

Mitigation of soil liquefaction using biochar

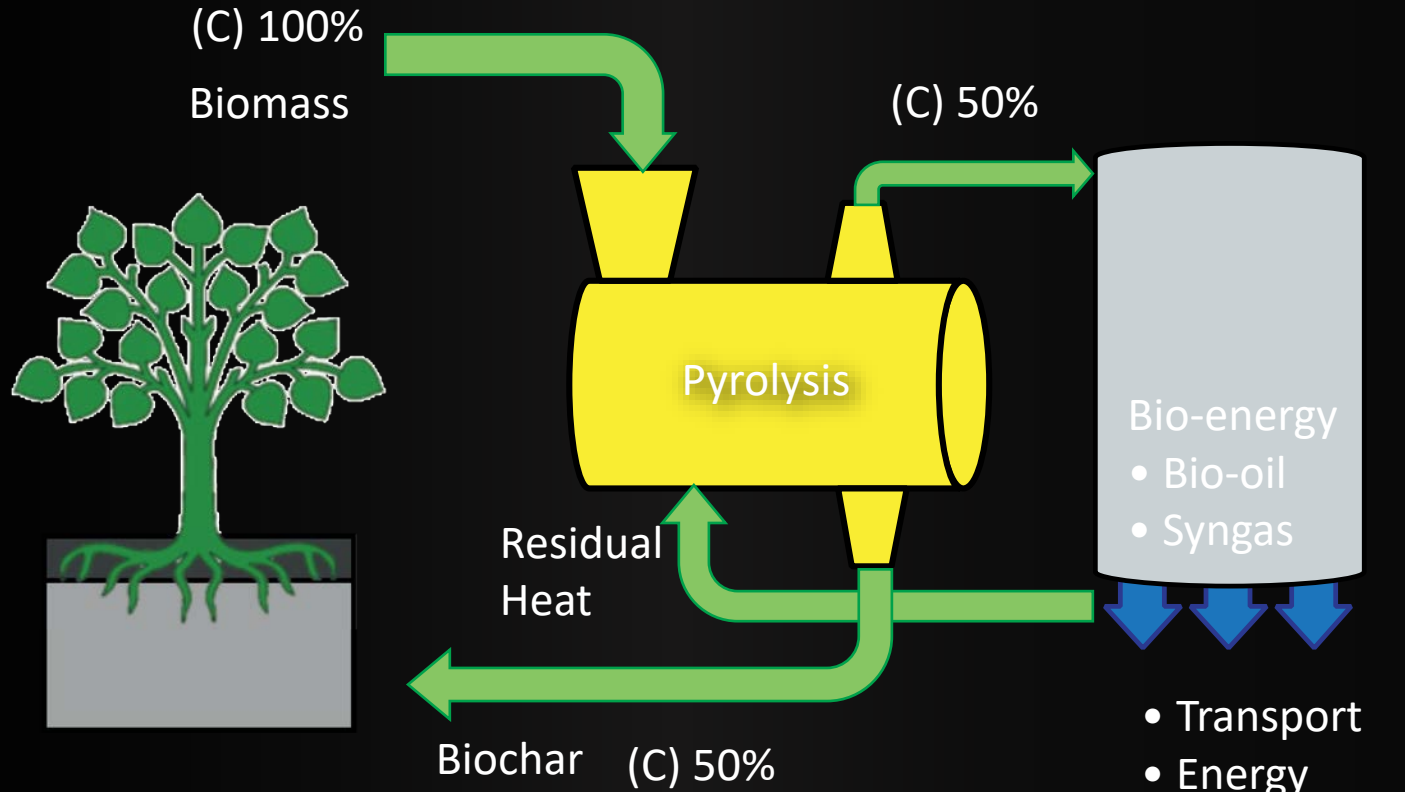
Gislaine Tobar

Geotechnical Engineer, Beca

PhD, University of Auckland

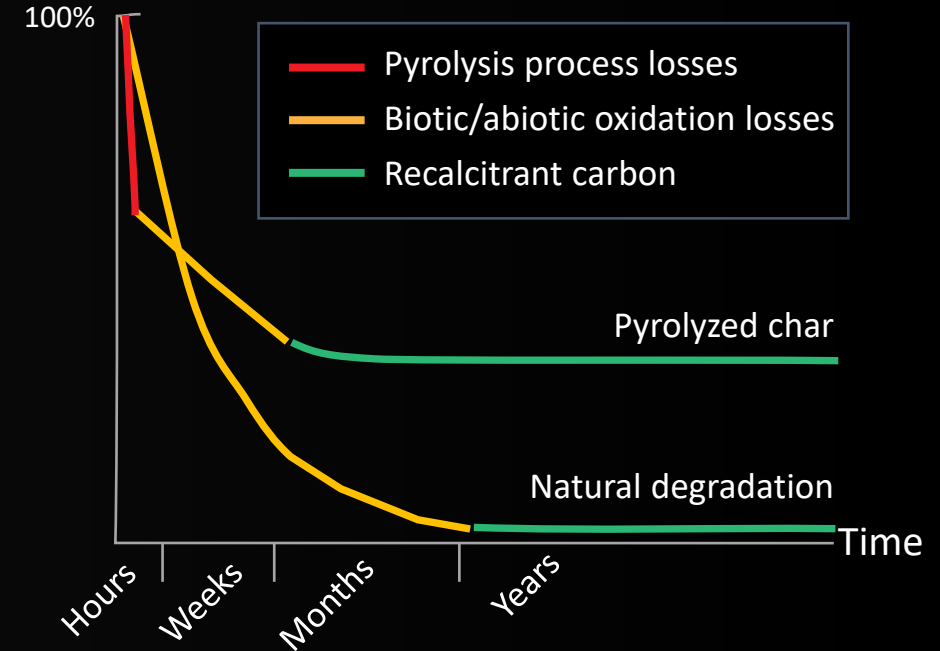


Introduction: Biochar



- Carbon sequestration
- Agricultural applications
- Absorption of contaminants
- Reduce wastes to landfill

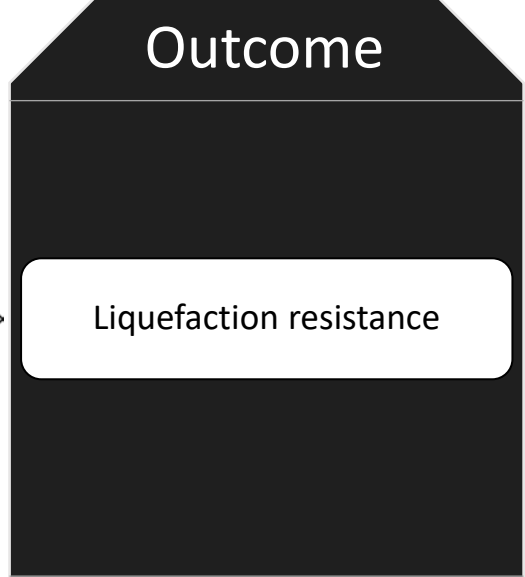
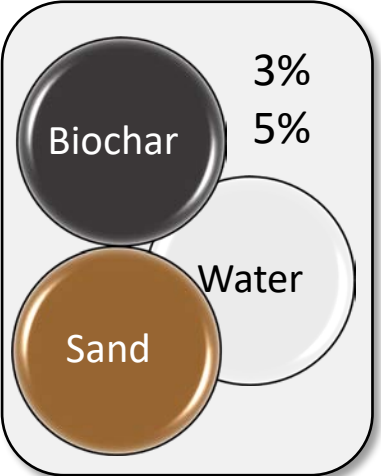
Carbon remaining from biomass



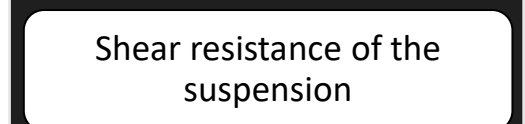
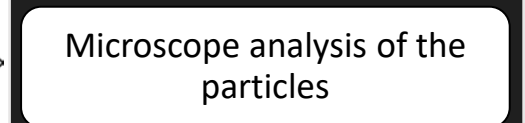
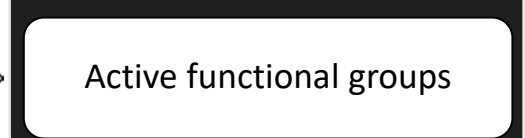
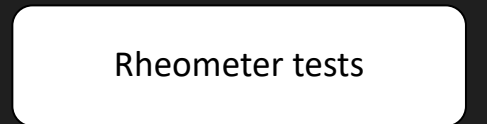
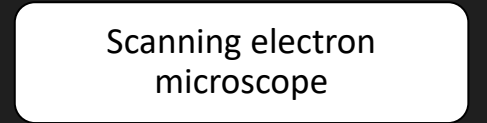
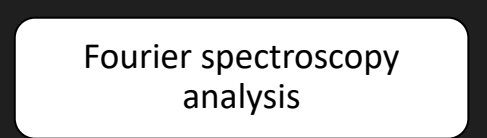
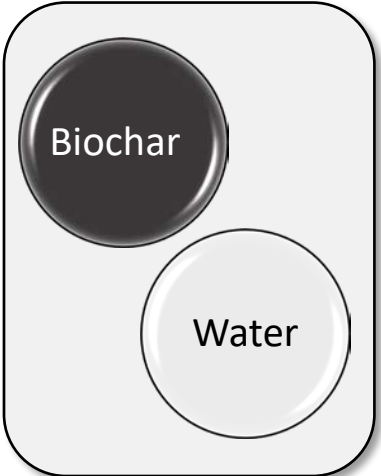
(Brewer et al, 2014)

