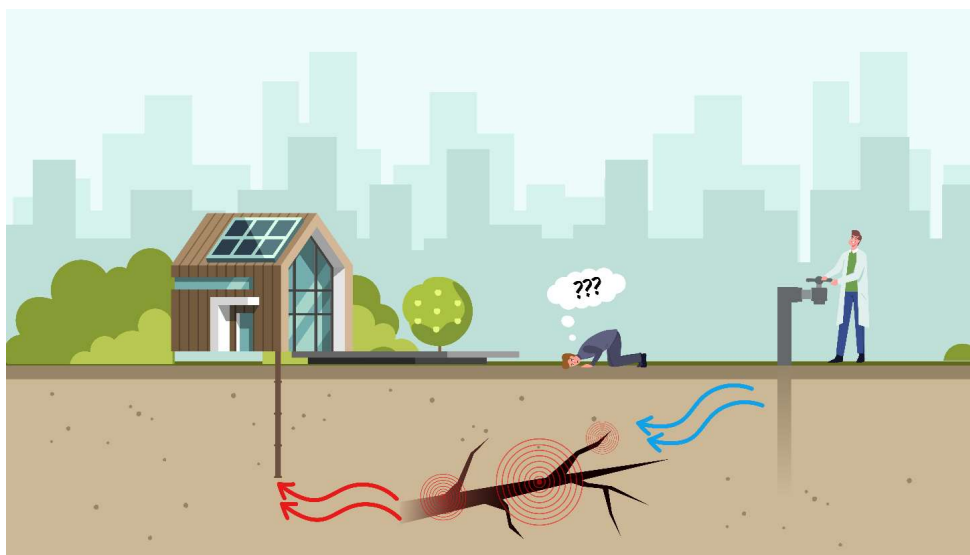# Injection-induced sequences give us insights about what is happening at depth during natural earthquake swarms

Philippe Danré[1], Louis De Barros[1], and Frédéric Cappa[1,2]

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[2]Institut Universitaire de France, Paris, France

Danré, P., De Barros, L., Cappa, F., & Ampuero, J. P. (2022). Fluid-induced anthropogenic and natural earthquake swarms are both driven by aseismic slip. in review at JGR : Solid Earth
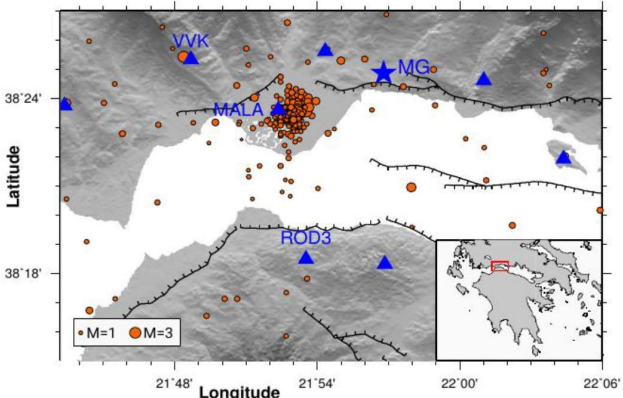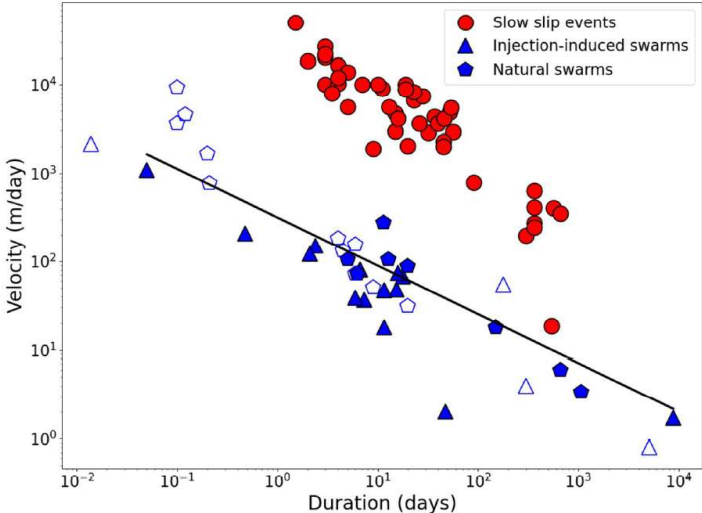
Danré, P., De Barros, L., Cappa, F., (2022). Inferring fluid volume during earthquake swarms using seismic catalogs. submitted to Geophysical Journal International
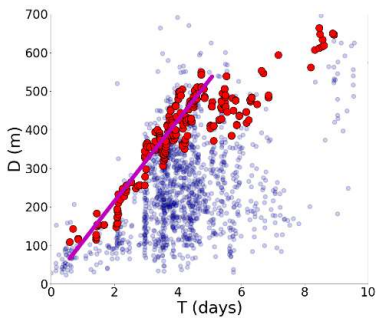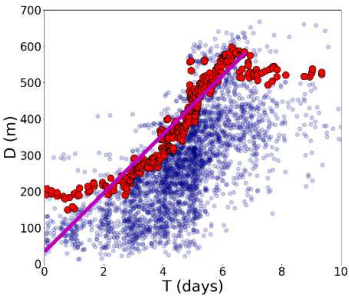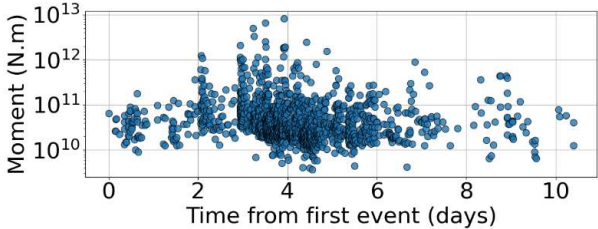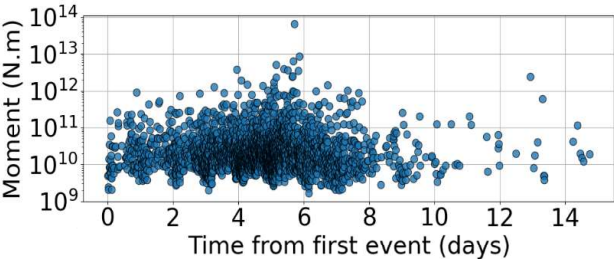
Injection-induced sequences give us insights about what is happening at depth during natural earthquake swarms
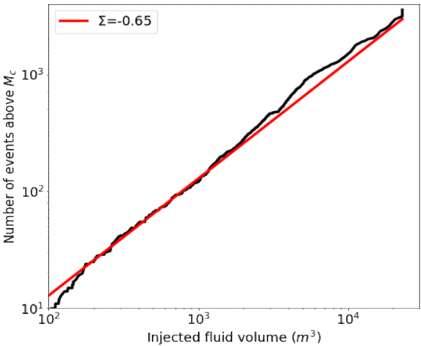

