Detachment of colloids at a swelling clay-water interface: *Conclusions based on rheological measurements*

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B+Tech Oy

Clay colloids in aqueous systems
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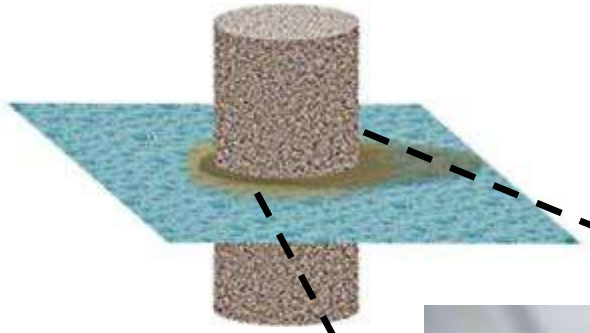
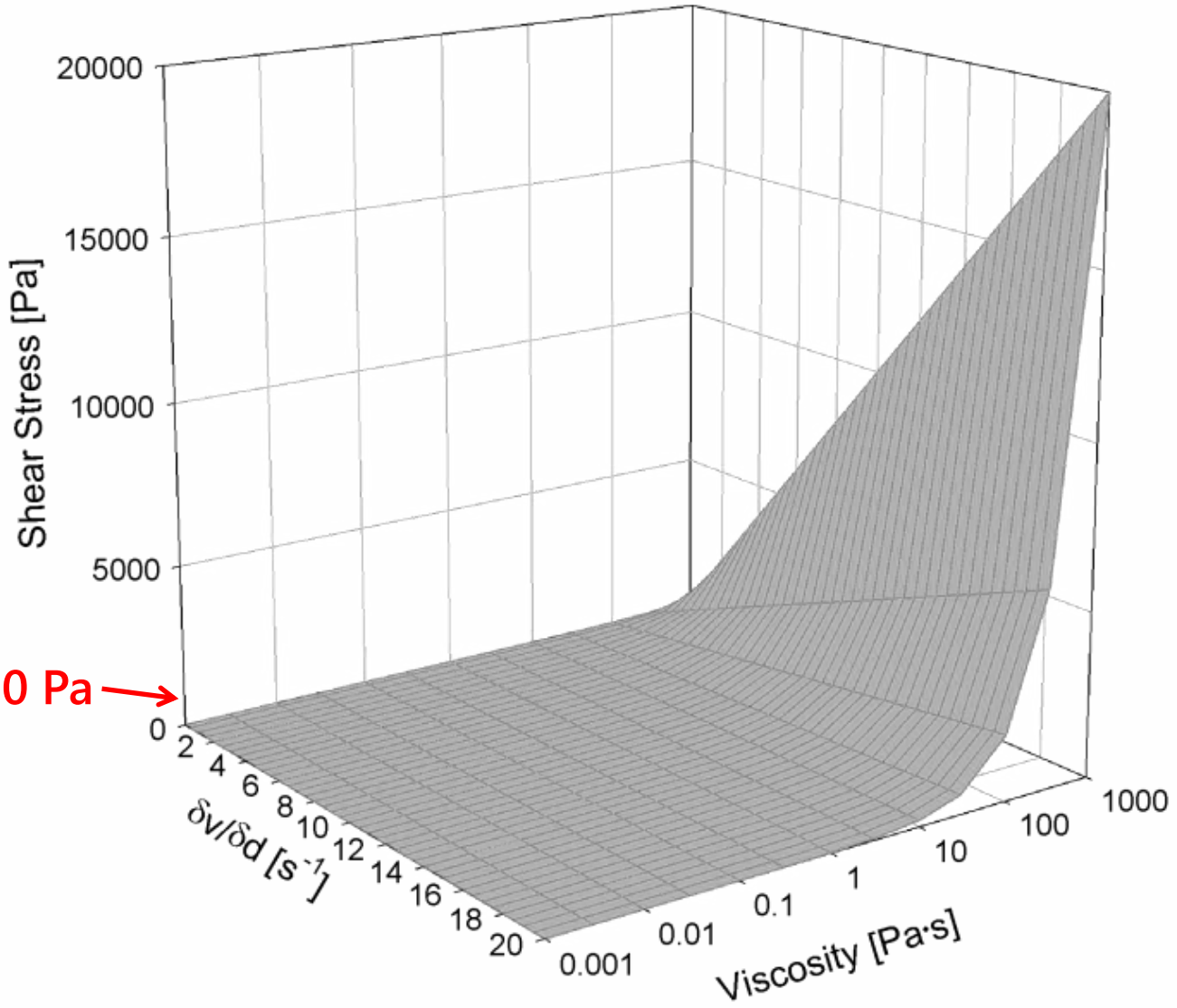
Background