Methodology

Liquefaction resistance

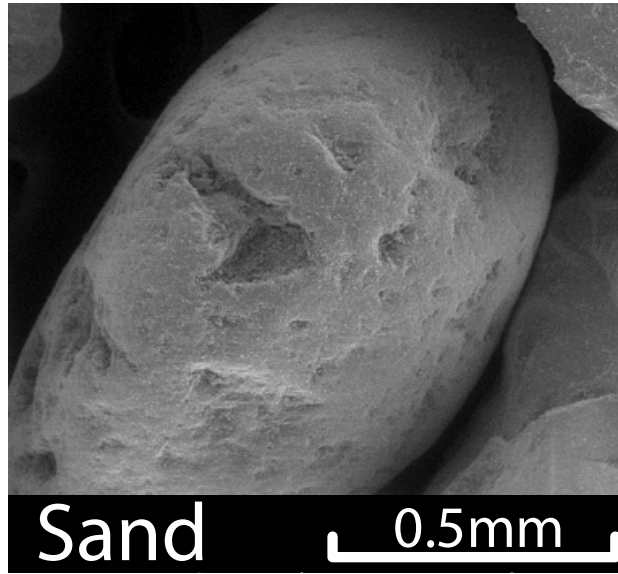
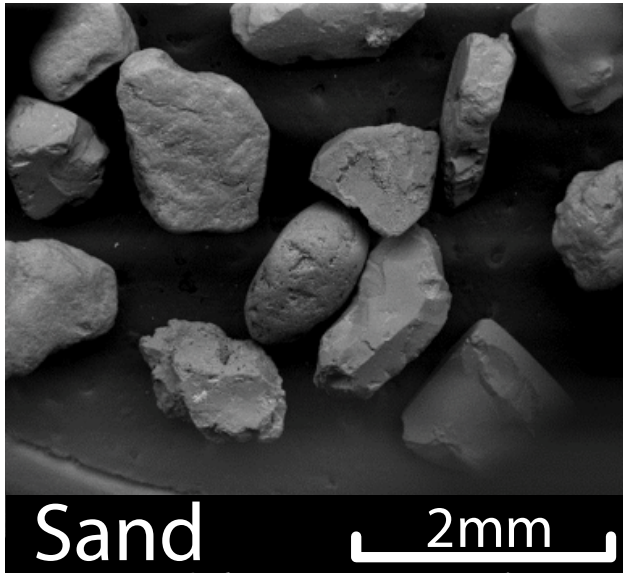


Mechanism

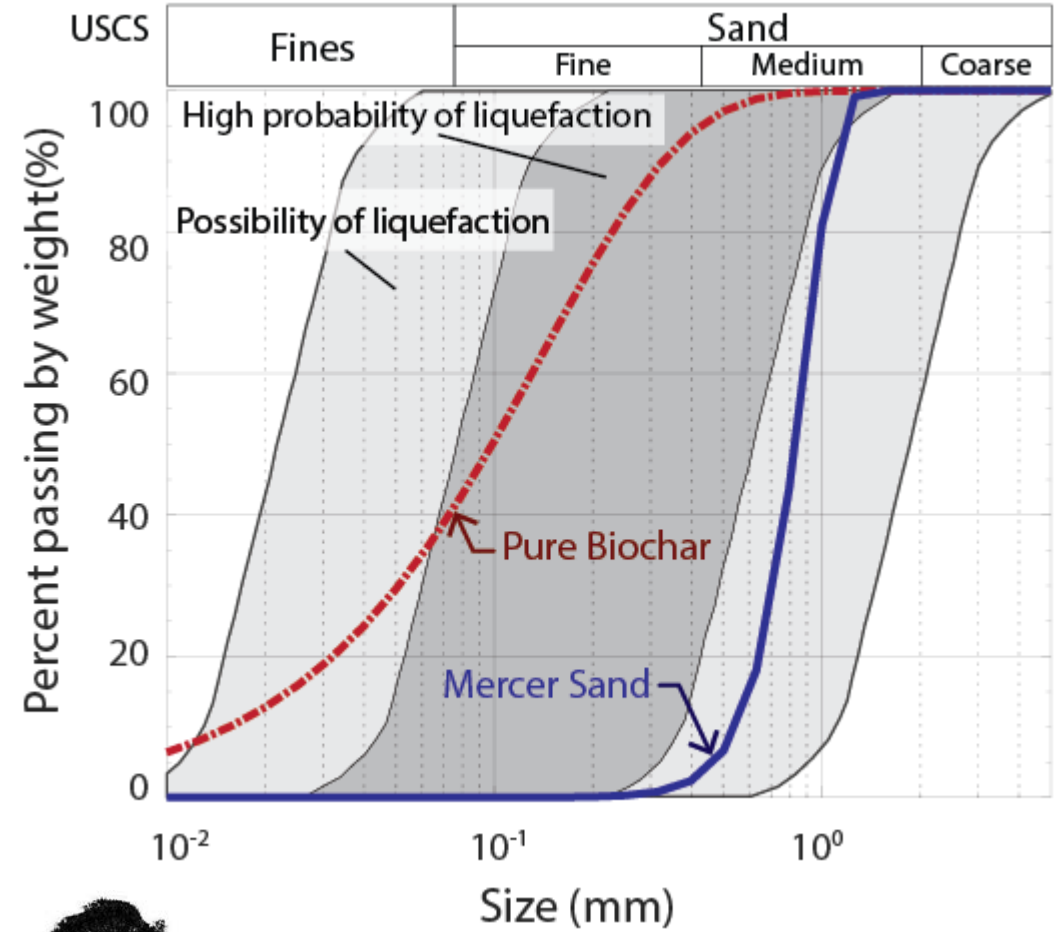
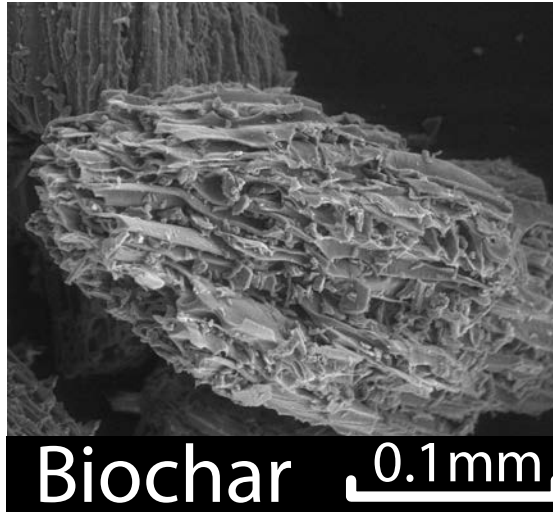
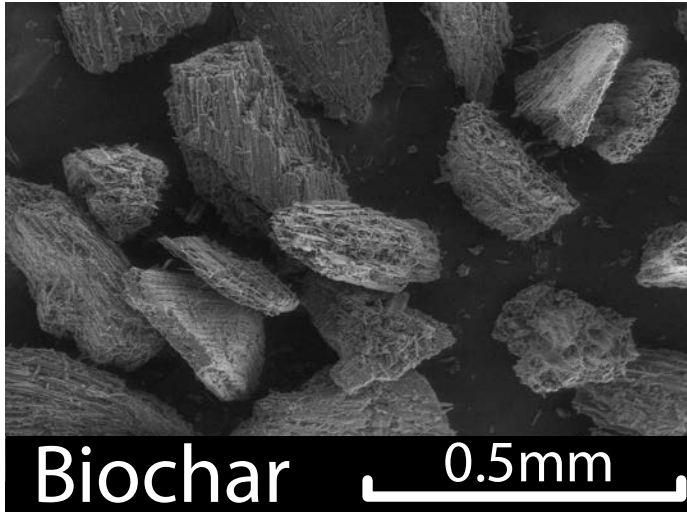


Materials

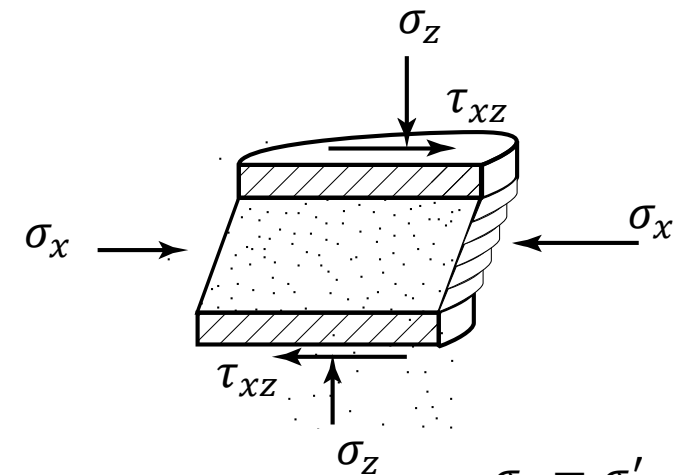
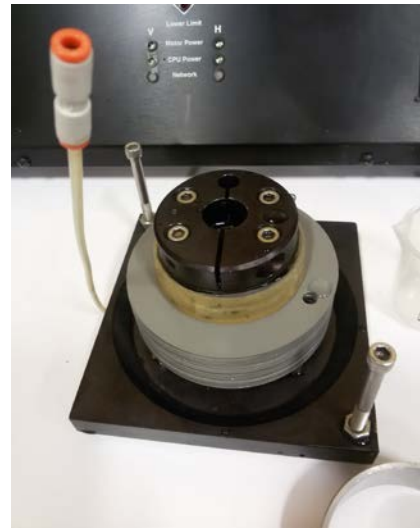
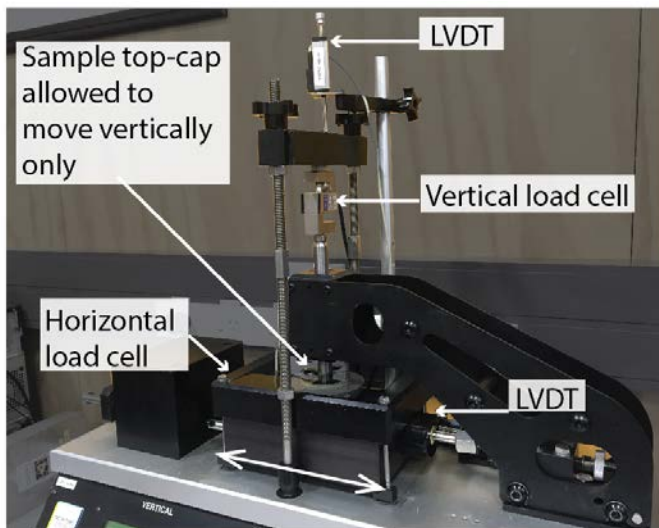
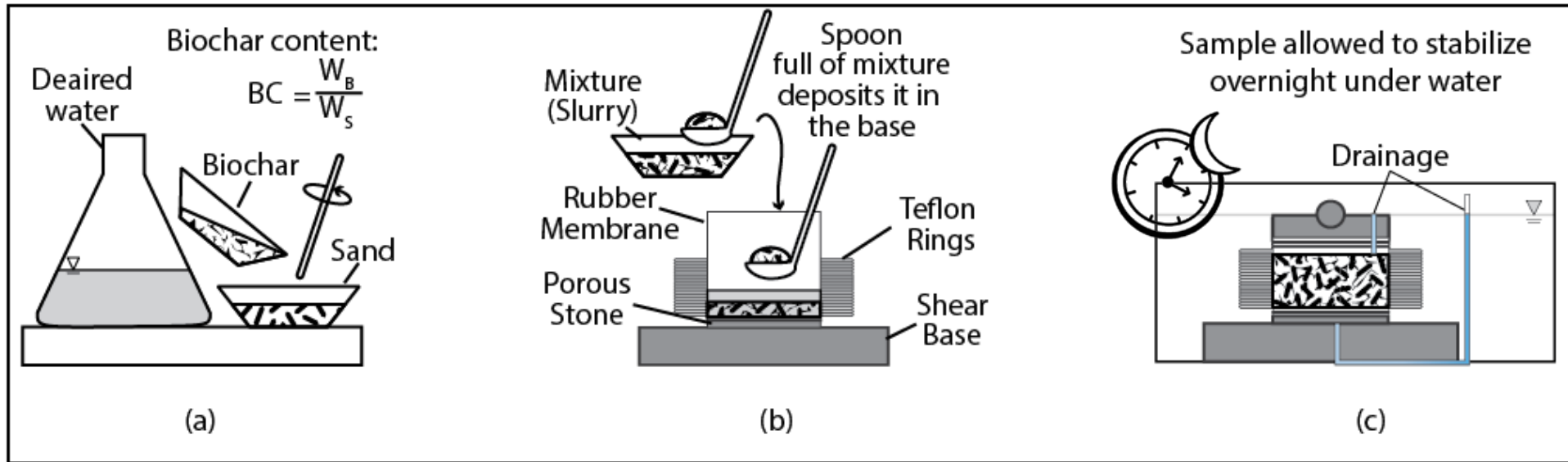
Host Sand



