Dilation and compaction accompanying changes in slip velocity in clay-bearing fault gouges

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TS4.1 EGU21-8679

Slip velocity increases are accompanied by dilation in a granular material and cause pore fluid pressure to drop, whereas slip velocity decreases show compaction of material and cause pore fluid pressure to increase.

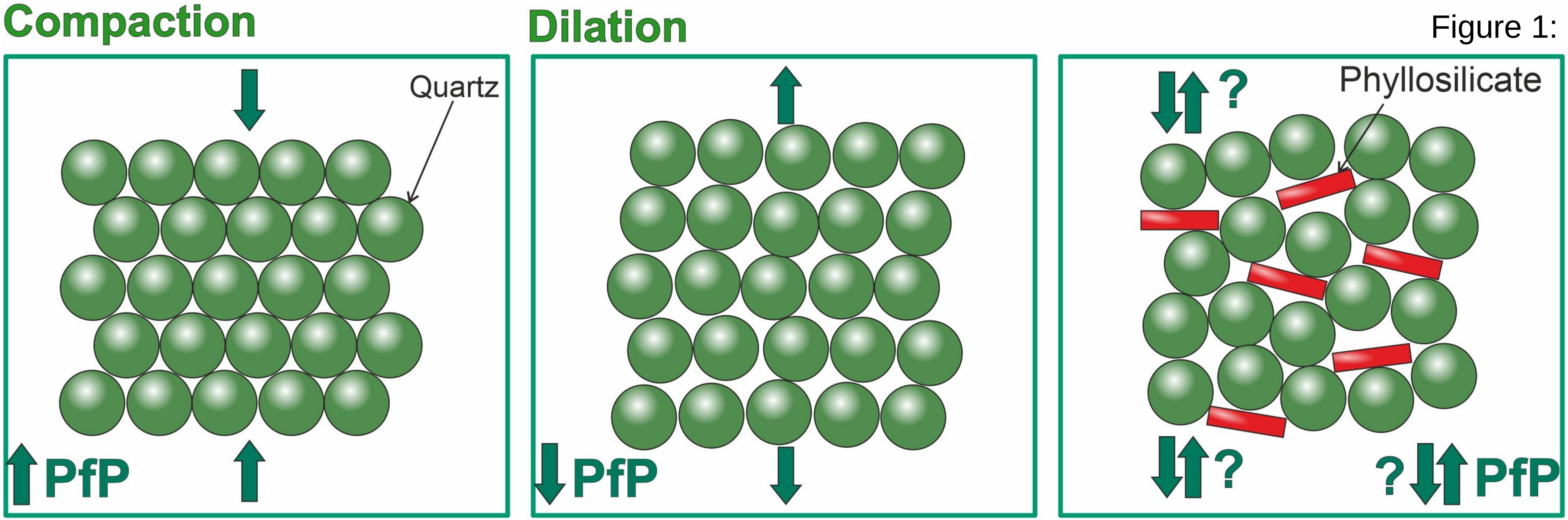

Figure 1:

Pore pressures in low permeability fault gouges would be highly sensitive to volume changes due to the slow rate of fluid recharge.

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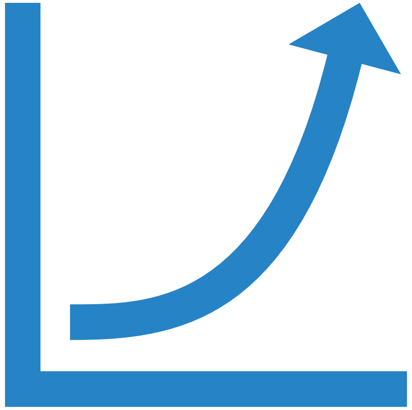
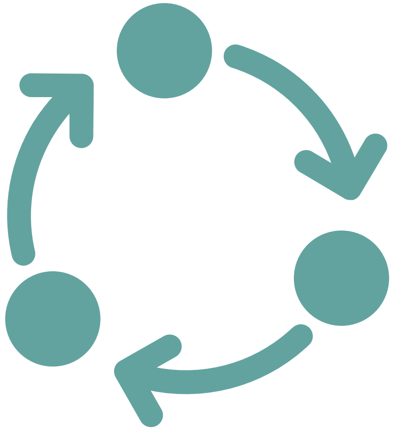
Research Questions

How does varying kaolinite content affect μ and stability?



How does varying effective pressure affect μ and stability?



Does transient dilation and compaction occur in qtz-kao fault gouges?