Geopower Basel

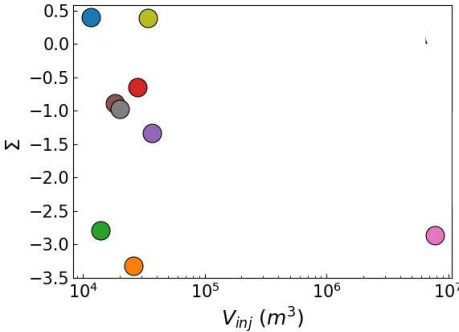De Barros et al., 2020

Common properties :

- Clustering (time, space)

- Seismicity migration

- Spatial moment release

- Scaling laws

- Fluid presence (?)

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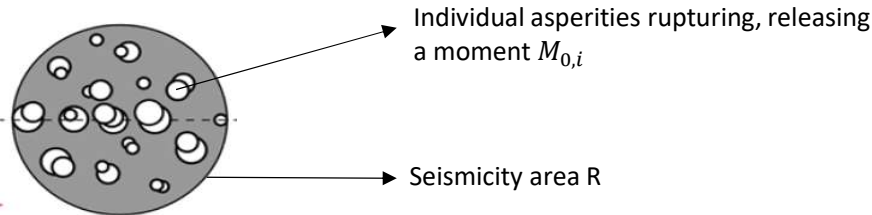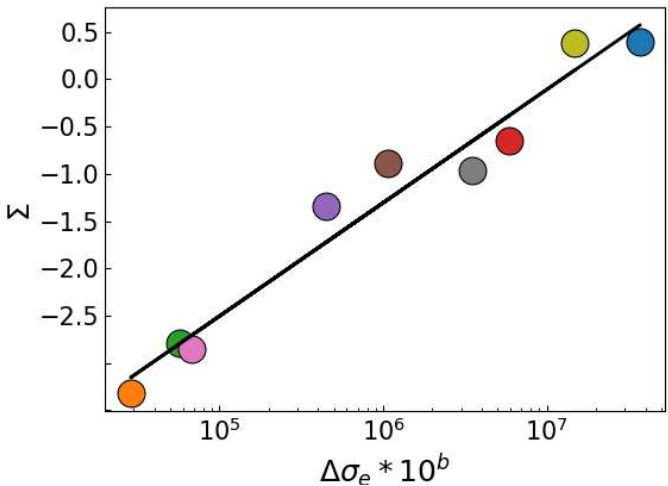
$$\Sigma = \log(N) - \log(V_{inj}) + bM_c$$

$$\Delta\sigma_e = \frac{7\Sigma M_{0,i}}{16R^3}$$

Individual asperities rupturing, releasing a moment $M_{0,i}$

Seismicity area R

Fischer and Haizml, 2017

Shapiro et al., 2010

Basel — ST1
SZ93 — Paradox
SZ96 — Cooper Basin 2003
SZ00 — Cooper Basin 2012
SZ03

