EGU 2022 SM8.1

Time-varying stick-slip behaviors described by dehydration kinetics of gypsum

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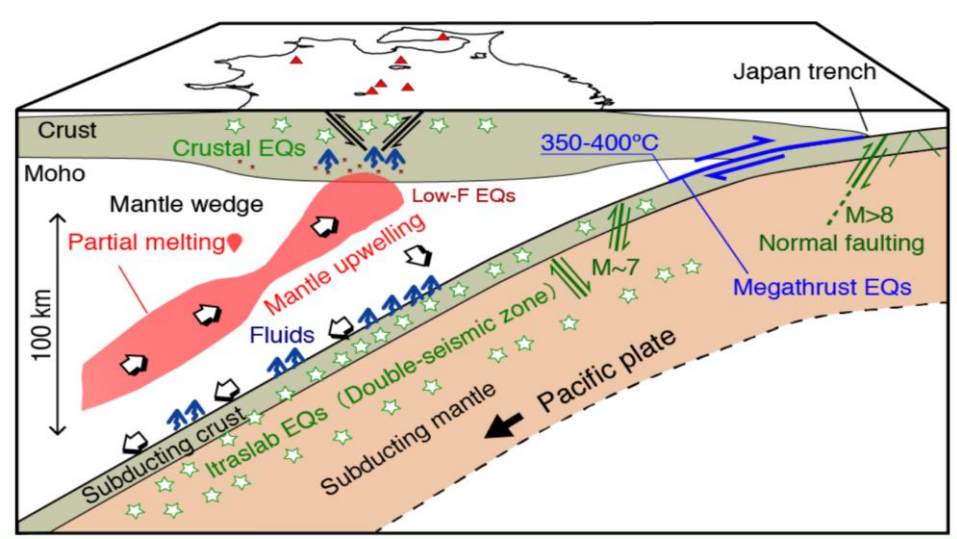
Backgrounds and Our purpose



Intermediate and deep earthquakes ?

Due to dehydration of hydrous minerals?

Schematic model of subduction zone (Nakajima, titech)

Mechanically

Pore fluid pressure (P_f)

Reduction of strength

Chemically

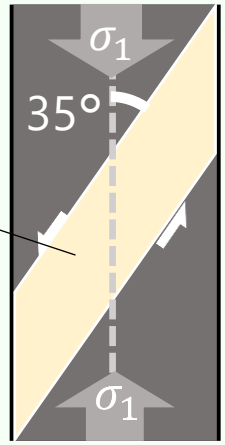
Reaction kinetics

Time dependence

Time evolution of pore fluid pressure (P_f)

Triaxial shear deformation experiments

gouge: bassanite (dehydrated gypsum), undrained

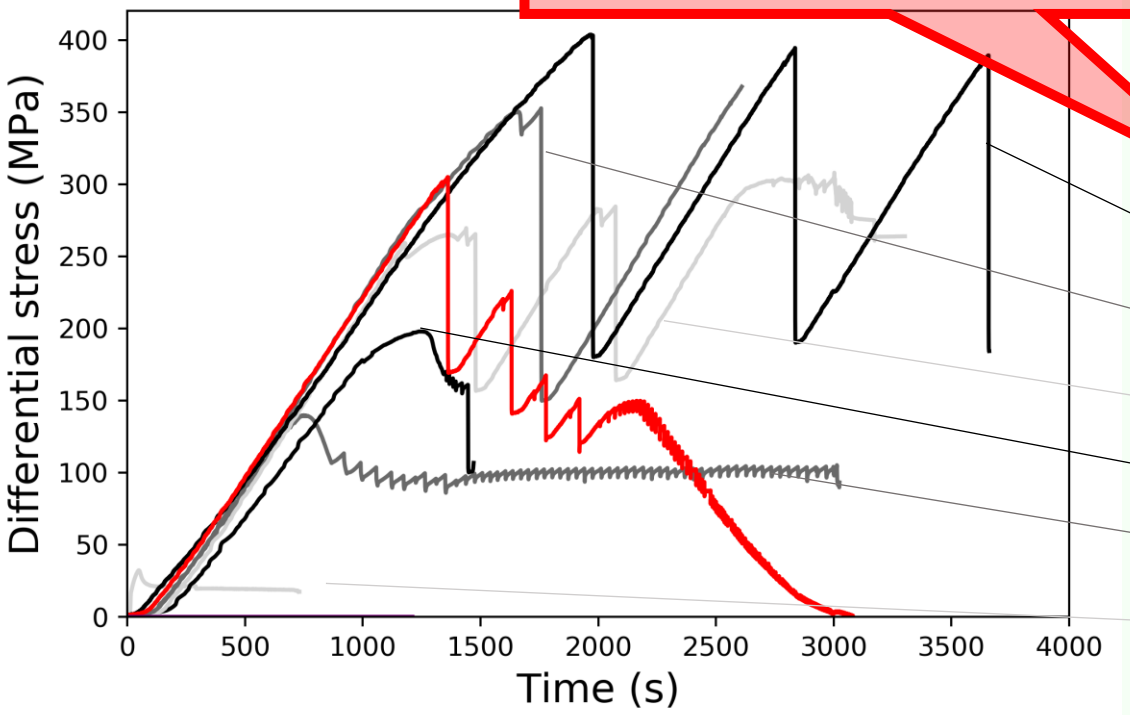


Gas apparatus

$$CaSO_4 \cdot 2H_2O \rightleftarrows CaSO_4 \cdot 0.5H_2O \rightleftarrows CaSO_4$$

