



SCAN ME

Or visit:

pollev.com/evanmascitti998

Who's in the audience?

Grounds manager - water access

Grounds manager - no water access

Contractor

Soil supplier

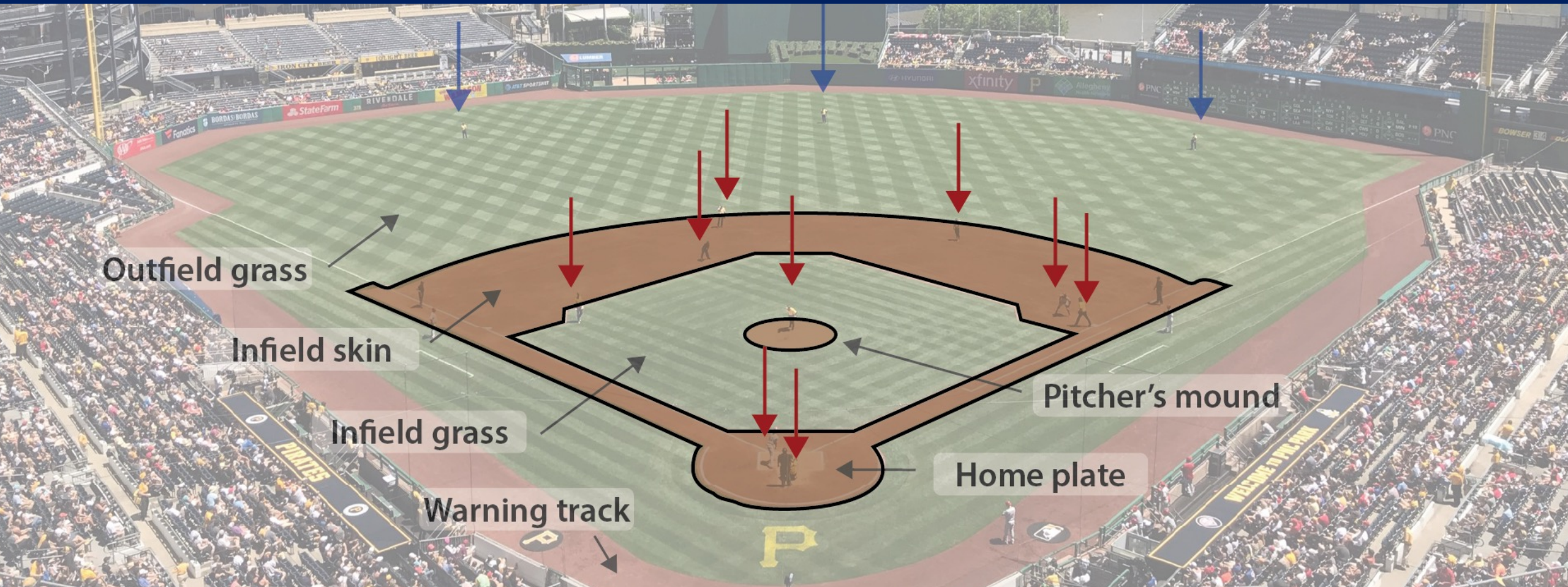
Academic/research

Other

New lab tests for infield soils

Evan C. Mascitti

2023-03-02



Outfield grass

Infield skin

Infield grass

Warning track

Pitcher's mound

Home plate

SPORTSTURF

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MARCH 2002

INTO THE MIX

In search
of the
ideal infield

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MARCH 2002

INTO THE MIX

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What's the skinny on the skin?

We are building a new high school baseball field and want to use the right kind of dirt for the infield skin. Our existing field was native soil that had been conditioned over the years with calcined clay to make a pretty good mix. When the moisture is just right it played great but we are prone to rainouts since we don't have infield rain covers. Is there any standard for making the baseball infield dirt?

clay, and sand. Crushed rock, bark chips, Ag-lime, and organic binders have also been used as local materials to amend existing skins or to serve as the pre-dominate material for construction or renovation.

There are many manufactured ball field mixes that may or may not fit these standards. Suppliers, sports turf managers, and coaches have developed different commercial mixes from their experience with local materials. Whenever possible consider using a processed and consistent ball field mix. As



Setting a realistic standard for infield mixes: opinions from the experts

➤ **REGIONS PARK**, Hoover, AL, courtesy of Southern Athletic Fields, Inc.