Triaxial Deformation Experiments

Triaxial Rig 2

Three effective normal stresses used to simulate different pore pressure scenarios:

- 60MPa
- 25MPa
- 10MPa

Sample fits between upper and lower assembly blocks

Sample Assembly

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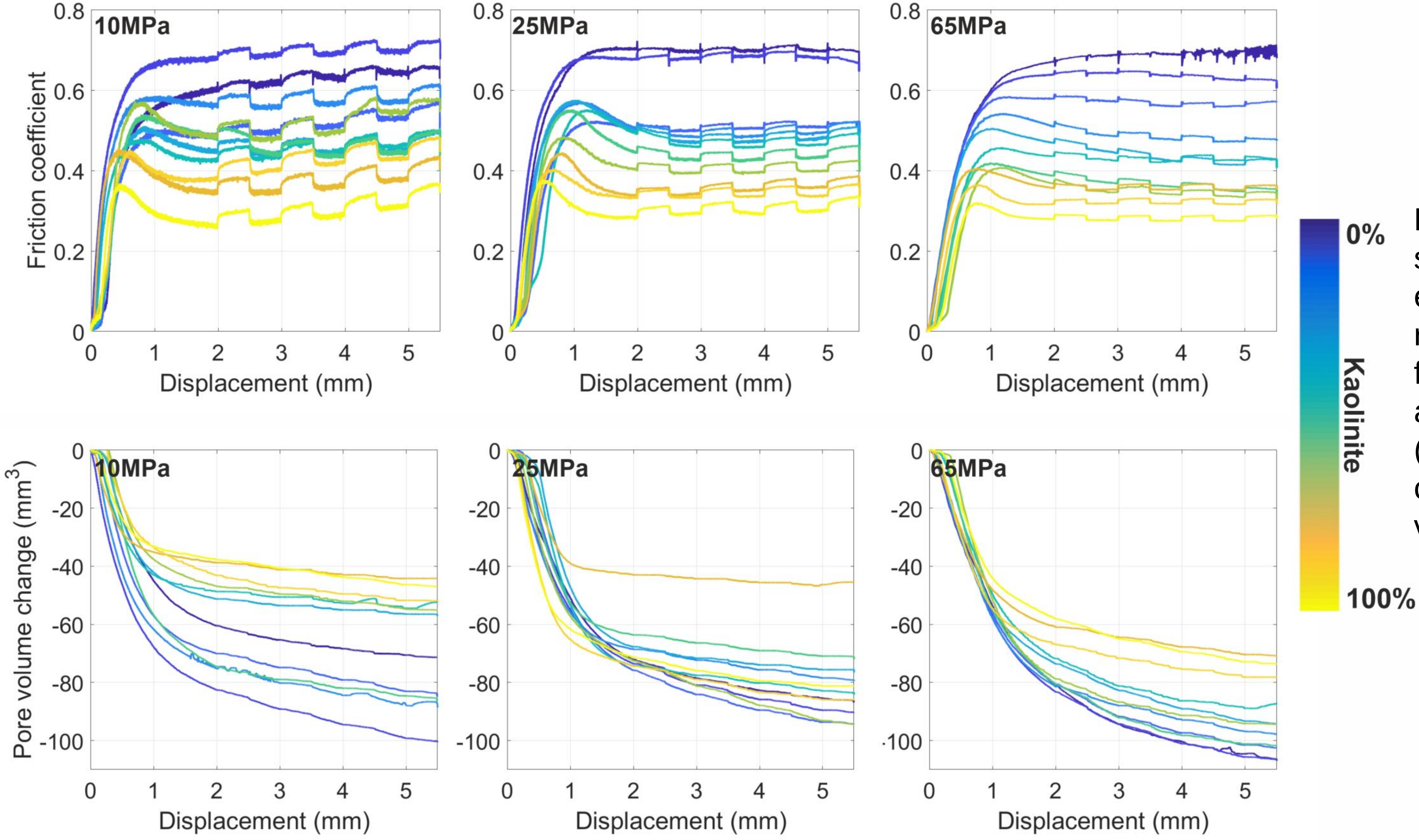

Figure 2: A summary of the experimental results showing the friction (top row) and volume (bottom row) curves from the velocity step tests.

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Mechanical Results:

- Kaolinite content is a key control on gouge frictional strength and frictional stability
- Effective normal stress is a control on gouge frictional stability, especially in kaolinite-rich gouges
    - Velocity weakening **[a-b]<0** slip accelerates; velocity strengthening **[a-b]>0** slip arrests

