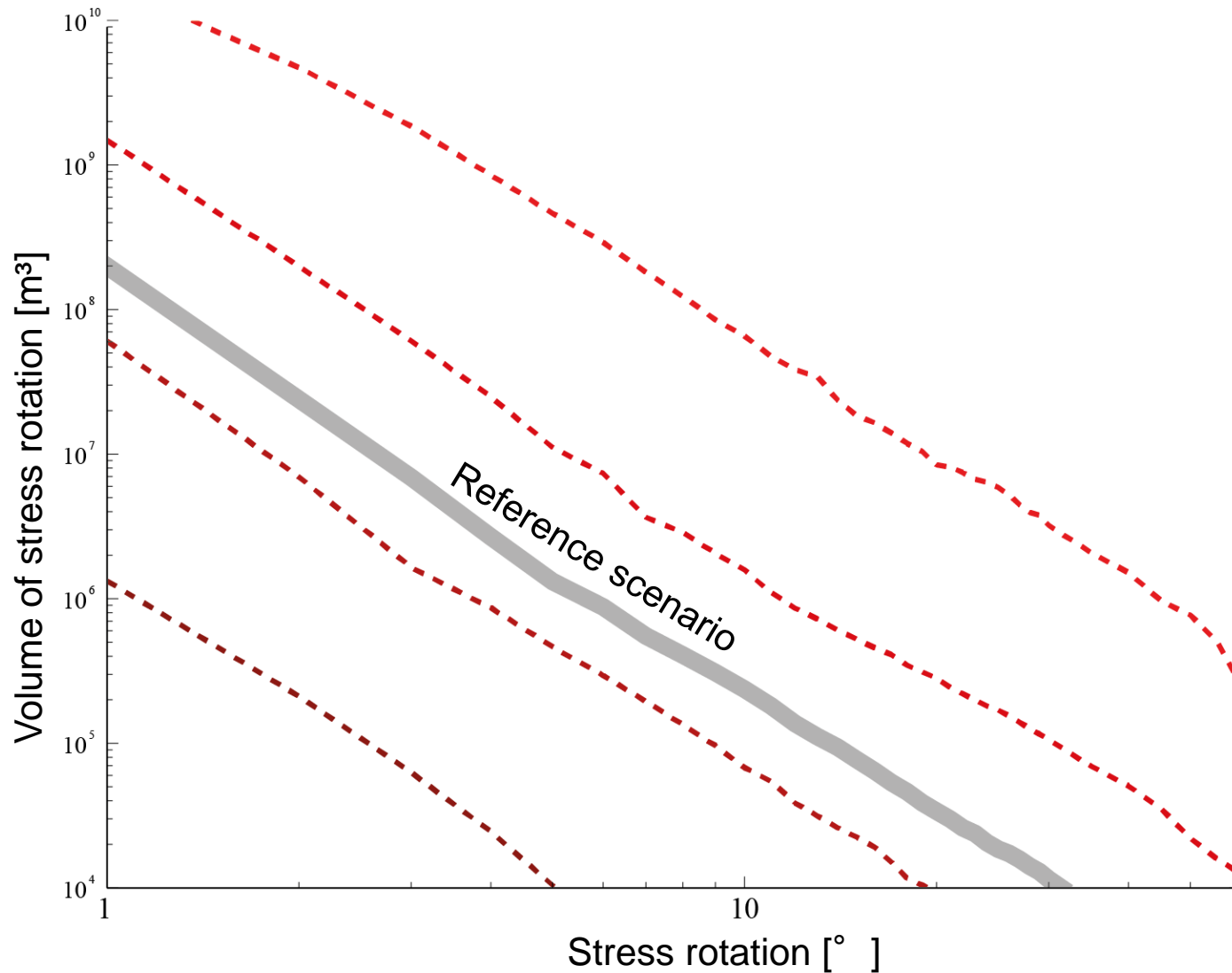


Representation of results

Reference scenario

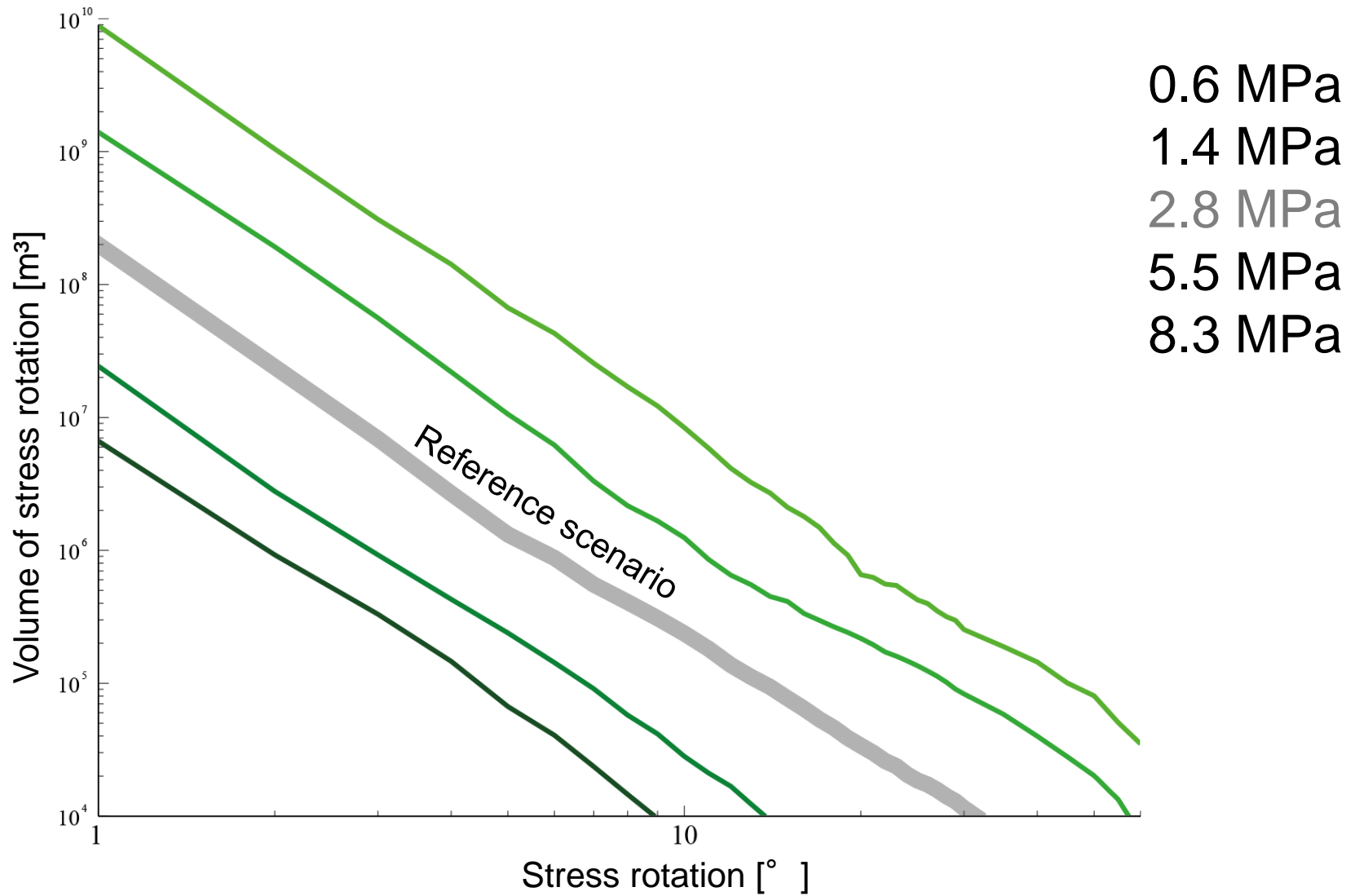


Permeability