kind of slope on your infield to

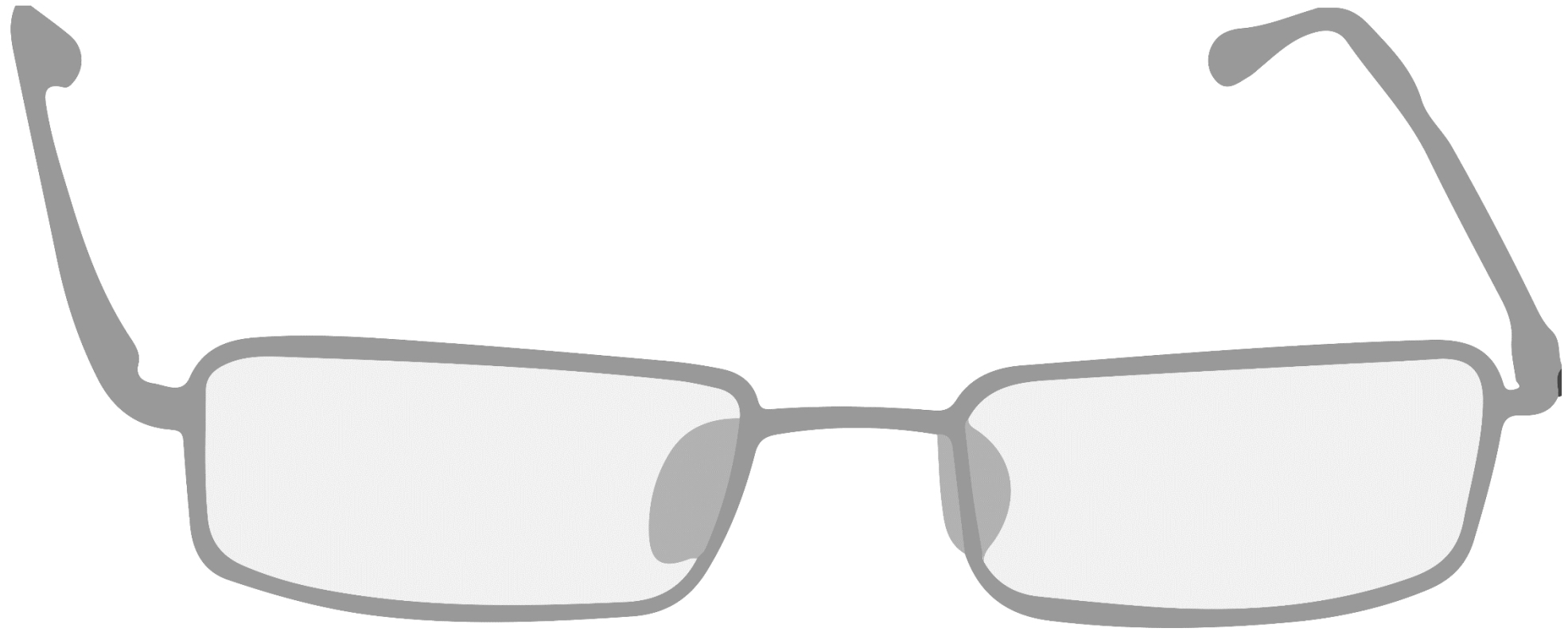
Current ideas

- Total sand (55-75 %)
- Sand sizes (>2/3 of the sand > 0.25 mm)
- Silt-to-clay ratio (0.5-1)

Particle size analysis isn't the whole story!

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What happens when the dirt gets wet?



2 parts to this presentation:

- Ways to think about clay soils
- Cleat-in/cleat-out test



small range | difficult to manage



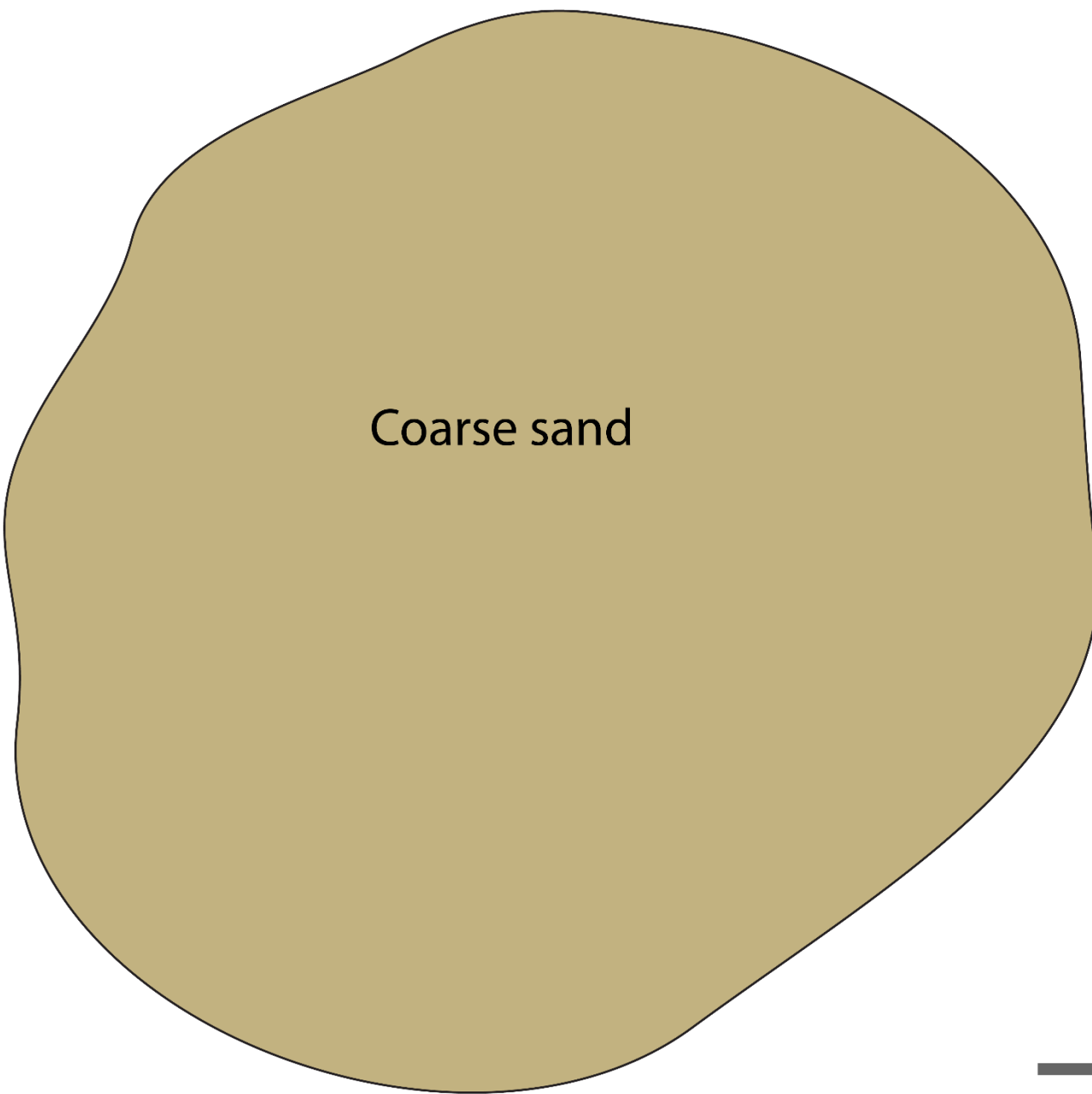
wider range | easier to manage



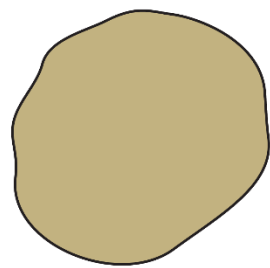
Part I: What's clay anyway?

What *are* silt and clay ???

- 3 definitions:
 - Particle size
 - Mineralogy
 - Behavior
- "Clays are soils which contain enough clay minerals to affect their engineering behavior."
 - Holtz et al. (2010)



Coarse sand



Fine sand



Silt



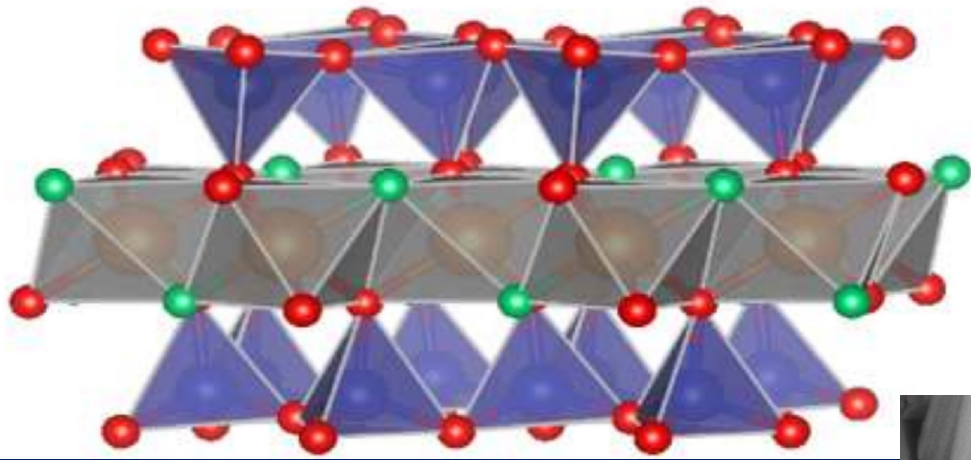
Coarse clay

Fine clay
(not visible at this scale)

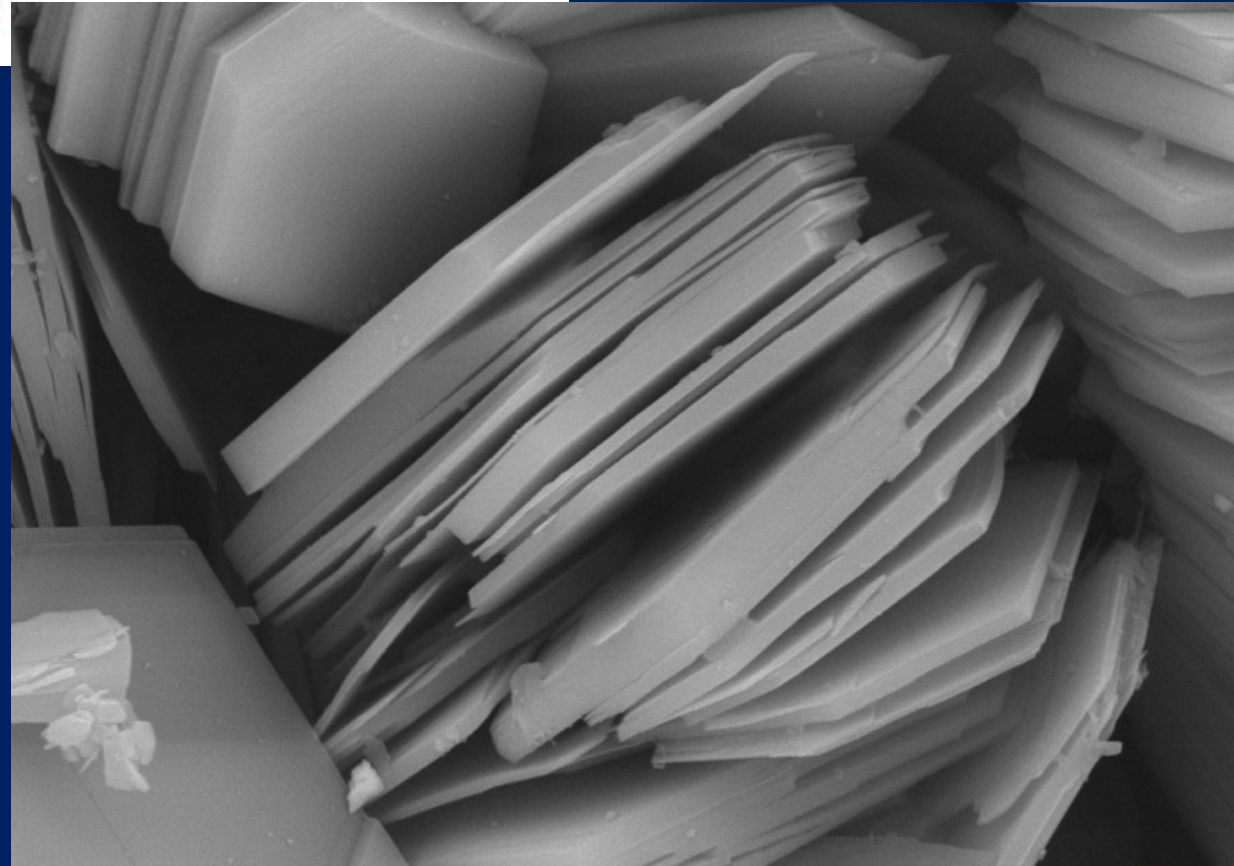
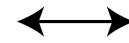
1 mm