gypsum — bassanite (start) — anhydrite

Dehydration can occur

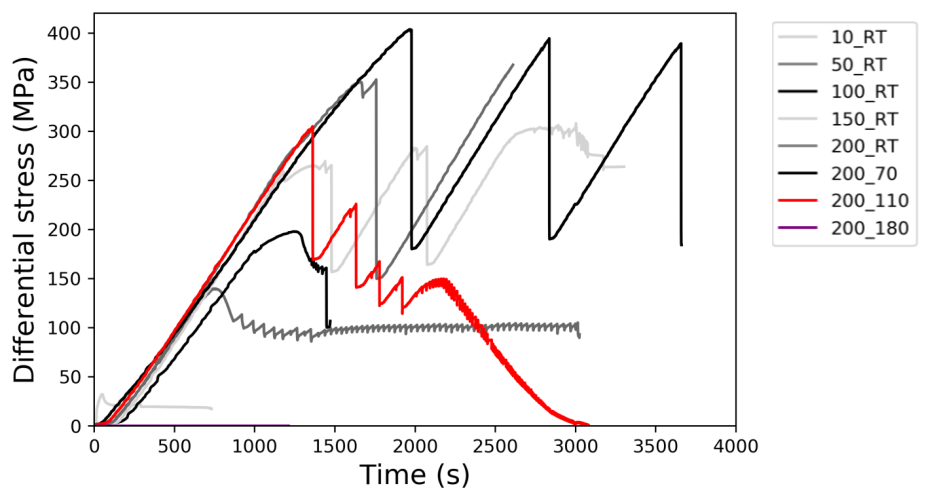


Differential stress vs. time

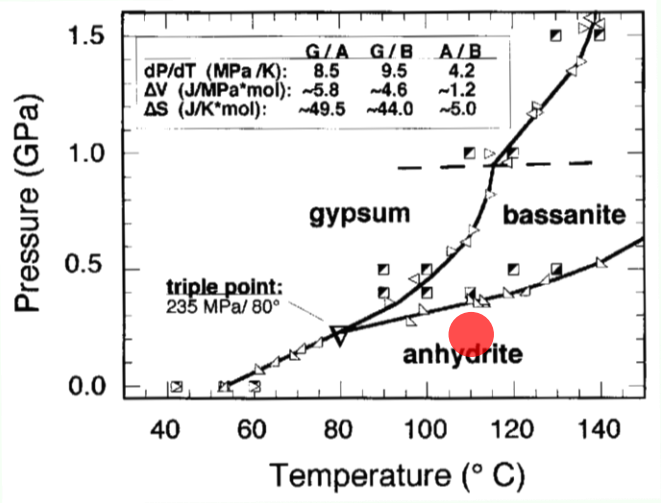
P_c (MPa)	T (°C)
200	180
200	110
200	70
200	RT
150	RT
100	RT
50	RT
10	RT

P_c: confining pressure
RT: room temp. (20~25 °C)

Reduction of mechanical strength



Differential stress vs. time



Phase diagram (Mirwald, 2008)

Under 200_{MPa} and $110_{°C}$...

$$CaSO_4 \cdot 2H_2O \rightleftarrows CaSO_4 \cdot 0.5H_2O \rightleftarrows CaSO_4$$

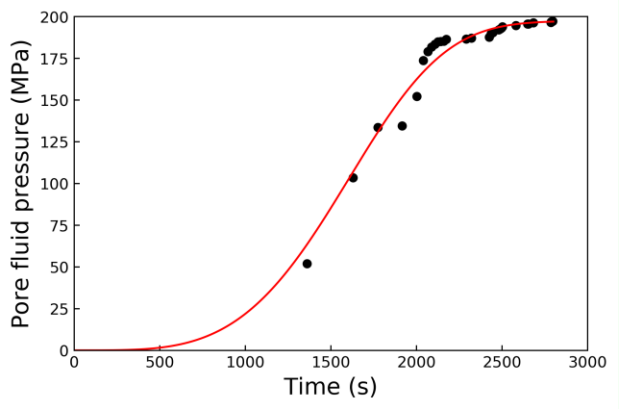
gypsum — bassanite (start) — anhydrite

Shortening of recurrence intervals

Anhydrite is the most stable

◇Dehydration of bassanite to anhydrite
◇Reduction of strength due to pore fluid pressure

Time evolution of pore fluid pressure



Pore fluid pressure plot

Avrami theory

$$X = 1 - \exp(-kt^n)$$

X : reaction ratio
k : reaction rate (s^{-n})
t : elapsed time (s)
n : Avrami exponent

The cause of P_f : dehydration

①More dehydration, higher P_f …

Assuming linearity between P_f and dehydration degree

②Time variation of dehydration degree

Reaction kinetics

$$P_f = A\{1 - \exp(-kt^n)\}$$ A: constant (MPa)

$$P_f = 197.3701\{1 - \exp(-2.7091 \times 10^{-13} \times t^{3.8791})\}$$

Time evolution of pore fluid pressure can be described based on reaction kinetics.