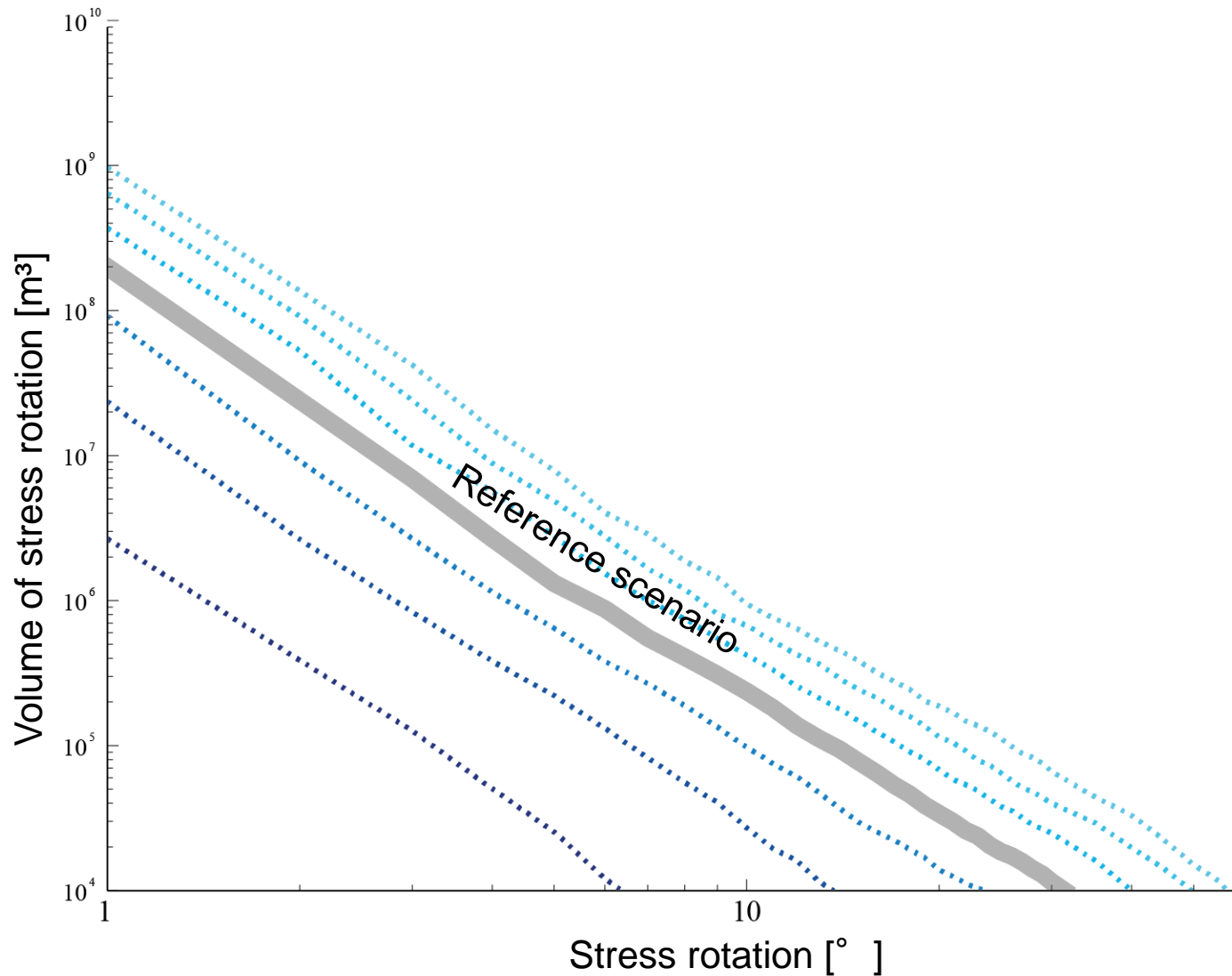


$1.5 \times 10^{-15} m^2$
 $5 \times 10^{-15} m^2$
 $1 \times 10^{-14} m^2$
 $1.5 \times 10^{-14} m^2$
 $5 \times 10^{-14} m^2$