weak bonds



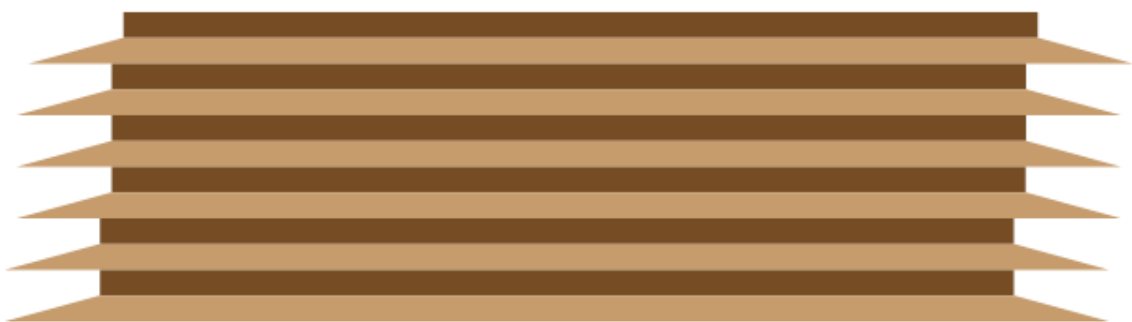
strong bonds



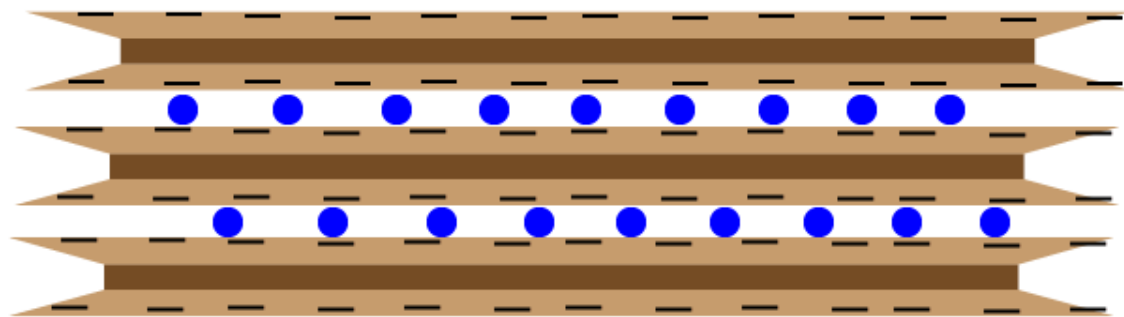
2 μm

20.00 kV AsB

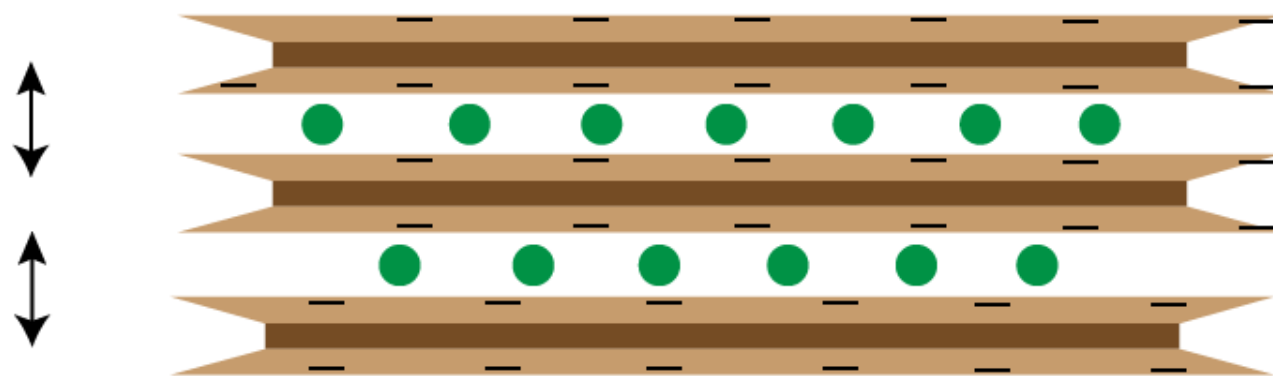
WD = 7.3 mm



Kaolinite (1:1), non-expansive



Illite (2:1), non-expansive



Smectite (2:1) expansive



plas·ti·kos



plas·ti·kos





