

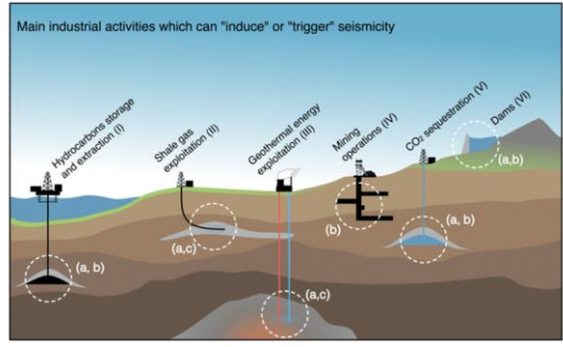
# Laboratory study on seismicity mitigation: The role of loading pattern and rate

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➤ Seismic activity directly or indirectly caused by such industrial operations



injection-driven



Geothermal, CO2 storage, and hydraulic fracturing

➤ Important parameters regarding seismicity mitigation

➤ Injection rate

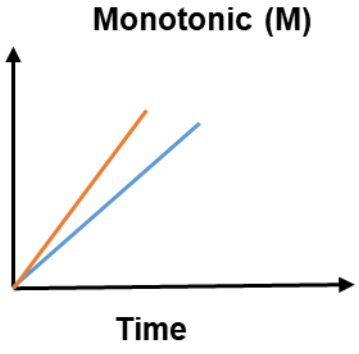
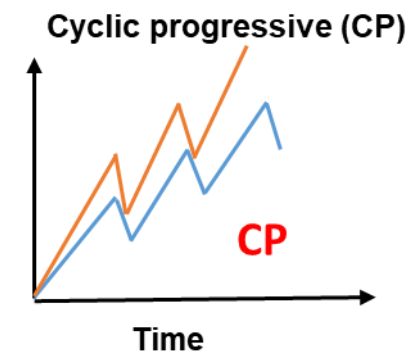
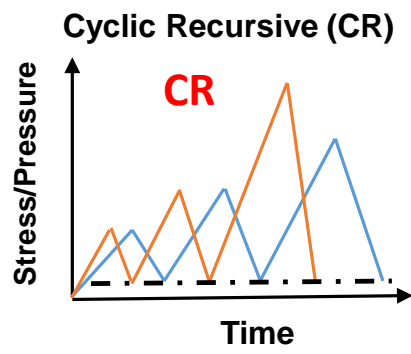
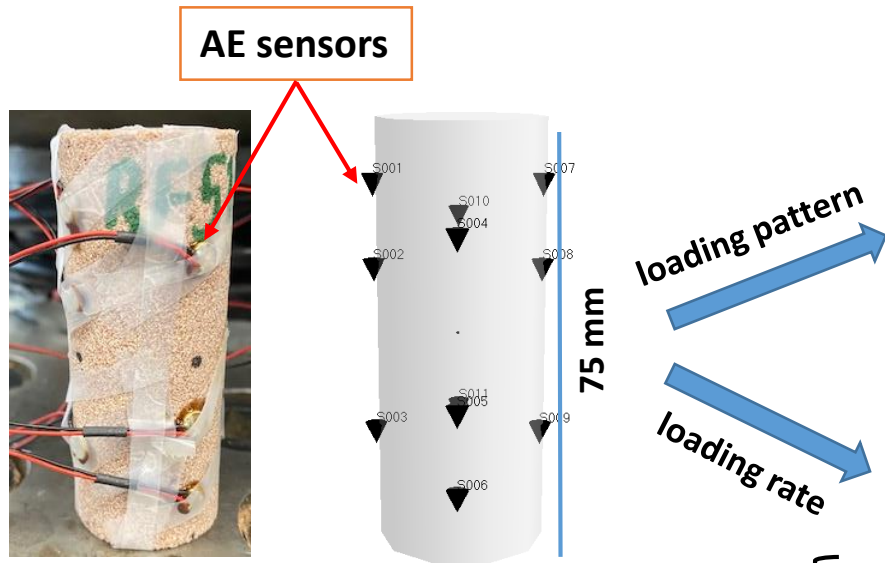
➤ Injection pattern

➤ Injection volume

Goal of study



Effect of loading pattern and rate on mechanical behavior and seismicity evolution



low, medium, and high rates that are  $10^{-4} \text{ mm/s}$ ,  $5 \times 10^{-4} \text{ mm/s}$ , and  $5 \times 10^{-3} \text{ mm/s}$ , respectively