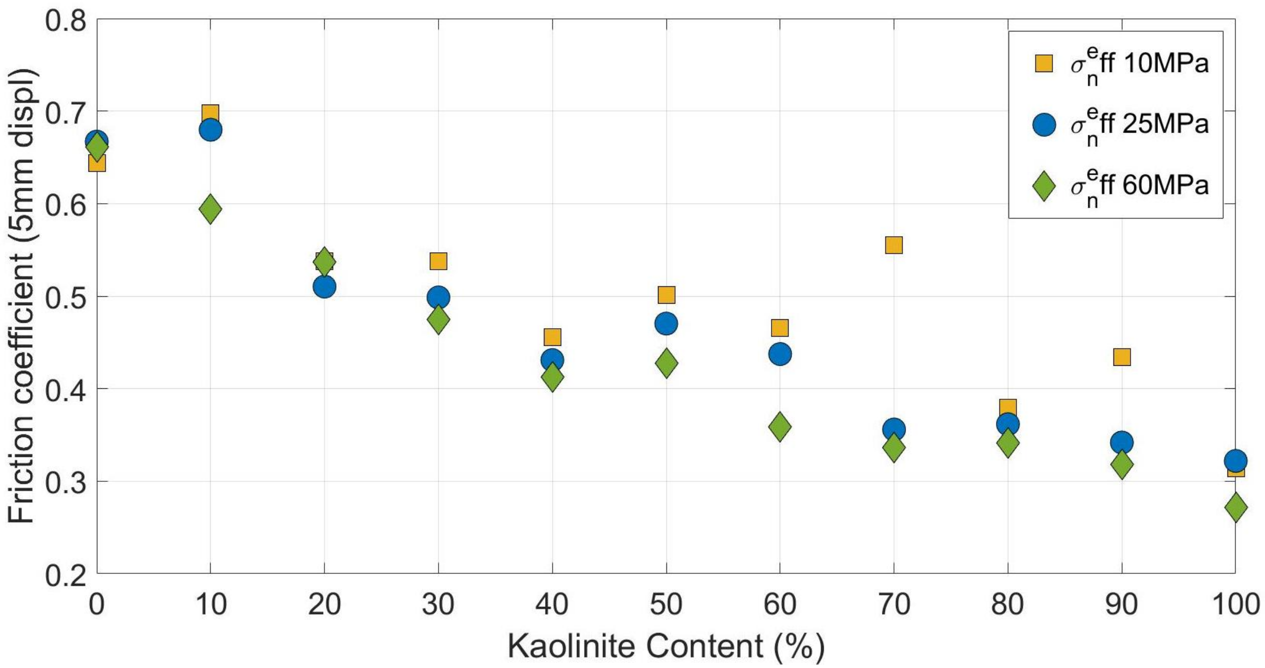

Figure 3: Experimental frictional strength of synthetic fault gouges after 5mm displacement.

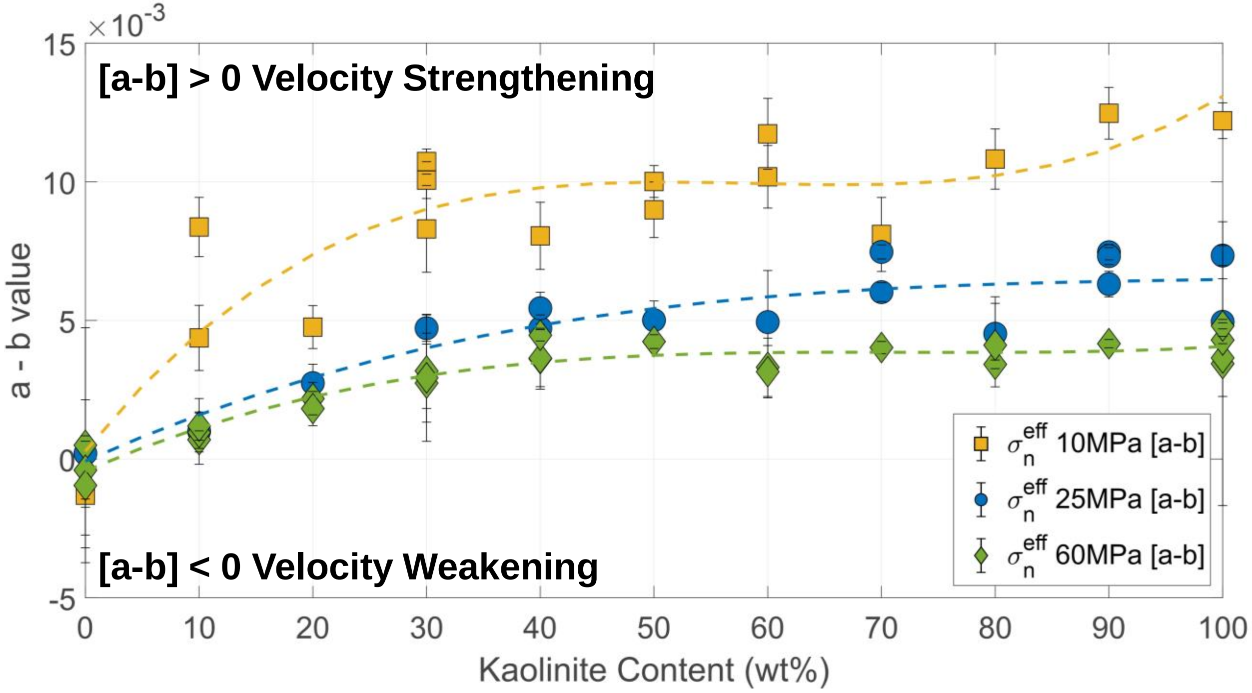

Figure 4: Experimental rate and state stability of synthetic fault gouges after 5mm displacement.