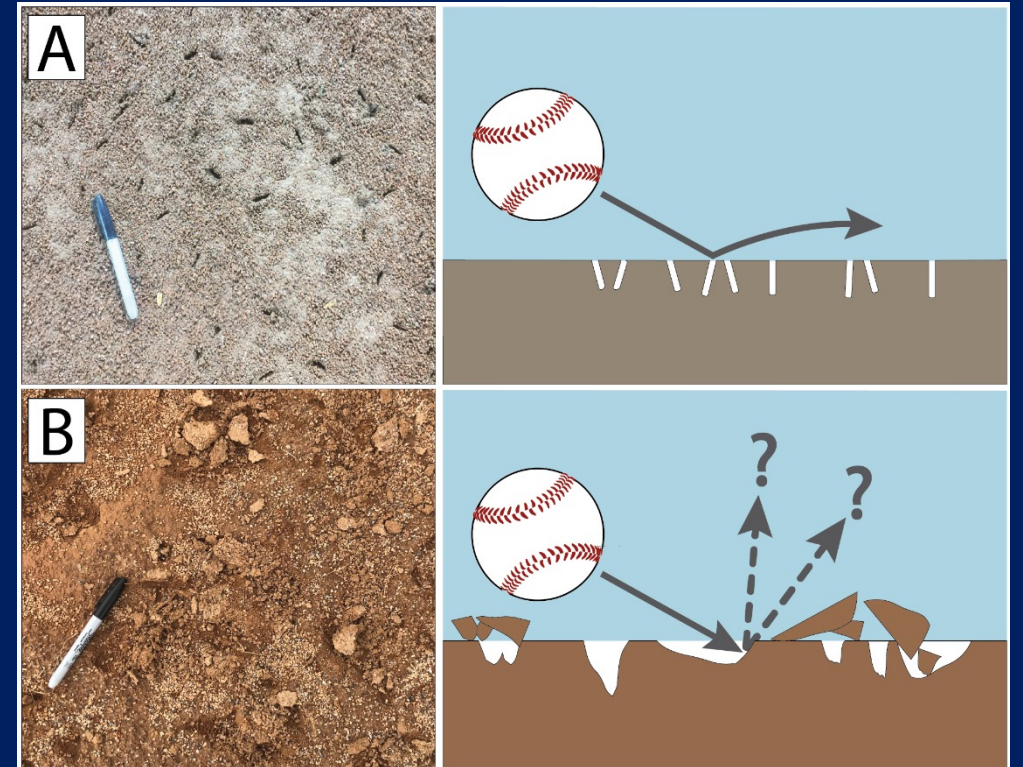


Part II: Cleat-mark test

What happens when the dirt ~~gets wet~~ dries out?

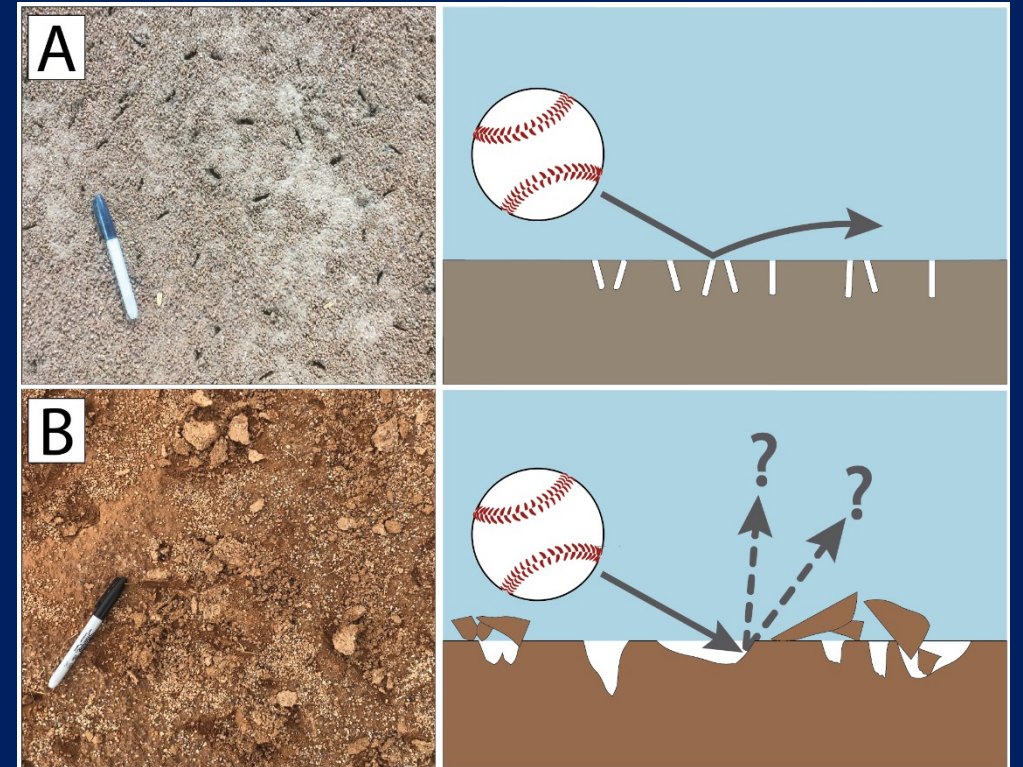
Objectives

- Create a laboratory method to measure water content when an infield begins to chunk out
- Use the method to compare experimental infield mixes