Important parameters

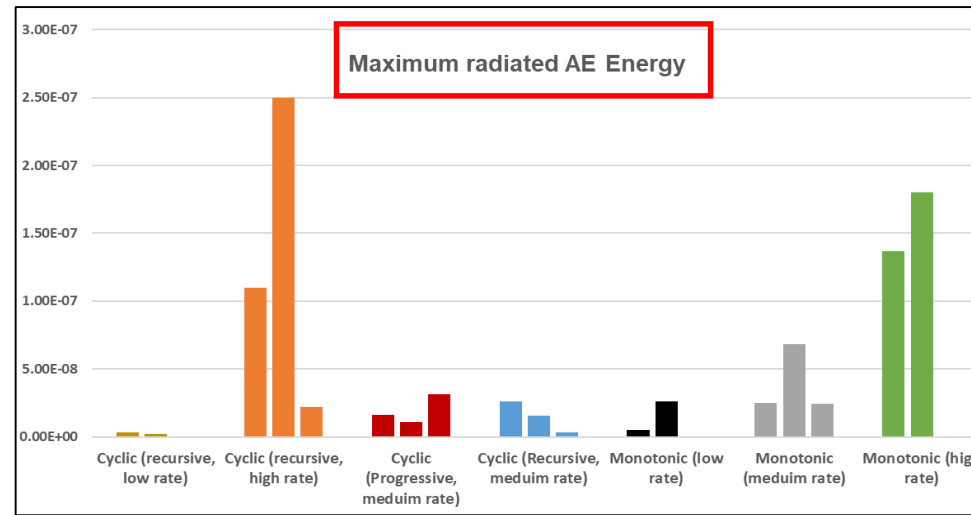
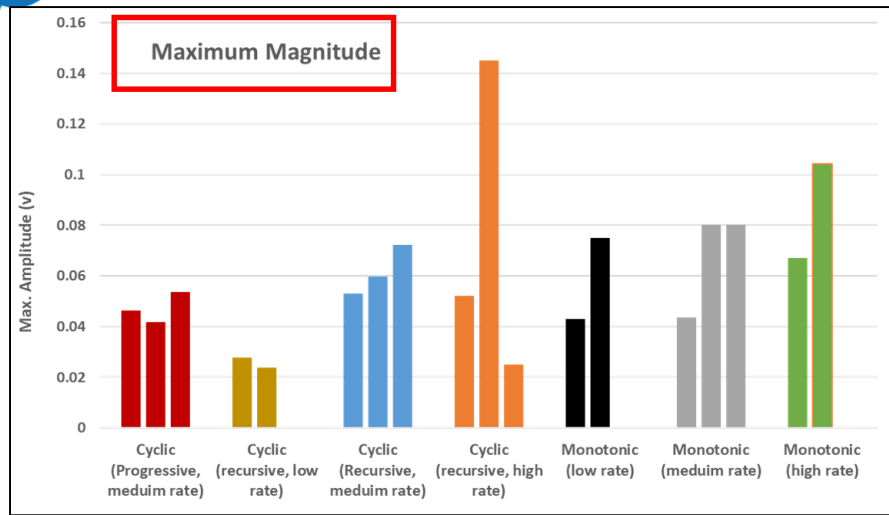
Magnitude distribution (b-value)

Maximum Magnitude

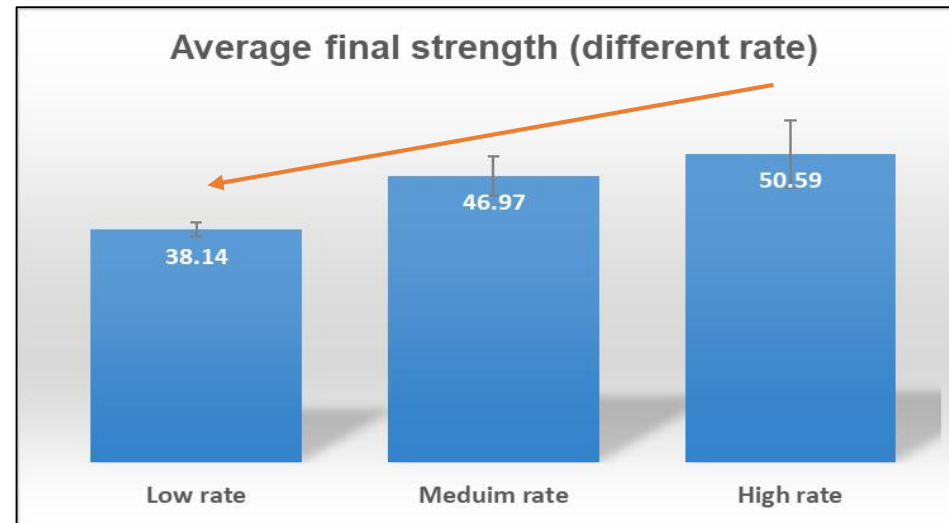
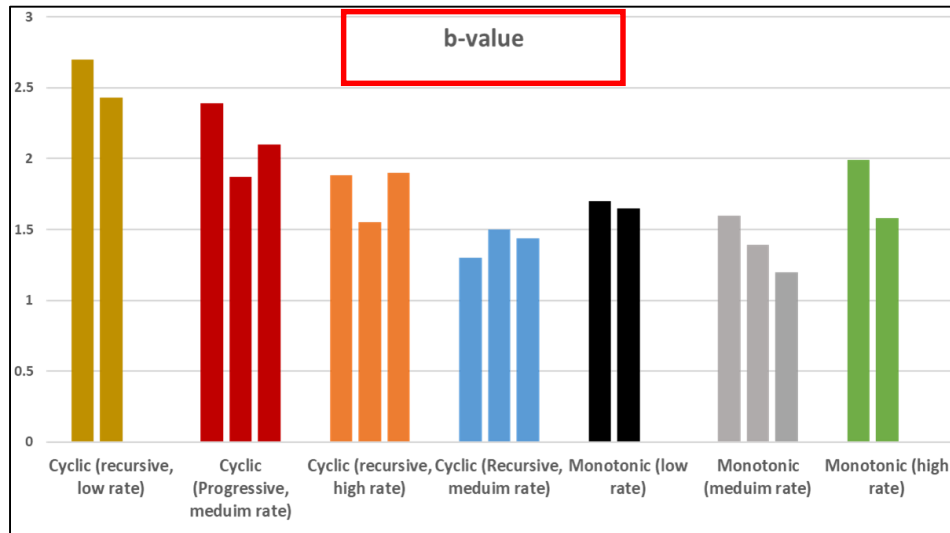
Seismic energy radiation

Mechanical behavior





➤ In general, by using cyclic loading and low loading rate maximum magnitude and radiated energy at failure point decrease



➤ Cyclic recursive loading with low loading rate is characterized by high b-value and by decreasing loading rate final strength decreases

➤ **Main conclusion:** Induced seismicity can be manageable in terms of maximum magnitude, radiated energy, number of events and distribution of magnitudes of events

Cyclic loading



Fractured pattern

Monotonic loading