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Volume Results:

- Gouges of all kaolinite-quartz contents displayed measurable pore volume change transients in response to a change in slip velocity
- Effective normal stress shows no effect on the scale of volume change transients
- Kaolinite content does show an effect on the scale of volume change transients

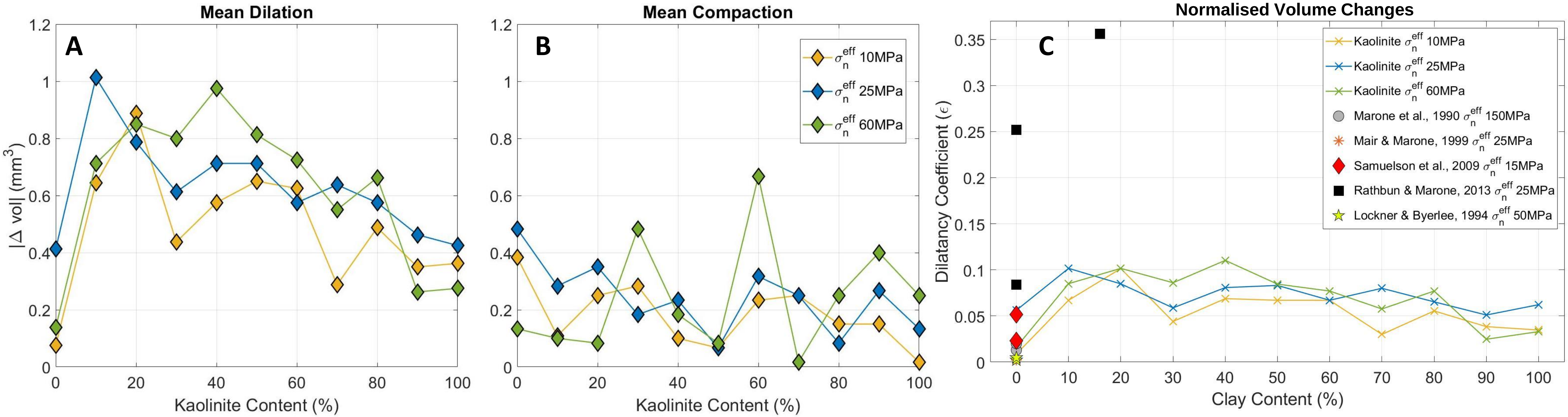

Figure 5: Measured volume changes in response to 10-fold velocity increases (A) and decreases (B); literature and experiment volume changes normalized to total pore volume for velocity increases (C) .

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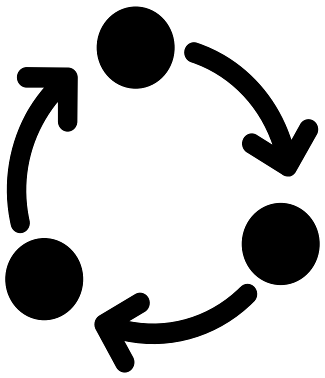
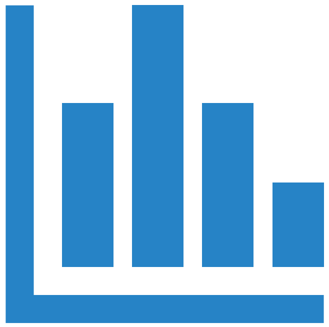
Summary

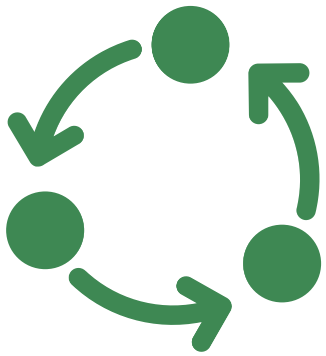


Compaction would cause apparent weakening; dilation would cause apparent strengthening.

Results show that increasing clay content decreases gouge strength.



Transient dilation and compaction occurs in all quartz-clay gouges.



Transient volume changes are not affected by effective pressure but are by clay content.

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