Biochar



Sample preparation



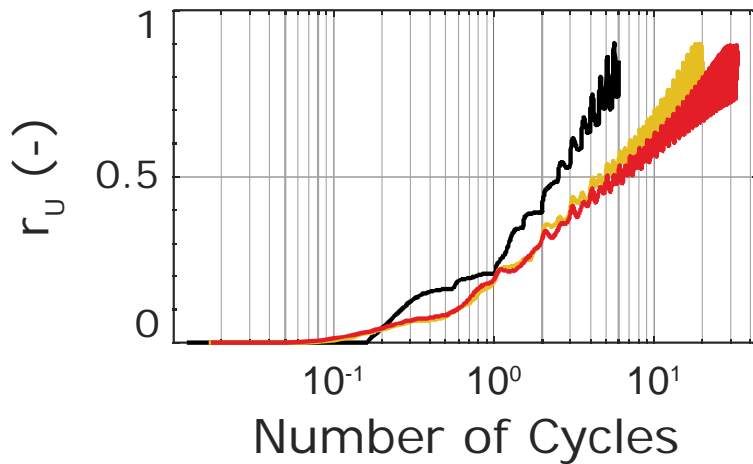
$$\sigma_z = \sigma'_{v0} = 100kPa$$

Undrained cyclic simple shear tests (CSSu)