Differential Stress



Injection Rate

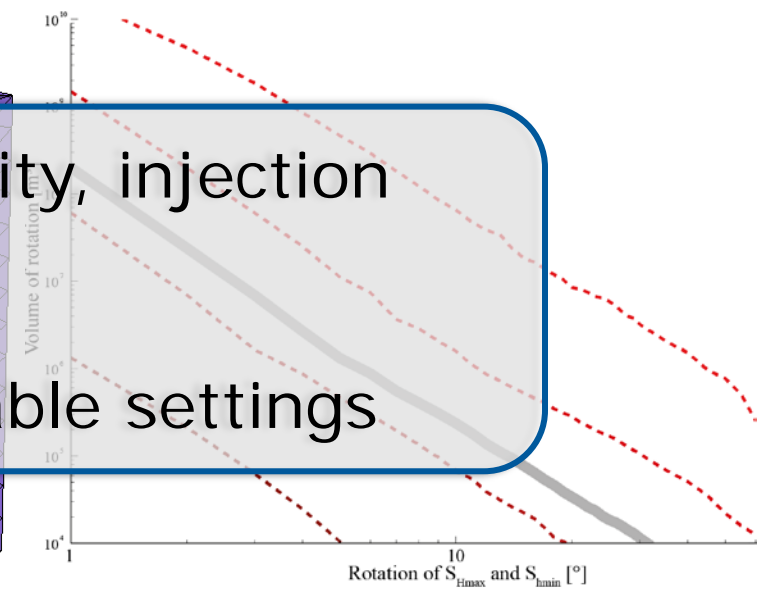
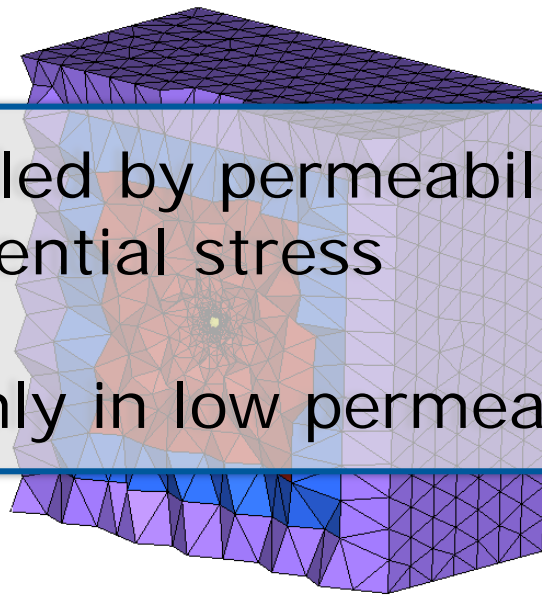
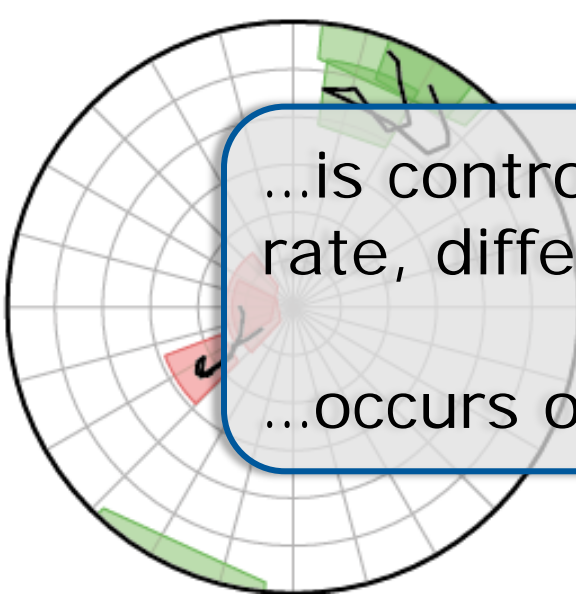