Detachment mechanism?

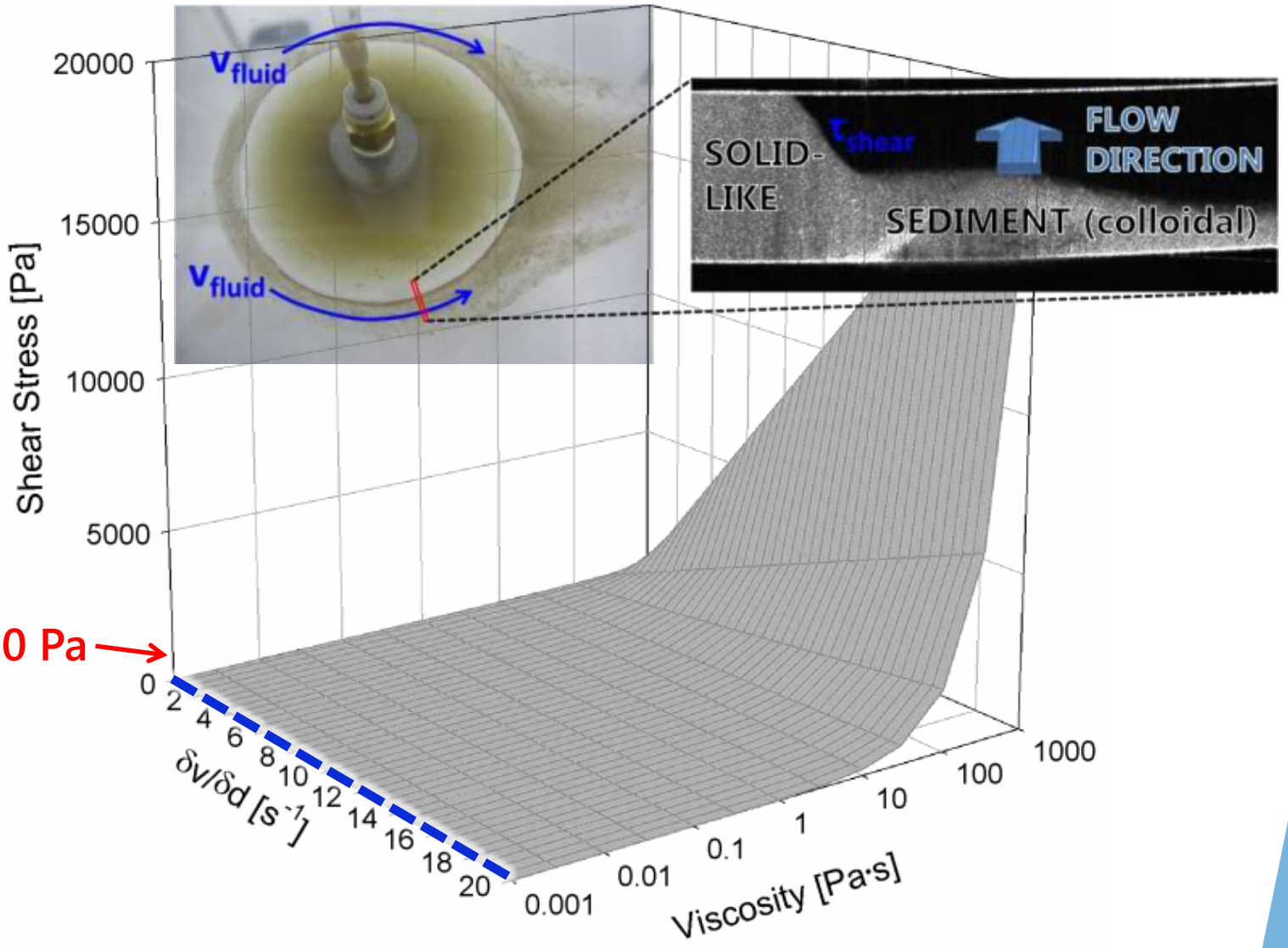
Shear stress



$\tau_y \geq$ ~100 Pa

Eriksson & Schatz, Appl. Clay Sci. 108 (2015), 12.