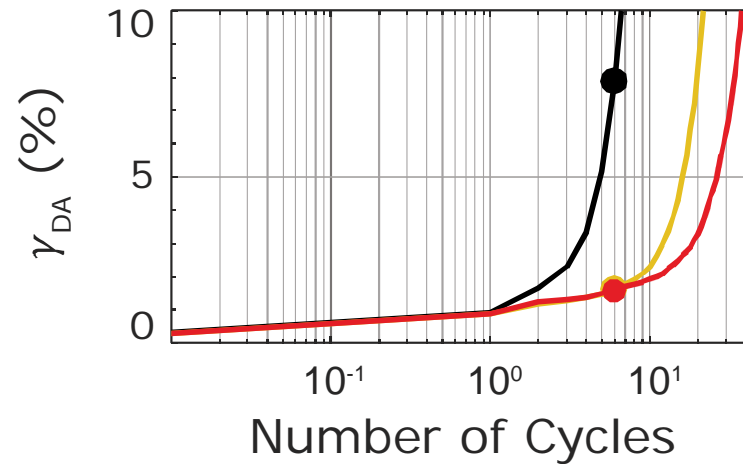
CSR = 0.18

$\sigma'_{v0} = 100kPa$

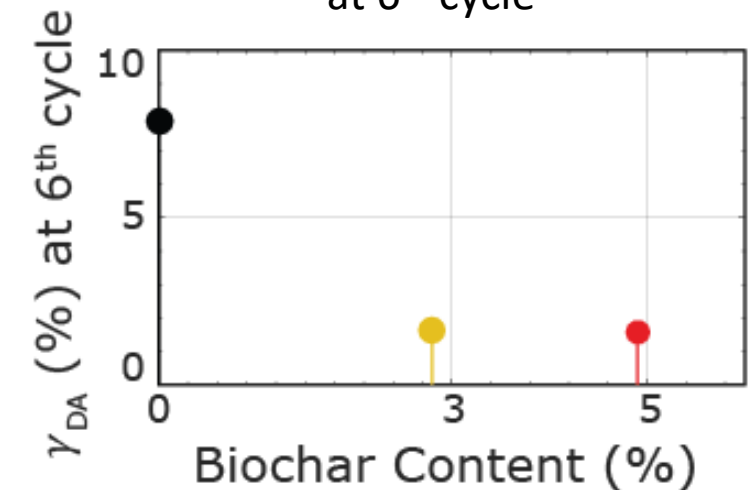
Excess of pore water pressure ratio



Shear strain double amplitude



Shear strain double amplitude at 6th cycle



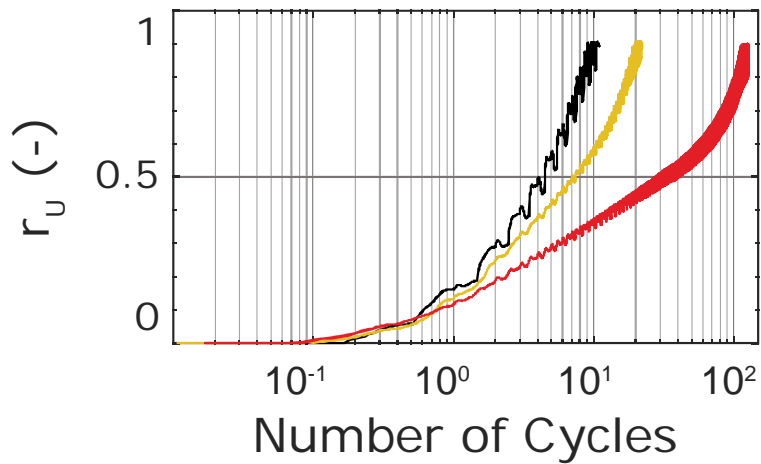
— Clean Sand — 3% Biochar — 5% Biochar

Undrained cyclic simple shear tests

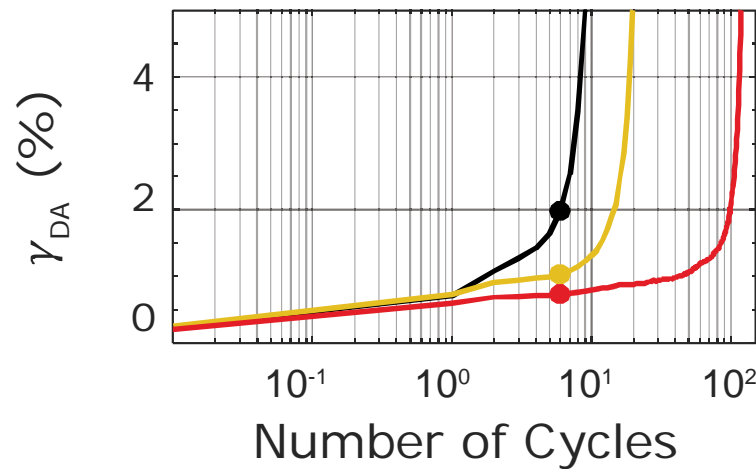
CSR = 0.14

$\sigma'_{v0} = 100kPa$

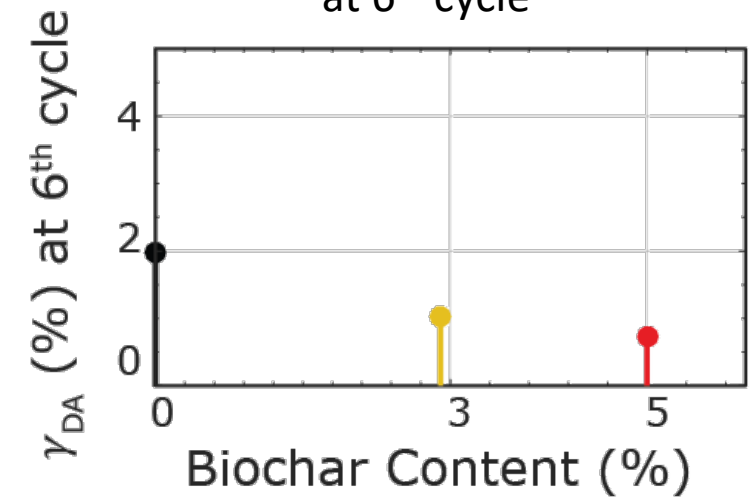
Excess of pore water pressure ratio



Shear strain double amplitude



Shear strain double amplitude at 6th cycle



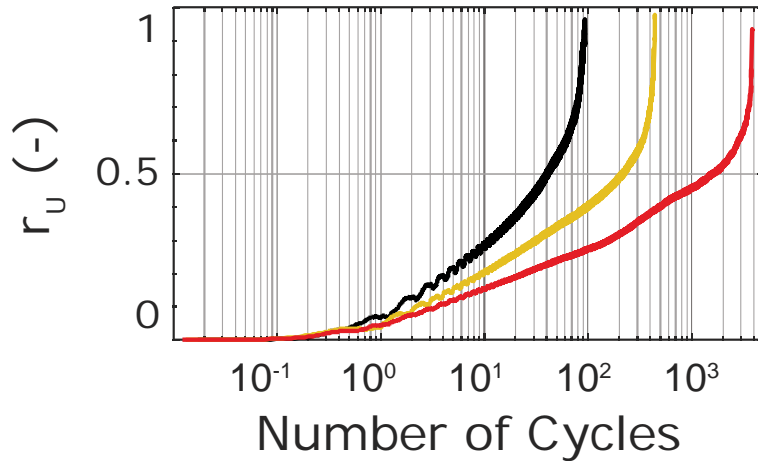
— Clean Sand — 3% Biochar — 5% Biochar

Undrained cyclic simple shear tests

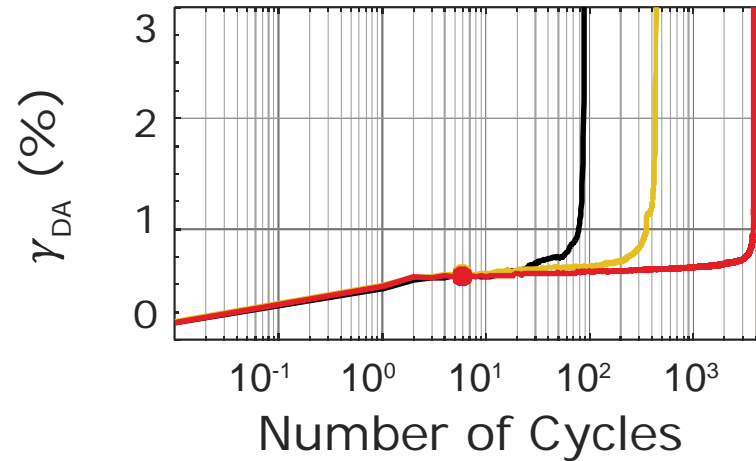
CSR = 0.09

$\sigma'_{v0} = 100kPa$