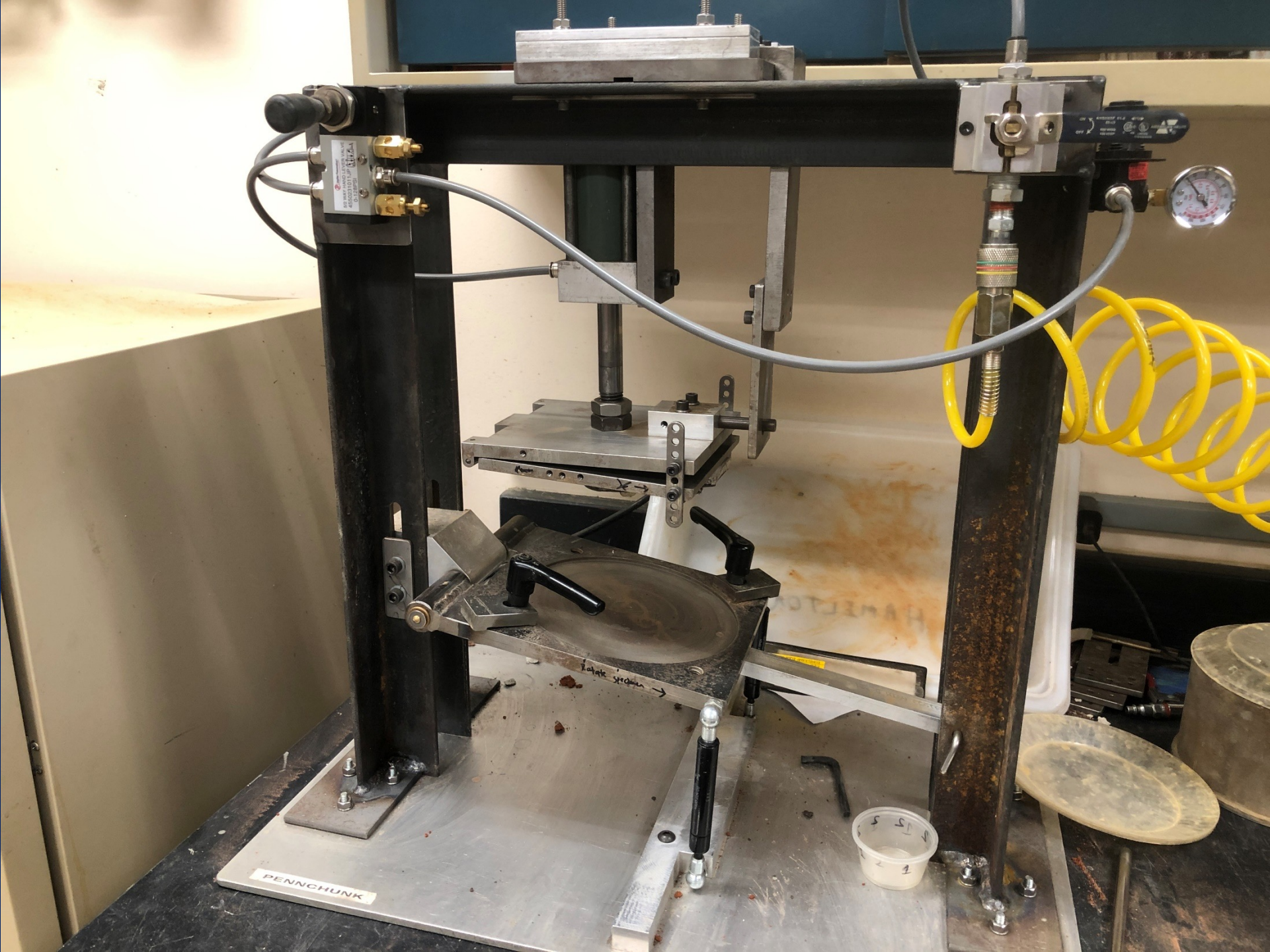


Objectives

- Create a laboratory method to measure *water content* when an infield begins to chunk out
- Use the method to compare experimental infield mixes