Shear stress



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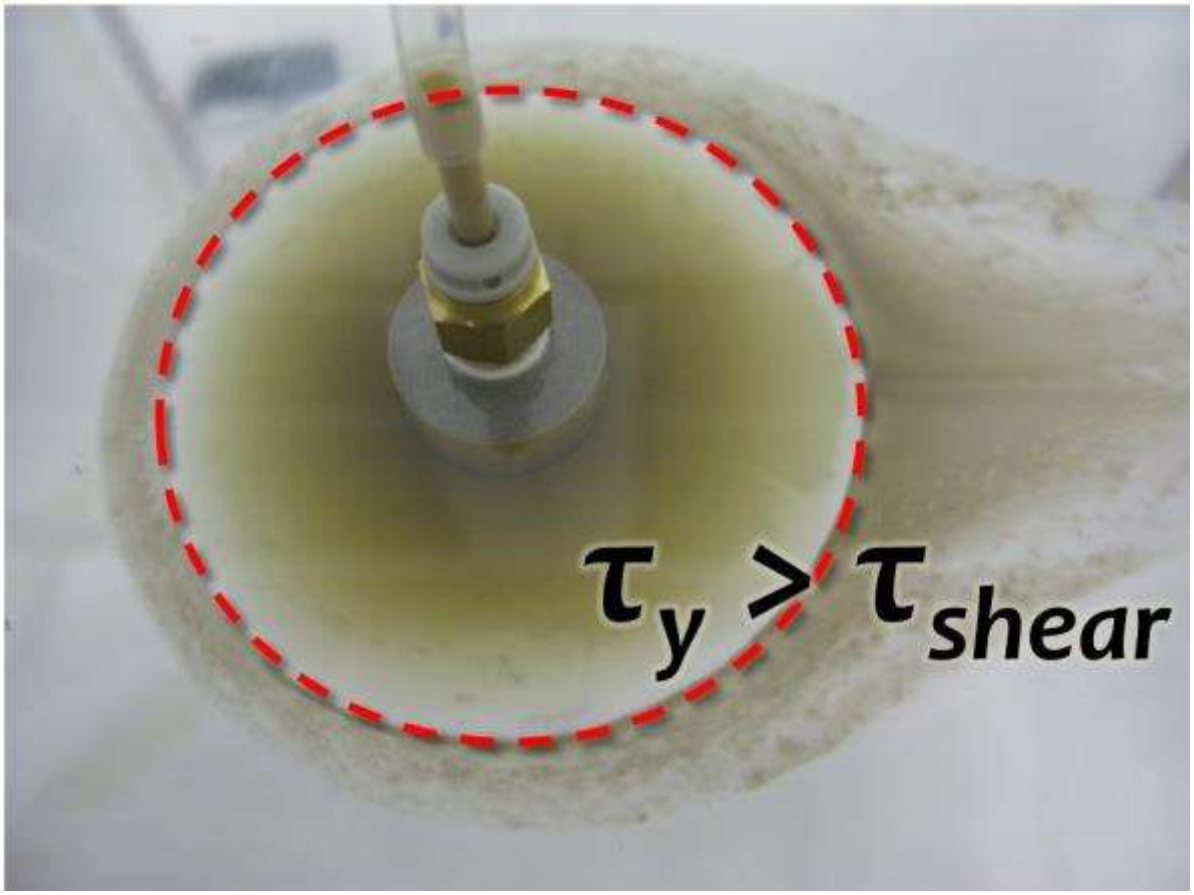
Shear stress