175 l/s
150 l/s
125 l/s
100 l/s
75 l/s
50 l/s
25 l/s

Stress rotation...

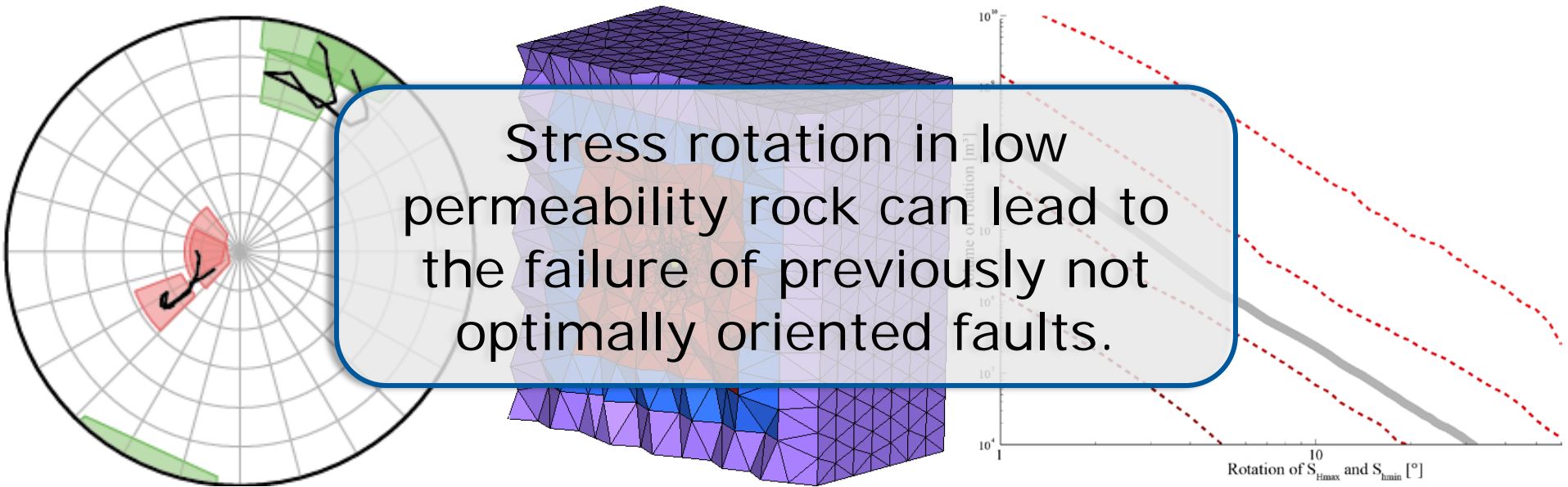
...is controlled by permeability, injection rate, differential stress

...occurs only in low permeable settings



Martínez-Garzón et al. 2013

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