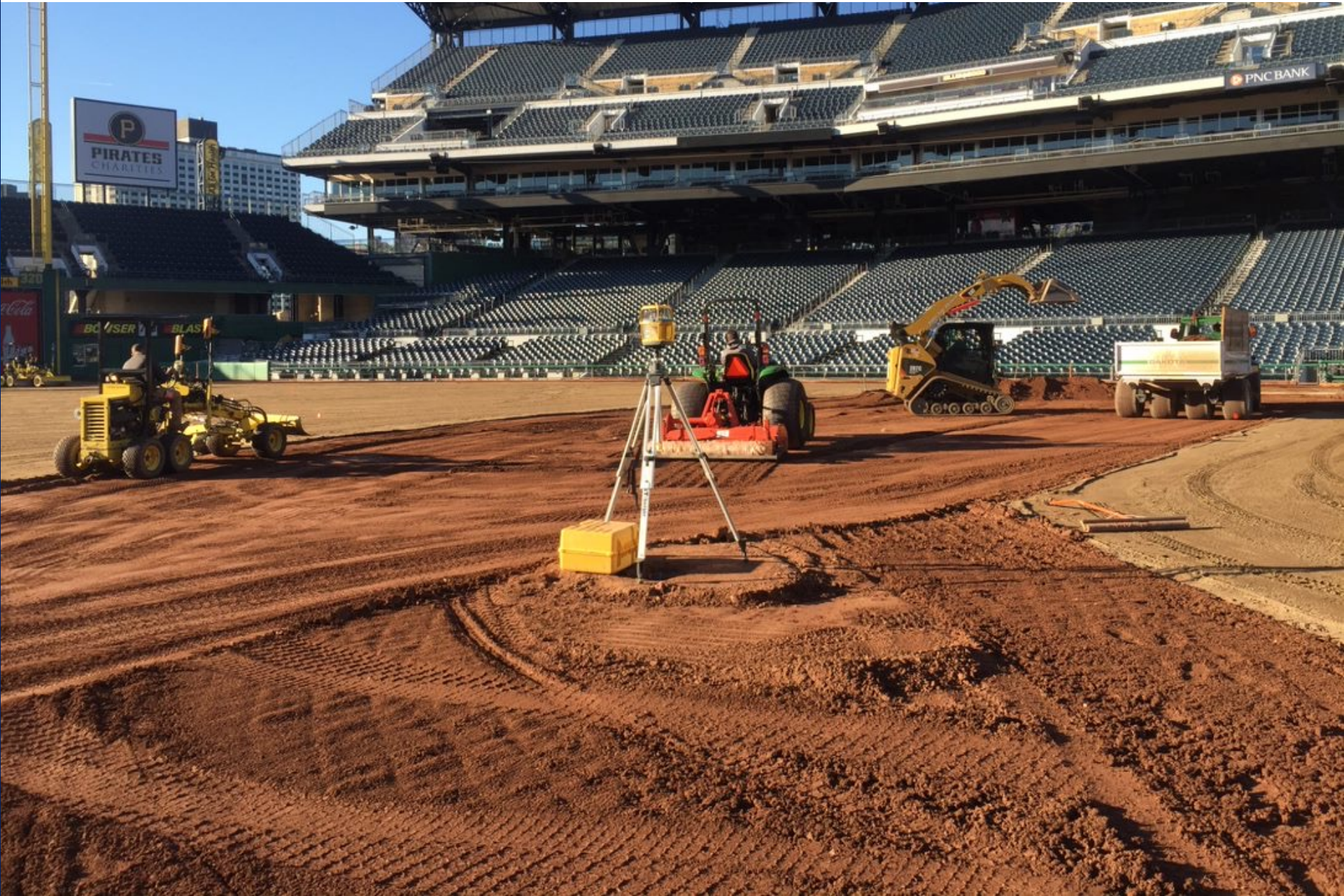








Lab research vs. reality

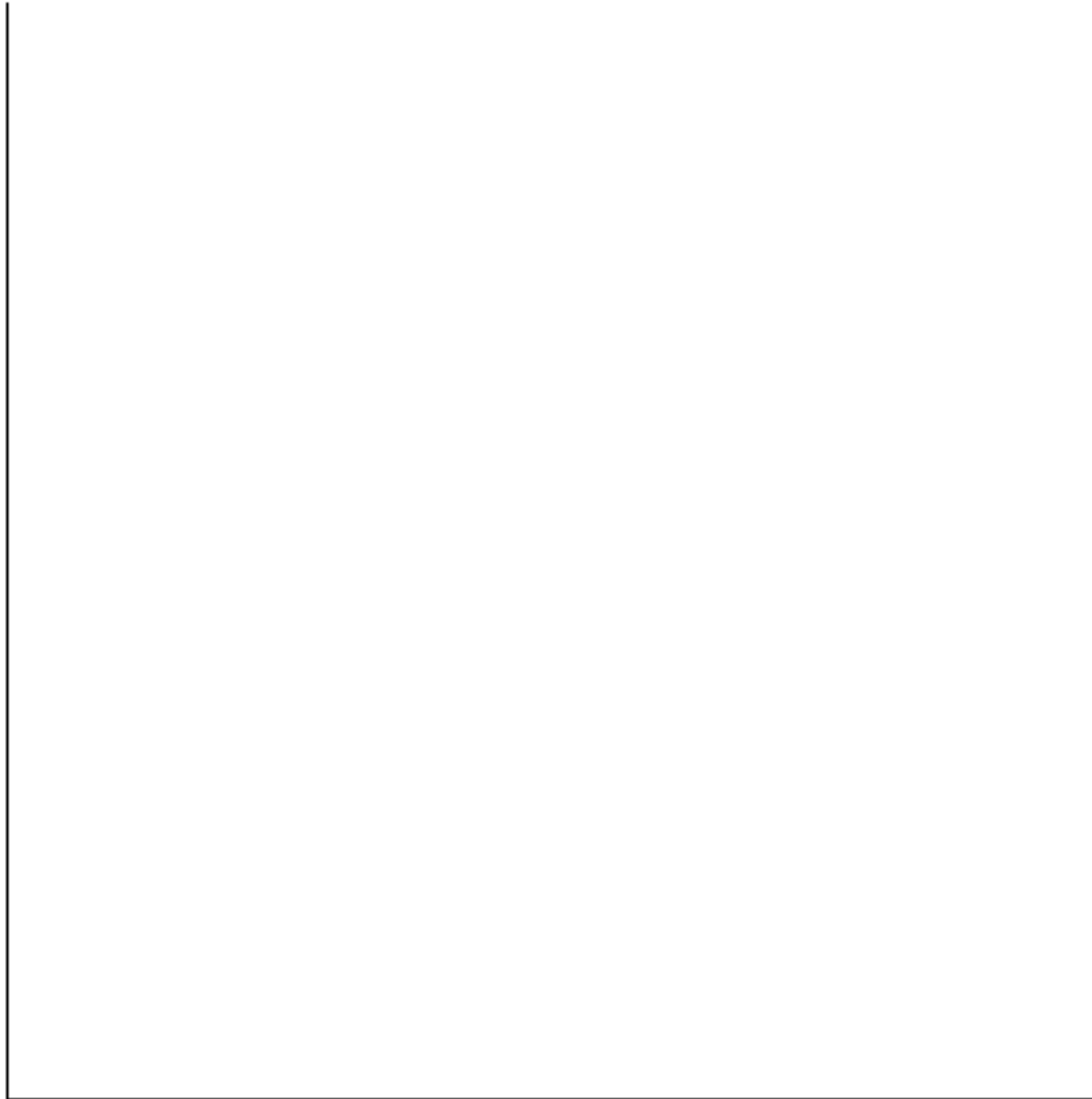