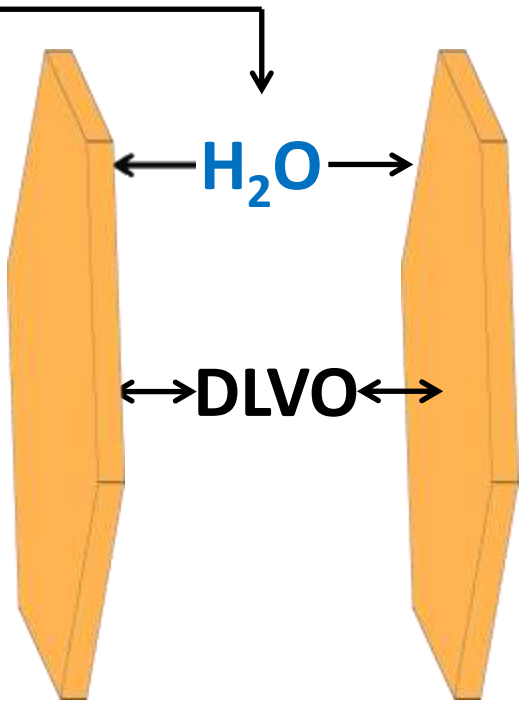
Effect of prolonged small shear stress?

Swelling mechanism

Assumption: ***chemical forces induce detachment***

~~**Brownian motion**~~ **(too weak to overcome adhesion)**

Osmosis

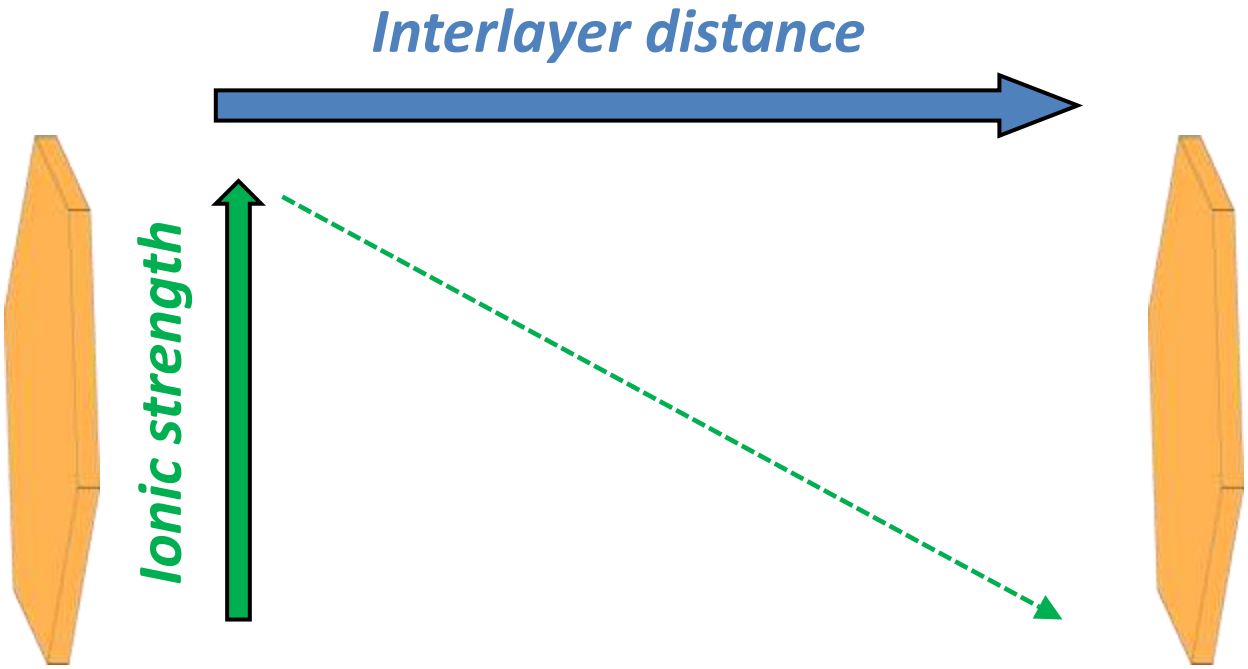


Swelling

Interaction energy as a function of interlayer distance:

- Assume constant number of (counter)-ions

- Ψ_0 = -100 mV, $A_H = 2 \cdot 10^{-20}$ J



Results – particle interactions

1 nm (3 M) → **Φ:** ***Negative (Attraction)*** **Slope:** ***Negative (strong repulsion)***

2 nm (1.5 M) → **Φ:** ***Negative (Attraction)*** **Slope:** ***Positive (Attraction)***

5 nm (0.6 M) → **Φ:** ***Negative (Attraction)*** **Slope:** ***Positive (Attraction)***

Detachment

10 nm (0.3 M) → **Φ:** ***Negative (Attraction)*** **Slope:** ***Positive (Weak attraction)***

50 nm (0.06 M) → **Φ:** ***Negative (Attraction)*** **Slope:** ***Positive (Negligible attraction)***

Less than one kT

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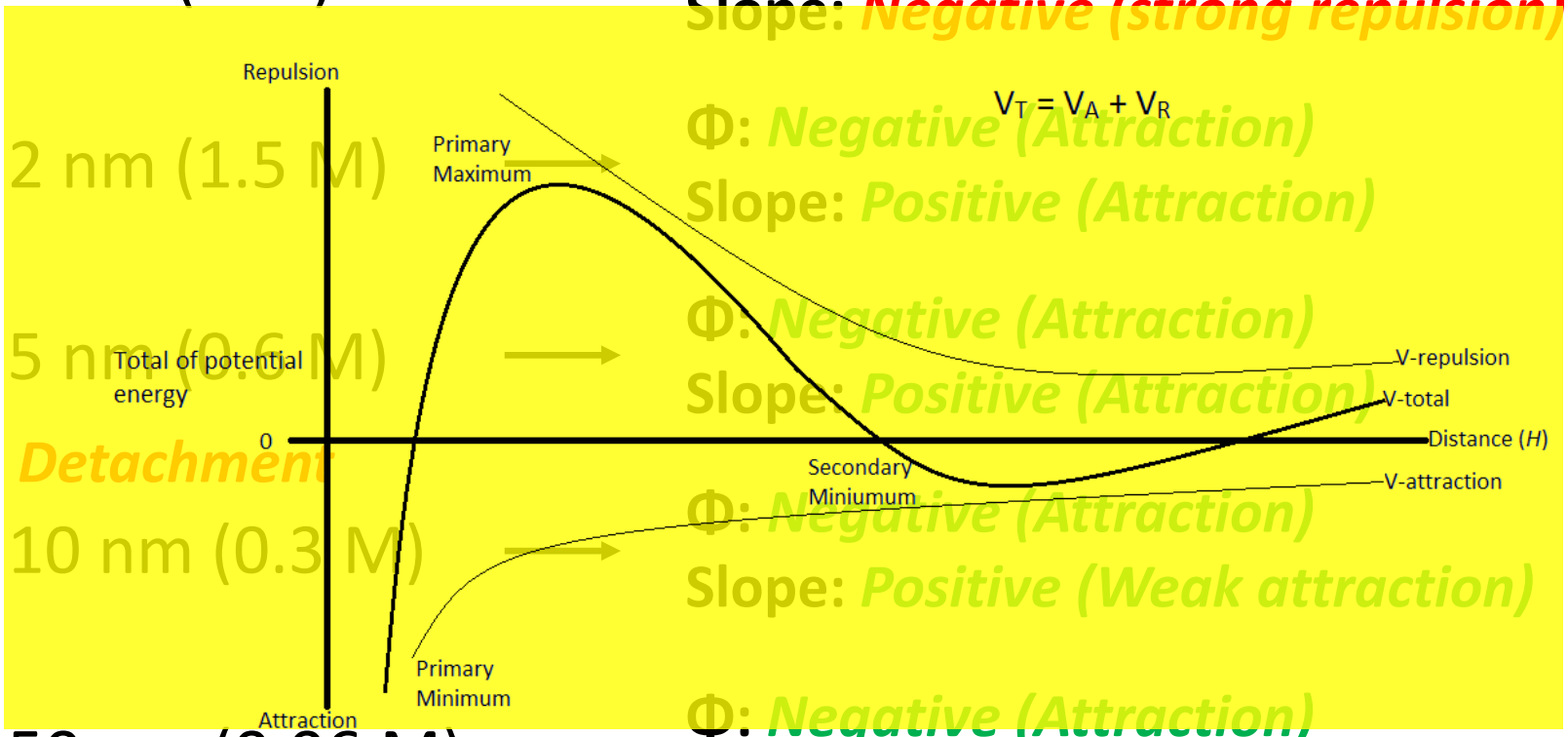