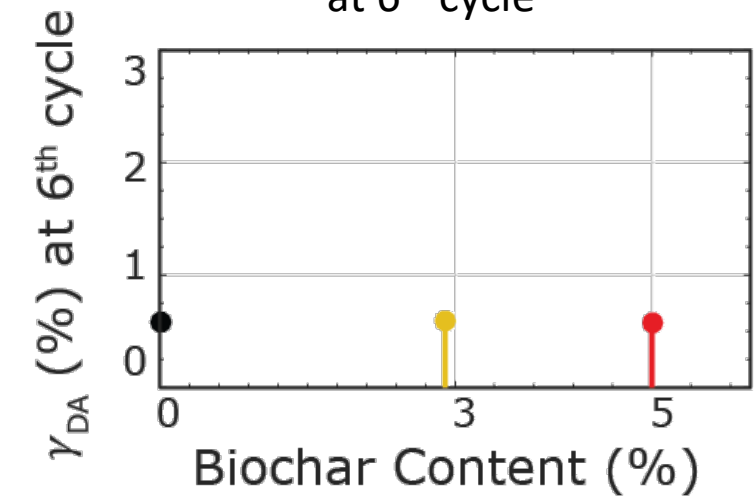
Excess of pore water pressure ratio



Shear strain double amplitude

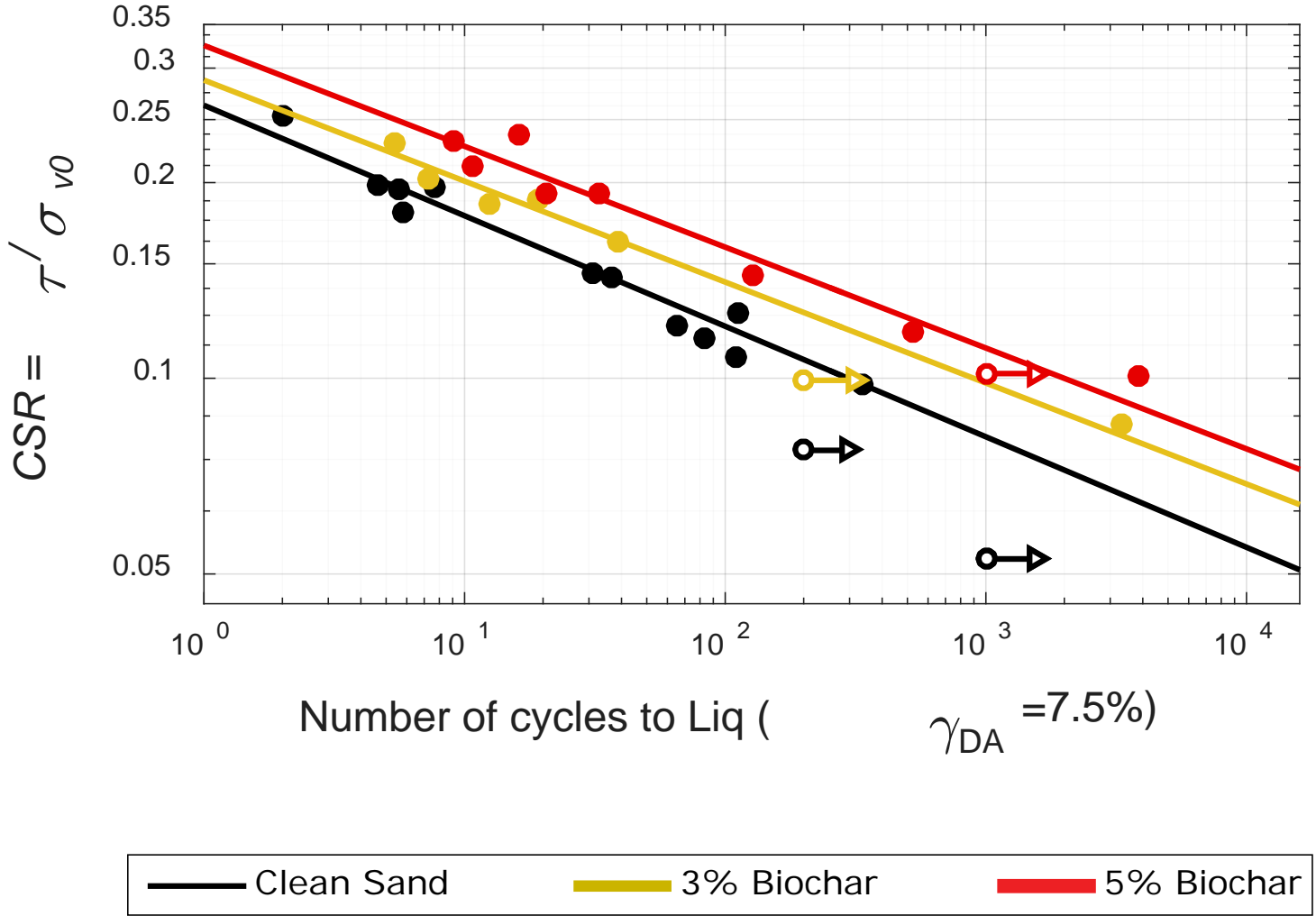


Shear strain double amplitude at 6th cycle

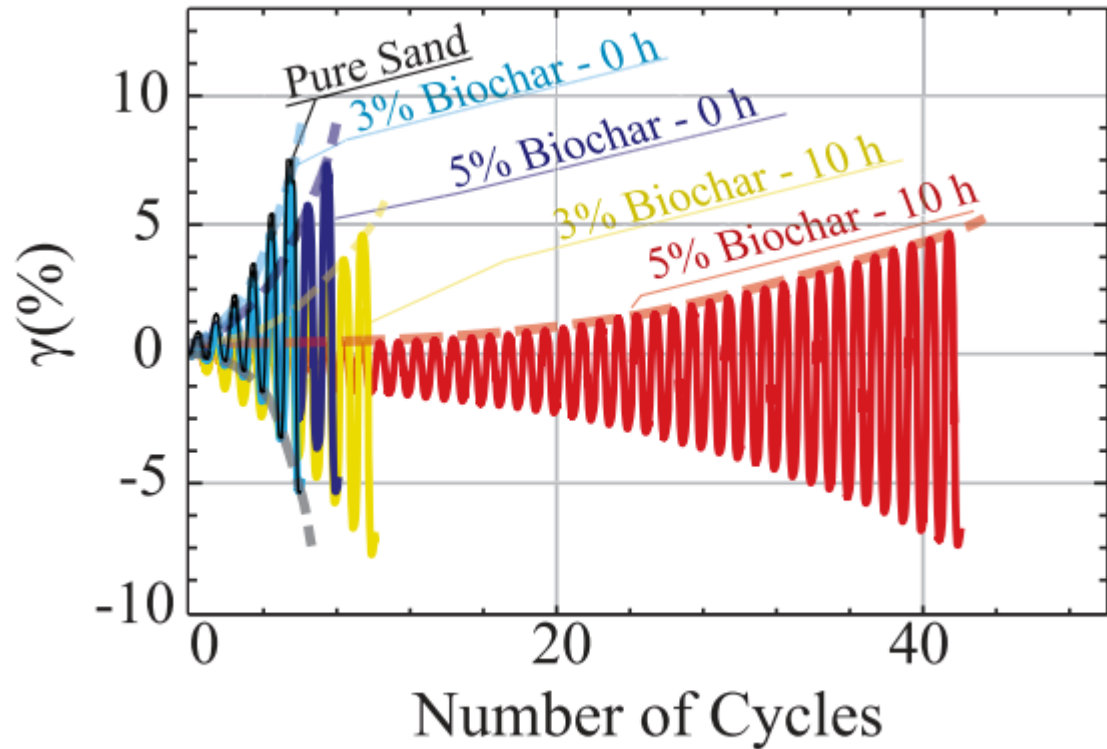


— Clean Sand — 3% Biochar — 5% Biochar

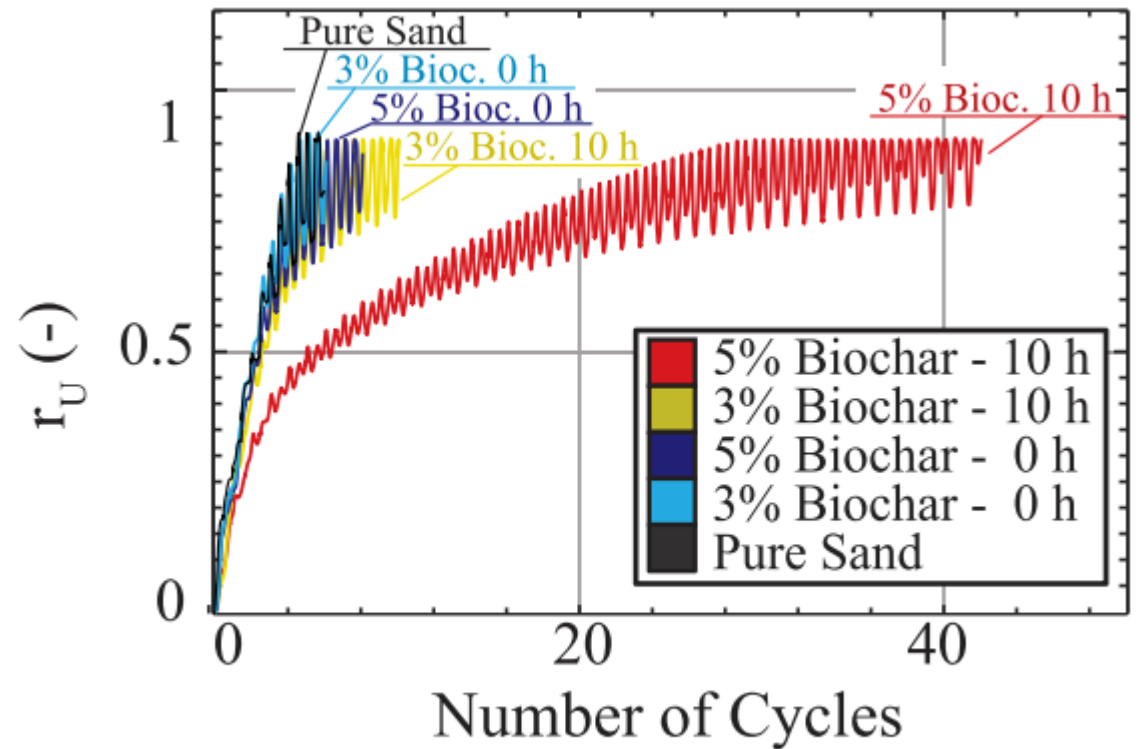
Undrained cyclic simple shear tests



Effect of time on the cyclic resistance at $CSR \approx 0.2$



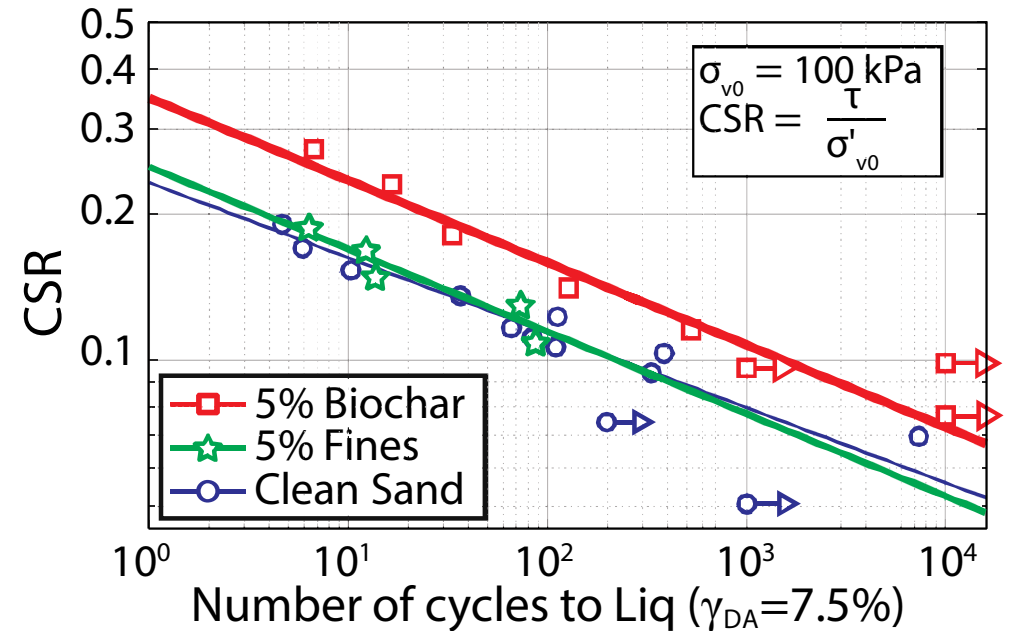
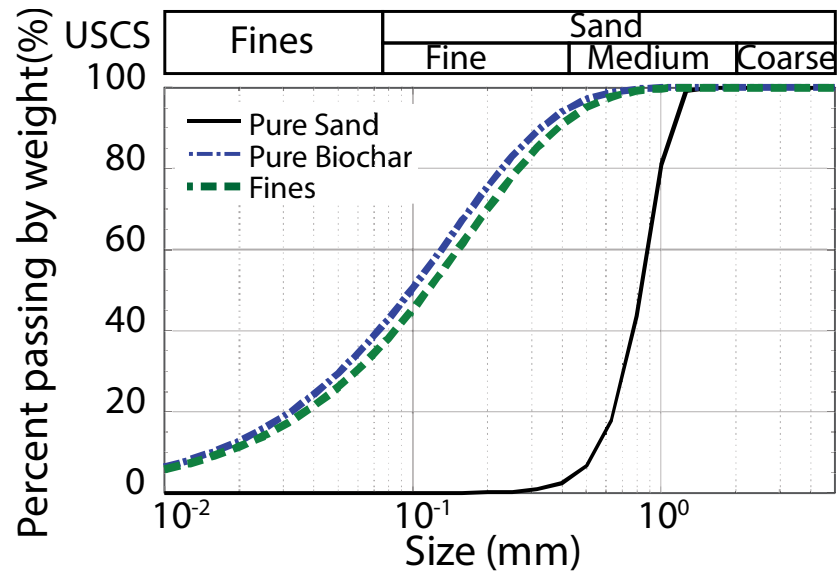
(a) Shear strain



(b) Excess pore water pressure ratio

Cyclic Simple Shear Tests (CSST)

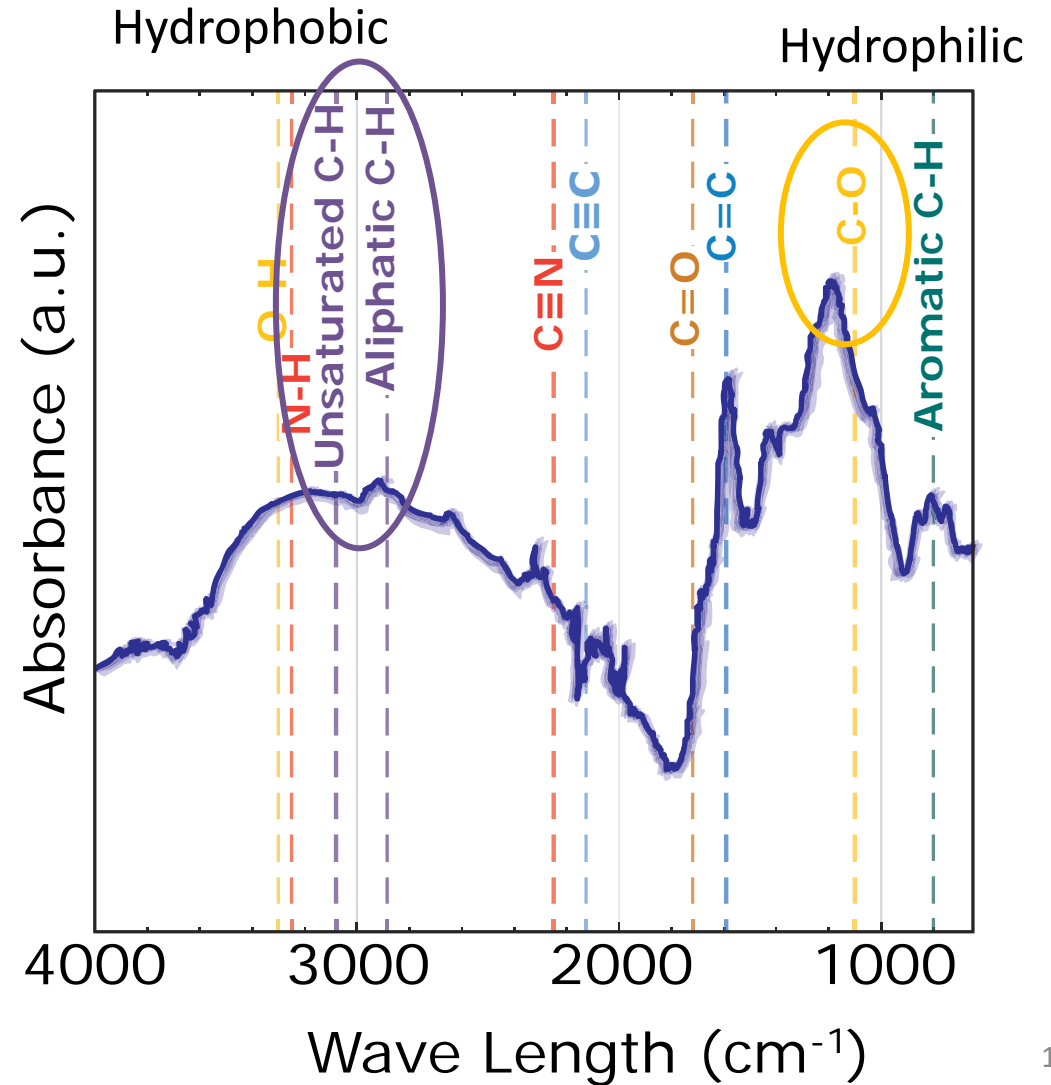
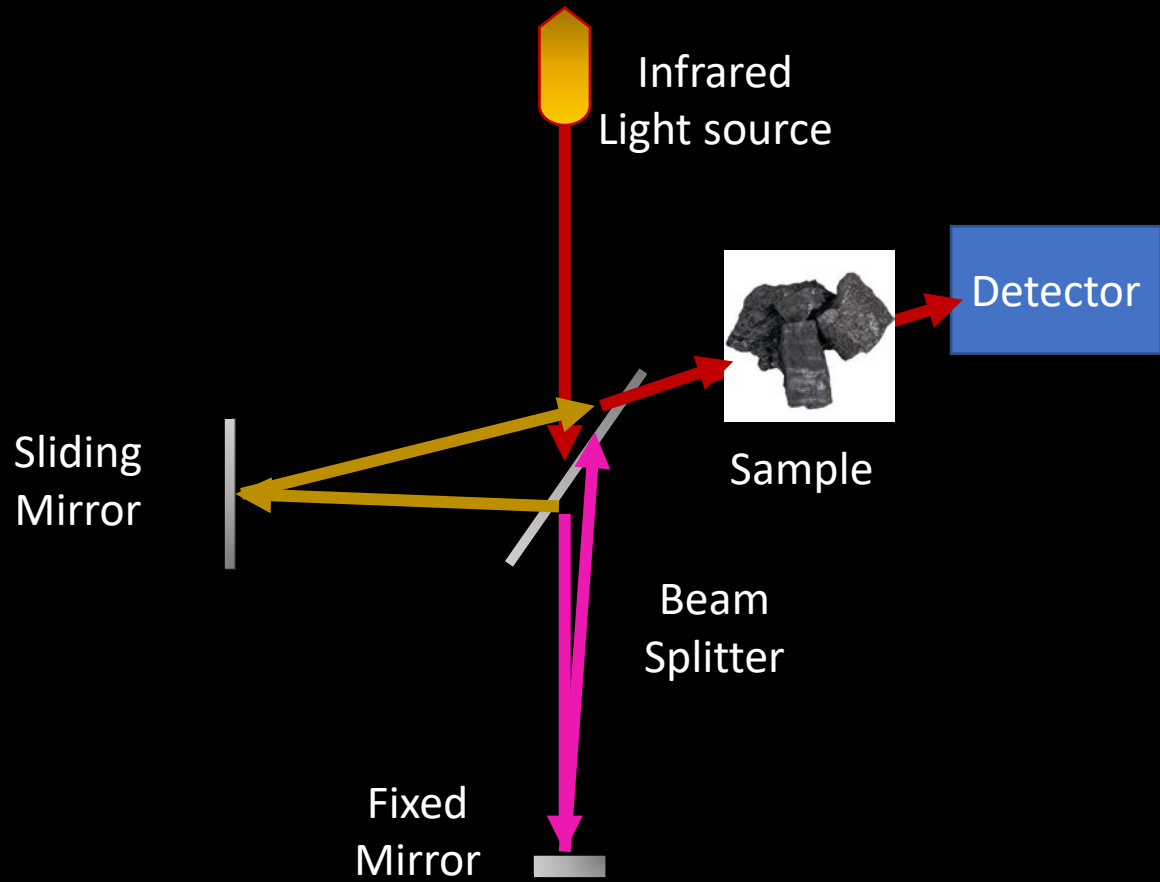
Comparison with adding 5% silty sand with similar grain size distribution than biochar