$$\Sigma = \log(N) - \log(V_{inj}) + bM_c$$

$$\Sigma = p * \log(\Delta\sigma e * 10^b) + q$$

$$V_{inj} = N * 10^{b*Ml} * (\Delta\sigma_e * 10^b)^{-p} * 10^{-q}$$

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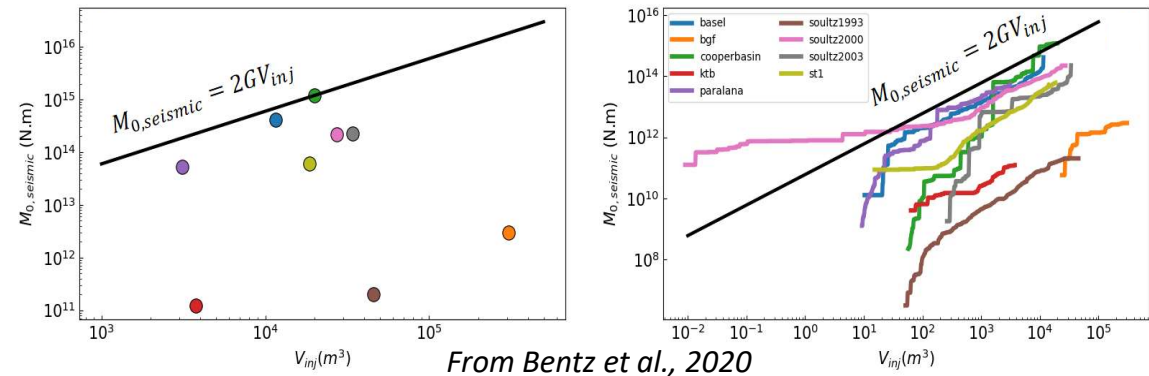**Injection-induced sequences give us insights about what is happening at depth during natural earthquake swarms**

$$V_{inj} = N * 10^{b*Ml} * (\Delta\sigma_e * 10^b)^{-p} * 10^{-q}$$

From Bentz et al., 2020

- It is possible to relate precisely injected fluid volume to observables, for injection-induced sequences

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$$V_{inj} = N * 10^{b*Ml} * (\Delta\sigma_e * 10^b)^{-p} * 10^{-q}$$

- We can compute fluid volumes for natural earthquake swarms

- Orders of magnitudes found are consistent with expected values

- Our method takes into account, indirectly the aseismic release

- This raises many questions regarding the origin and becoming of fluids, the role of fluid pressure, …
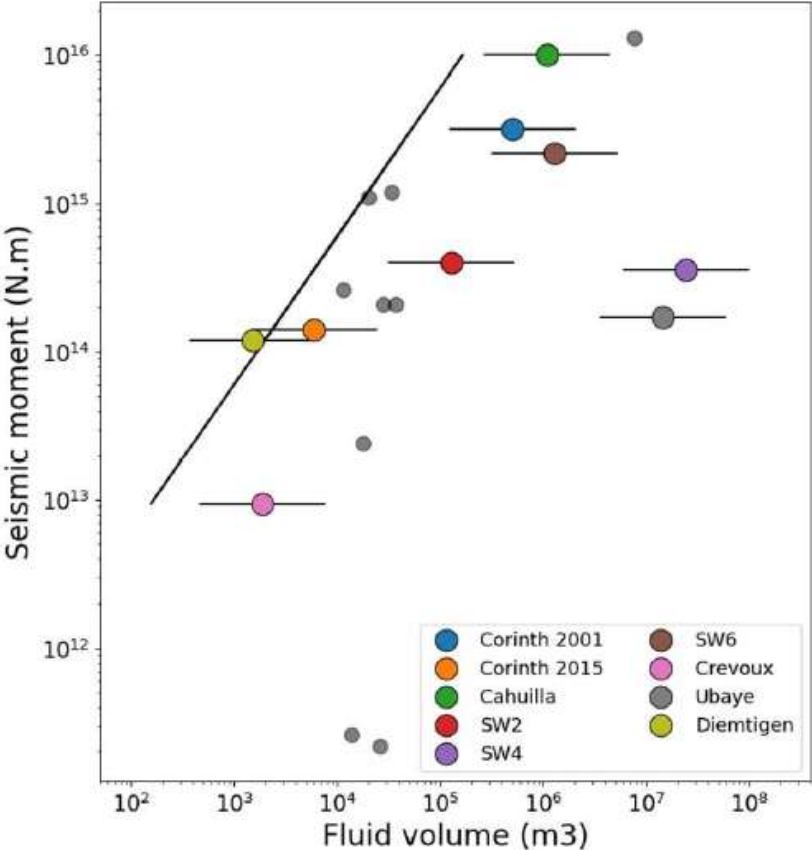
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- Injection-induced and natural earthquake swarms seem to obey the same physics

- Studying the relation between injected fluid volume and seismicity is crucial for injections but correlations are limited

- Using 9 injection-induced swarms, we propose a new relation between fluid volume and seismicity

- We apply this relation to natural earthquake swarms, allowing us to estimate the fluid volume circulating

Thank you for your attention

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