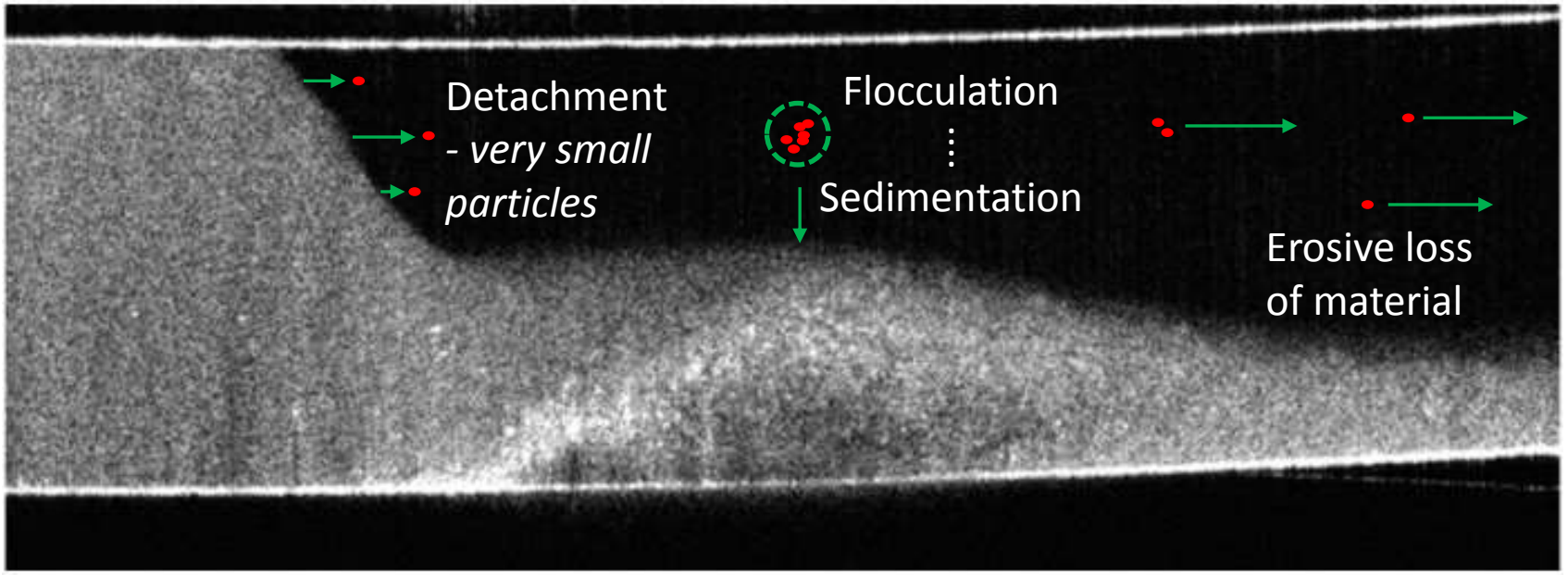


Results – particle interactions

Constant charge model: Non-vdW interaction energy much larger → vdW forces are overcome at shorter distances → detachment at smaller distance.



Conclusions

Particle detachment mechanism	Osmotic swelling (balance of forces: osmotic pressure / particle interactions / GW flow (velocity) / Brownian motion)
Groundwater chemistry / Clay – groundwater interactions	Increased ionic strength (of GW) → reduced osmotic driving force / flocculation due to compressed double layers Porewater composition largely depends on pore model (single vs. multi)
Groundwater velocity	Should have limited to no effect within expected range of velocities