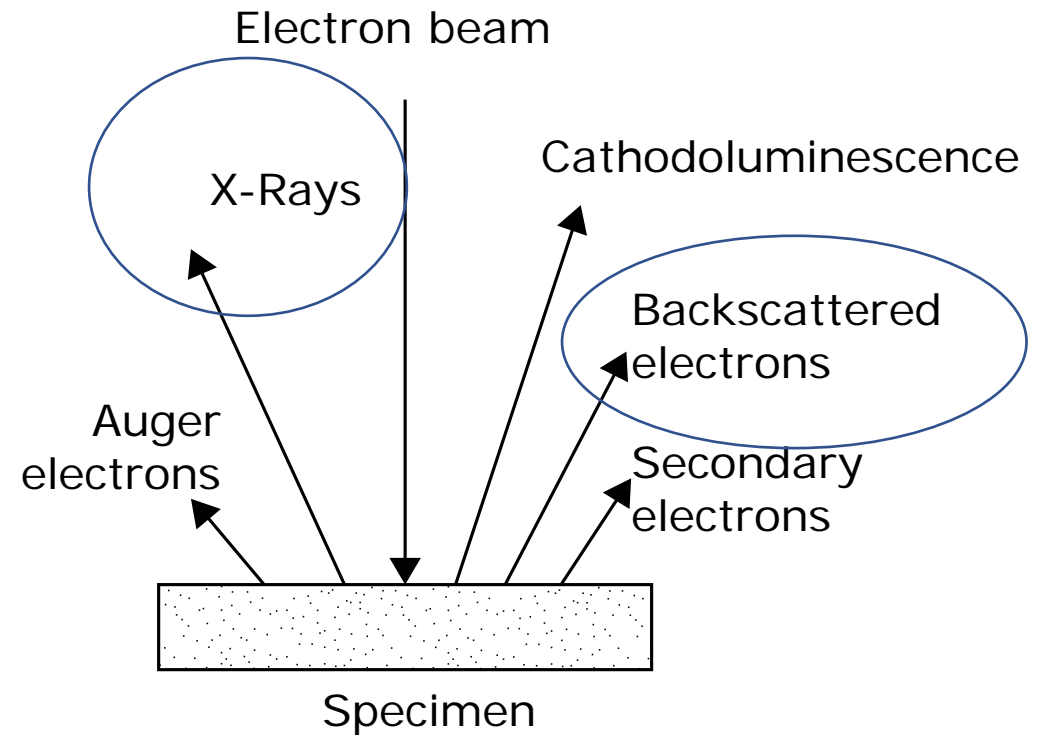
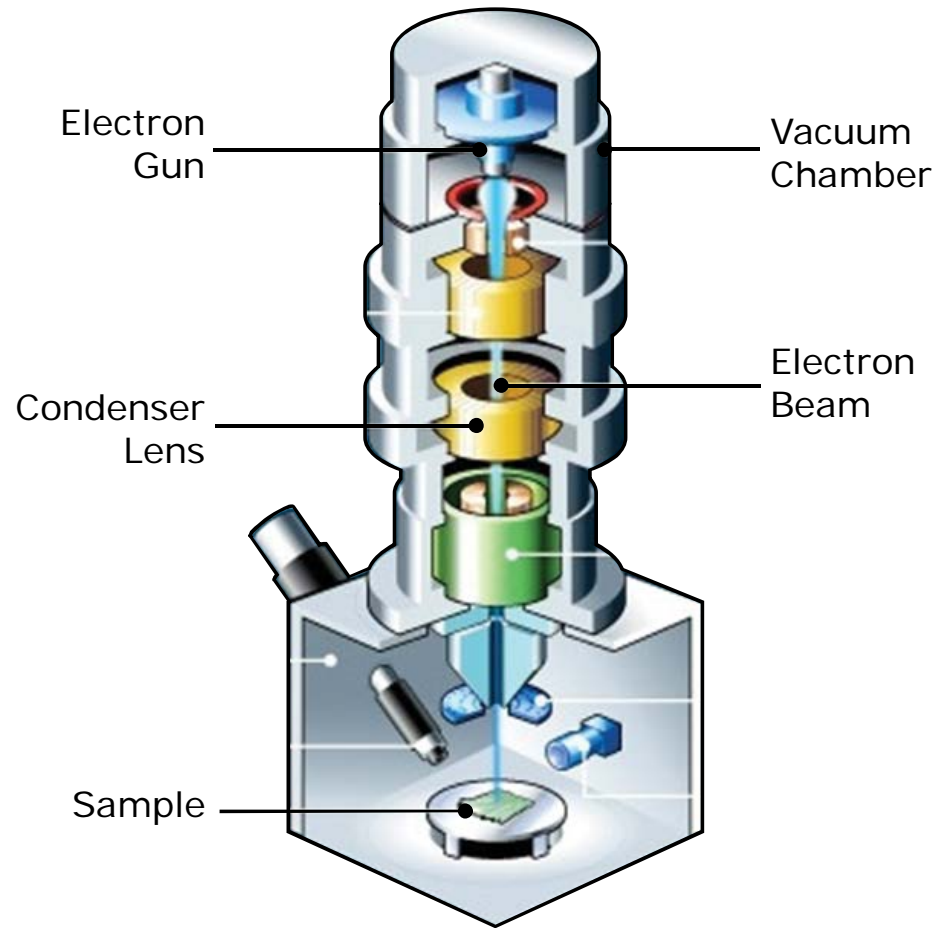
Mechanism



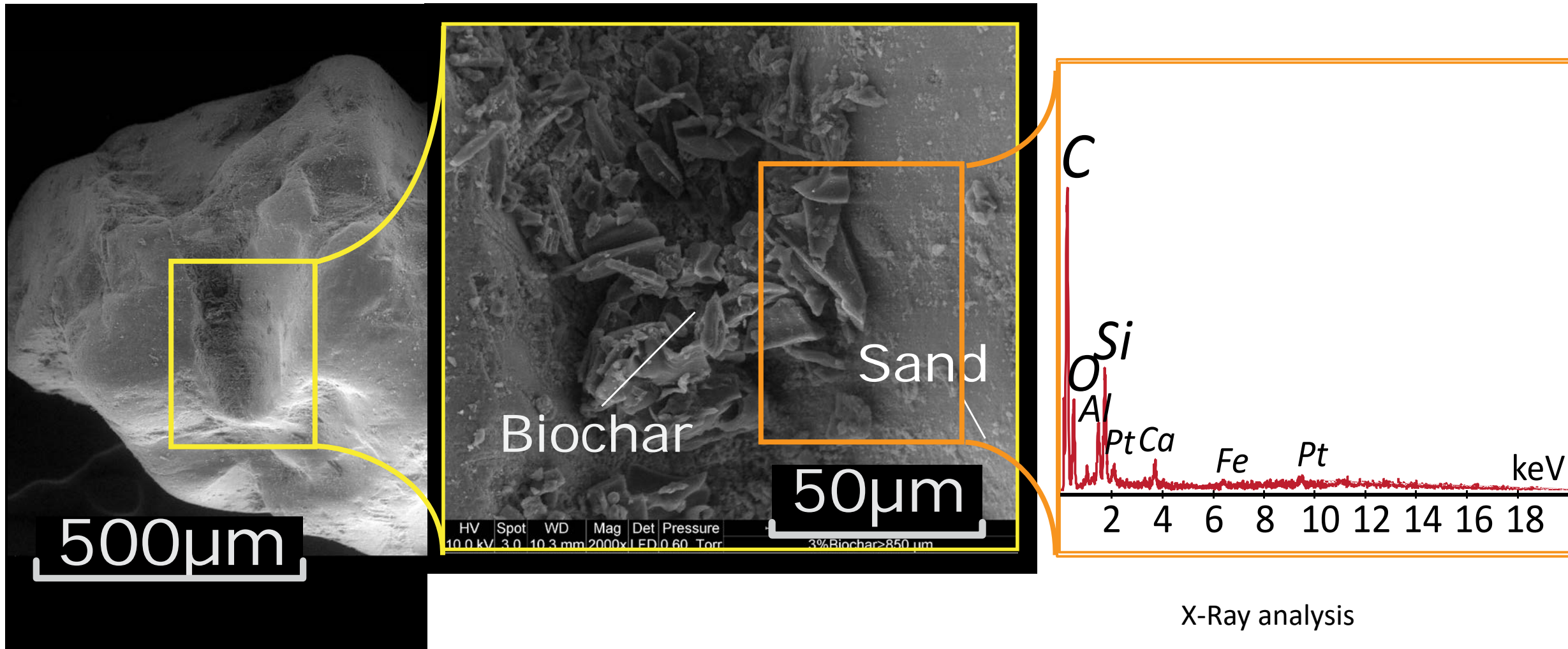
Fourier-Transform Infrared (FTIR) spectrometry



SEM: Scanning Electron Microscope



SEM: Scanning Electron Microscope



ESEM: Environmental Scanning Electron Microscope

Biochar
+ Water

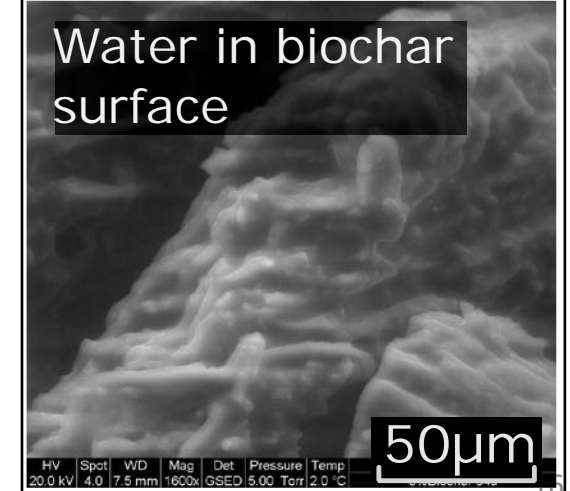
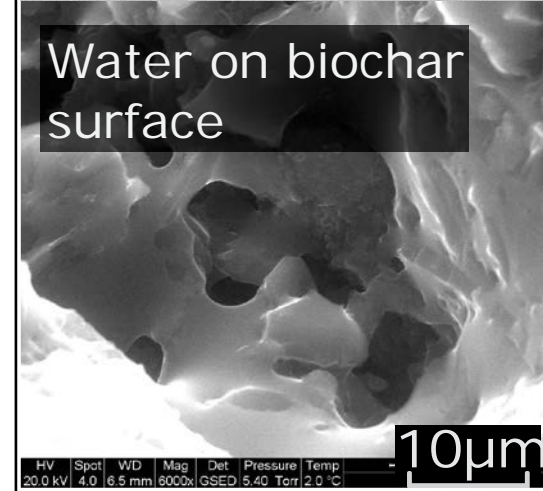
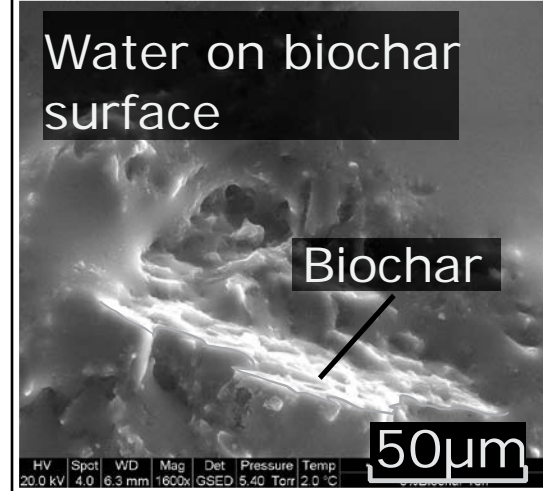
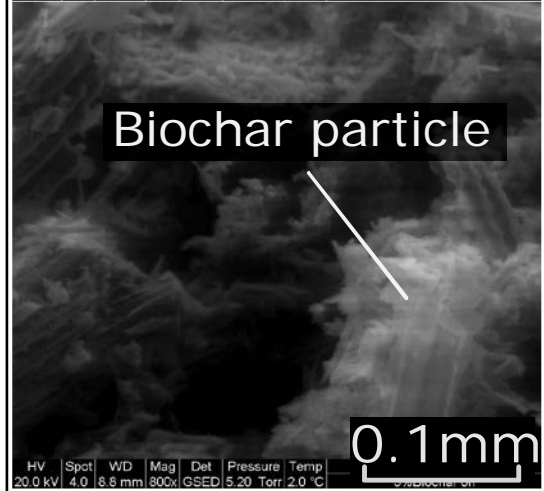
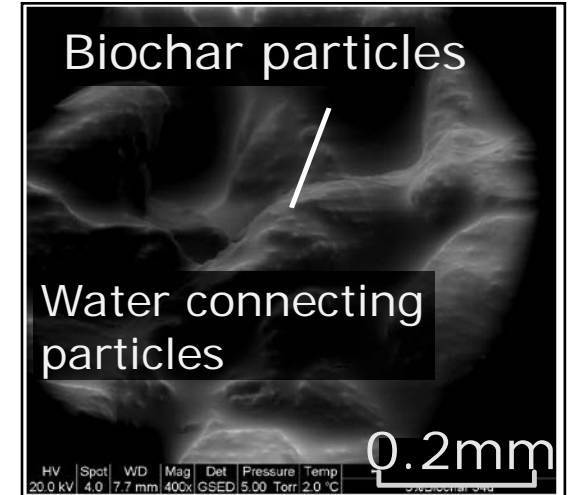
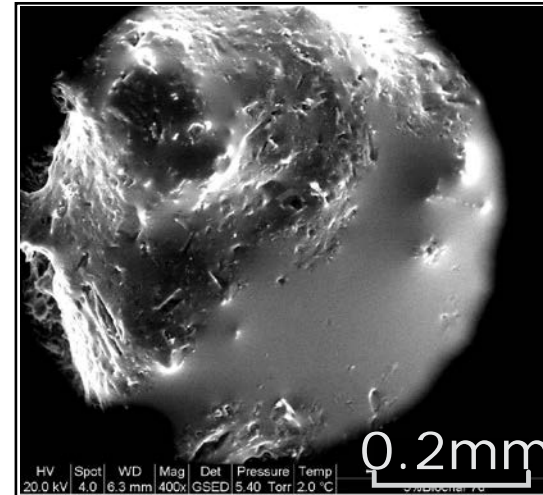
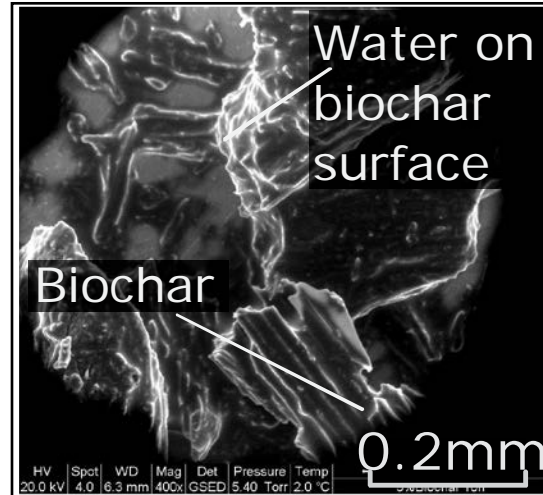
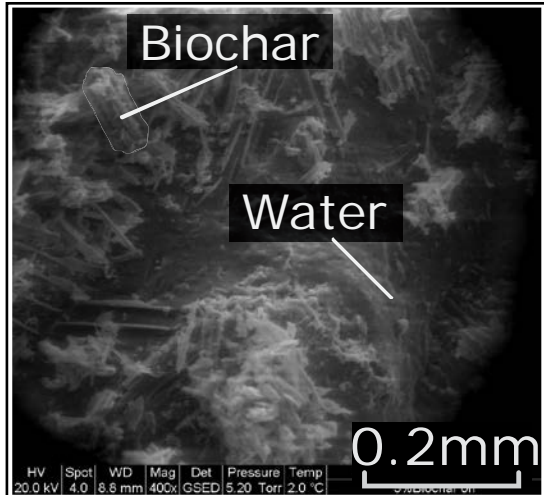


< 1 hour

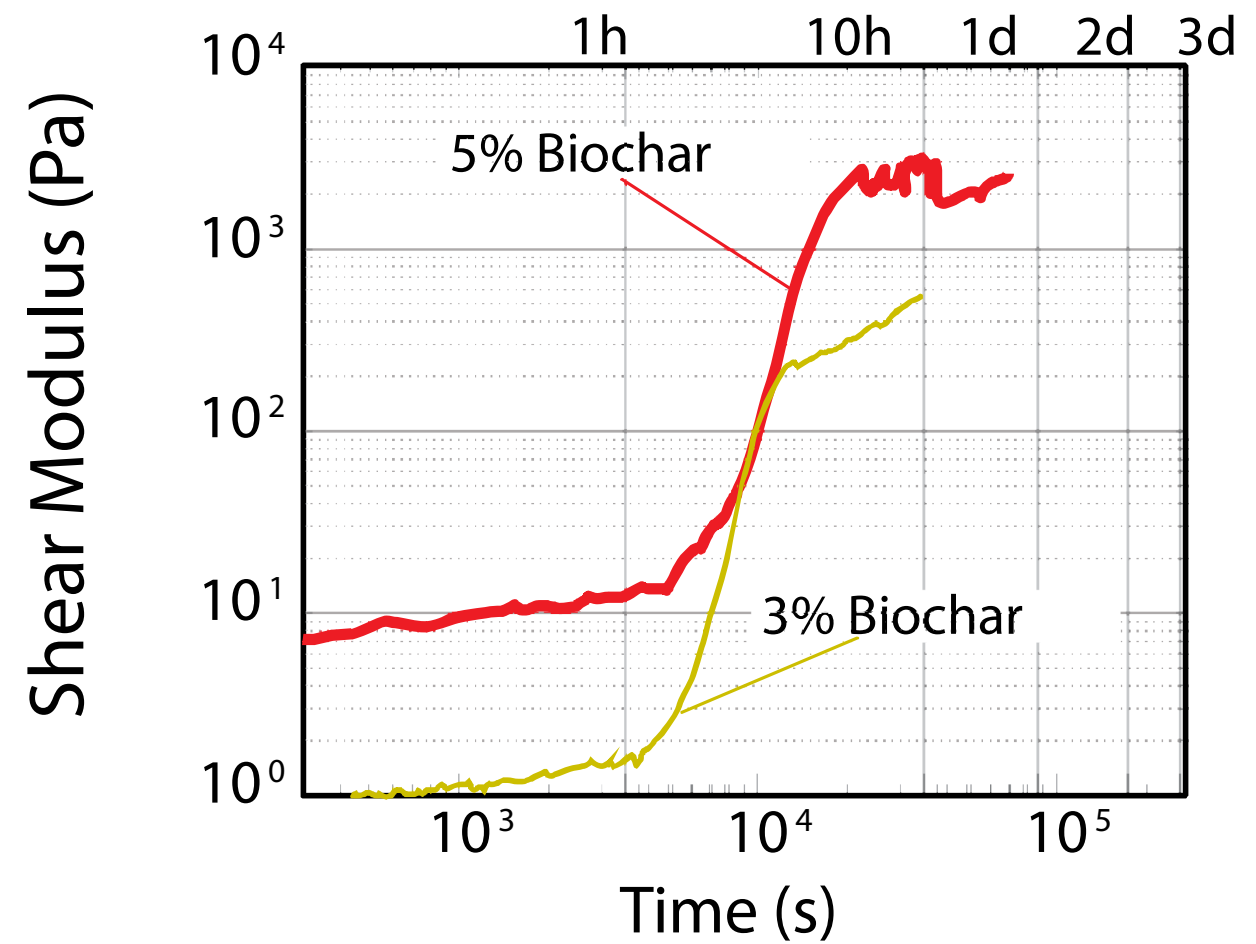
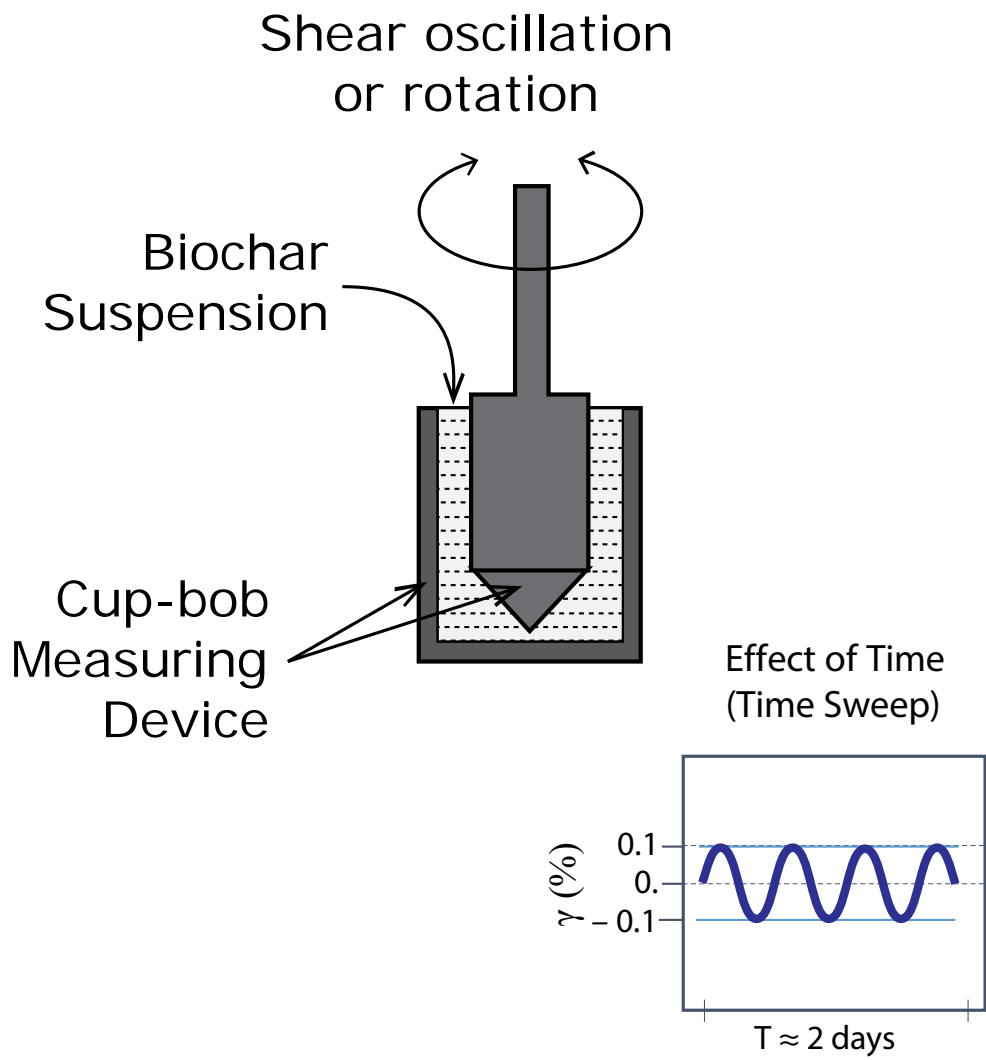
~ 10 hours

~ 1 week

~ 1 month

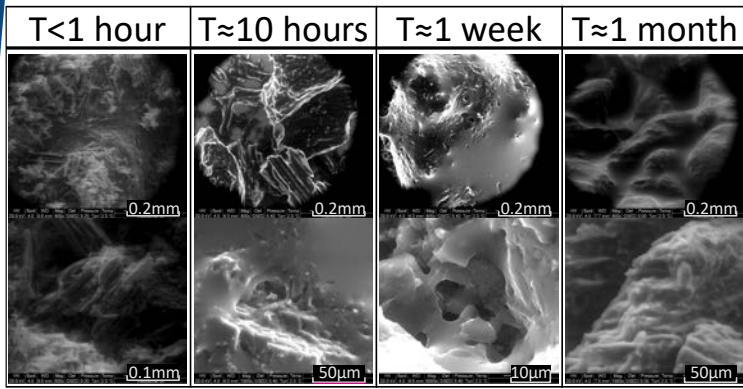
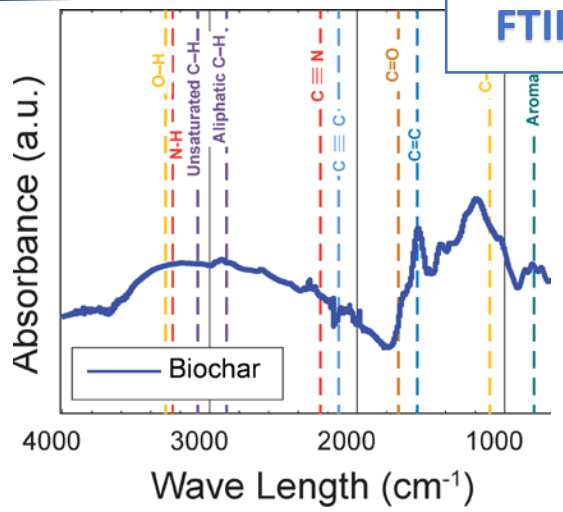
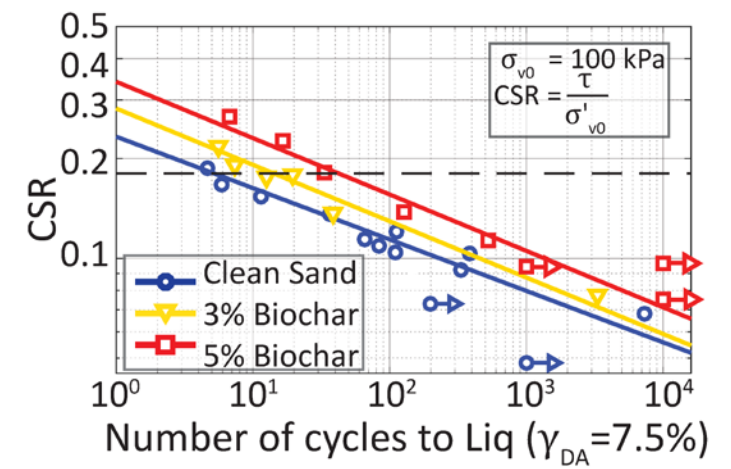
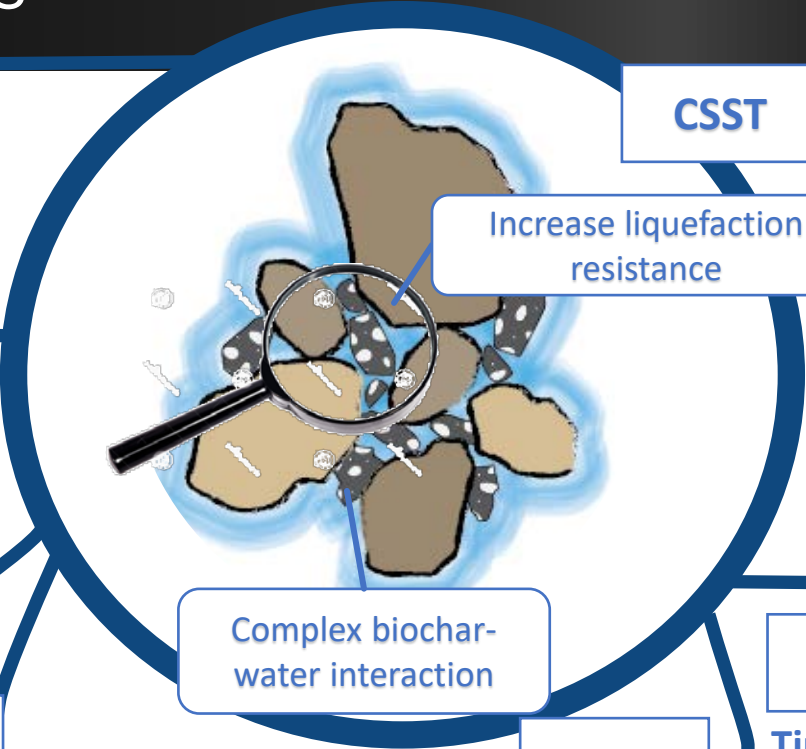
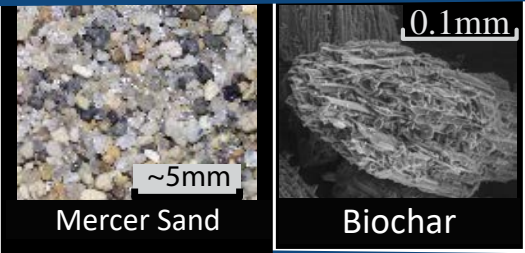


Rheological Measurements



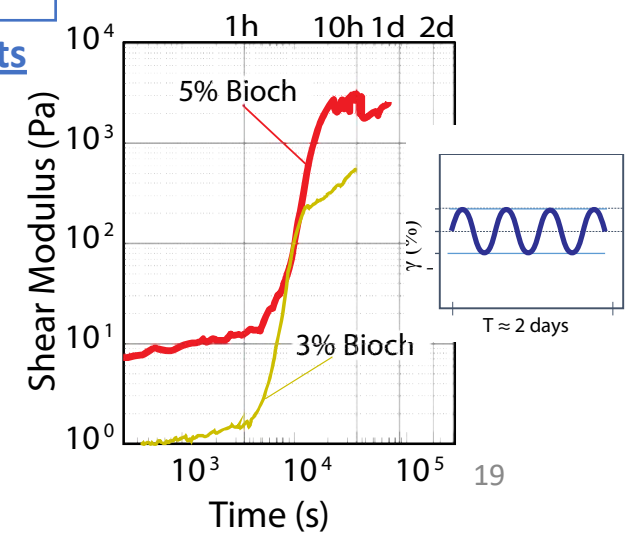
Concluding remarks

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Rheometer

Time sweep tests
(time effect)



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Thank you!
Questions?

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