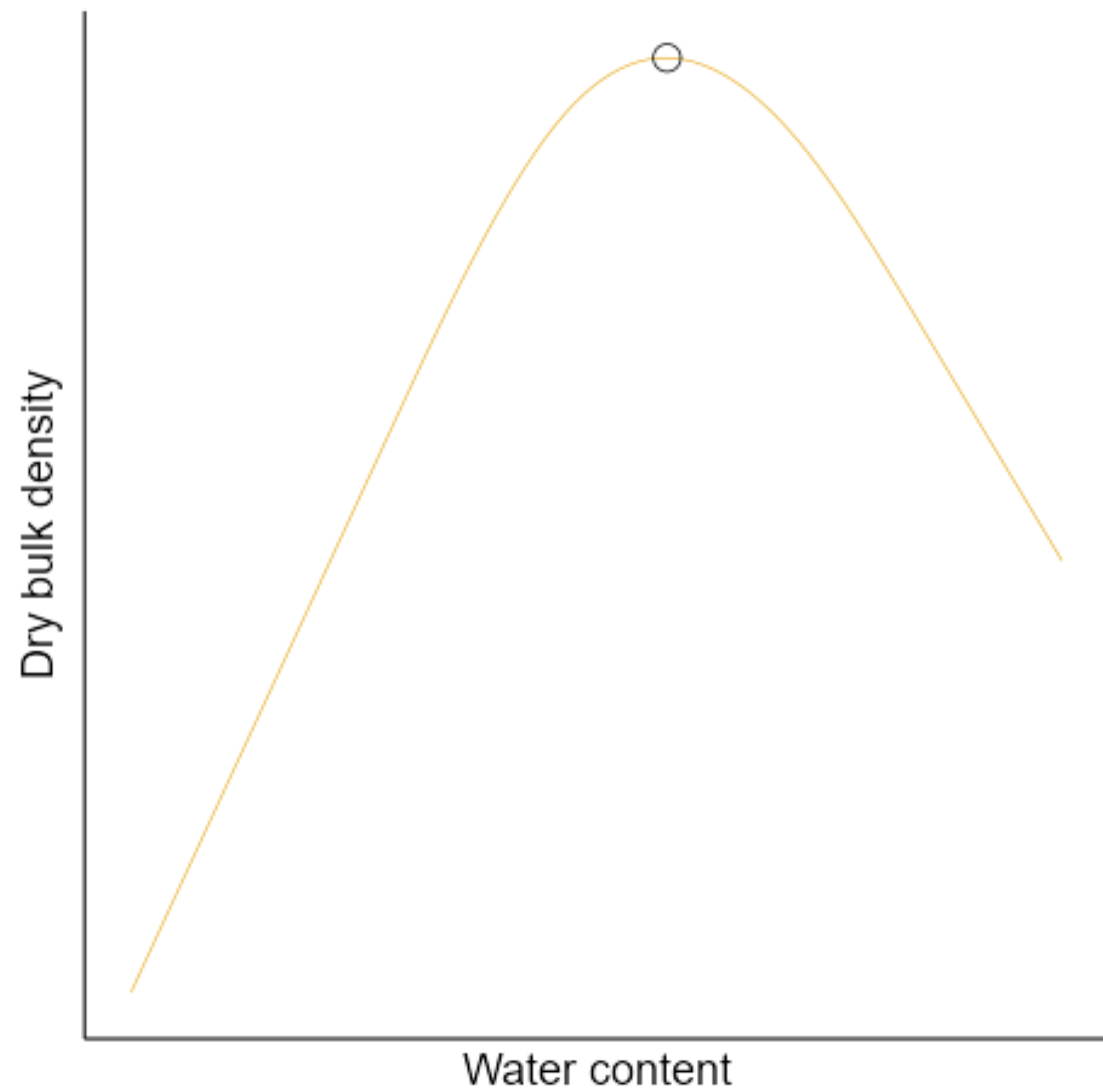
Proctor compaction test

Dry bulk density

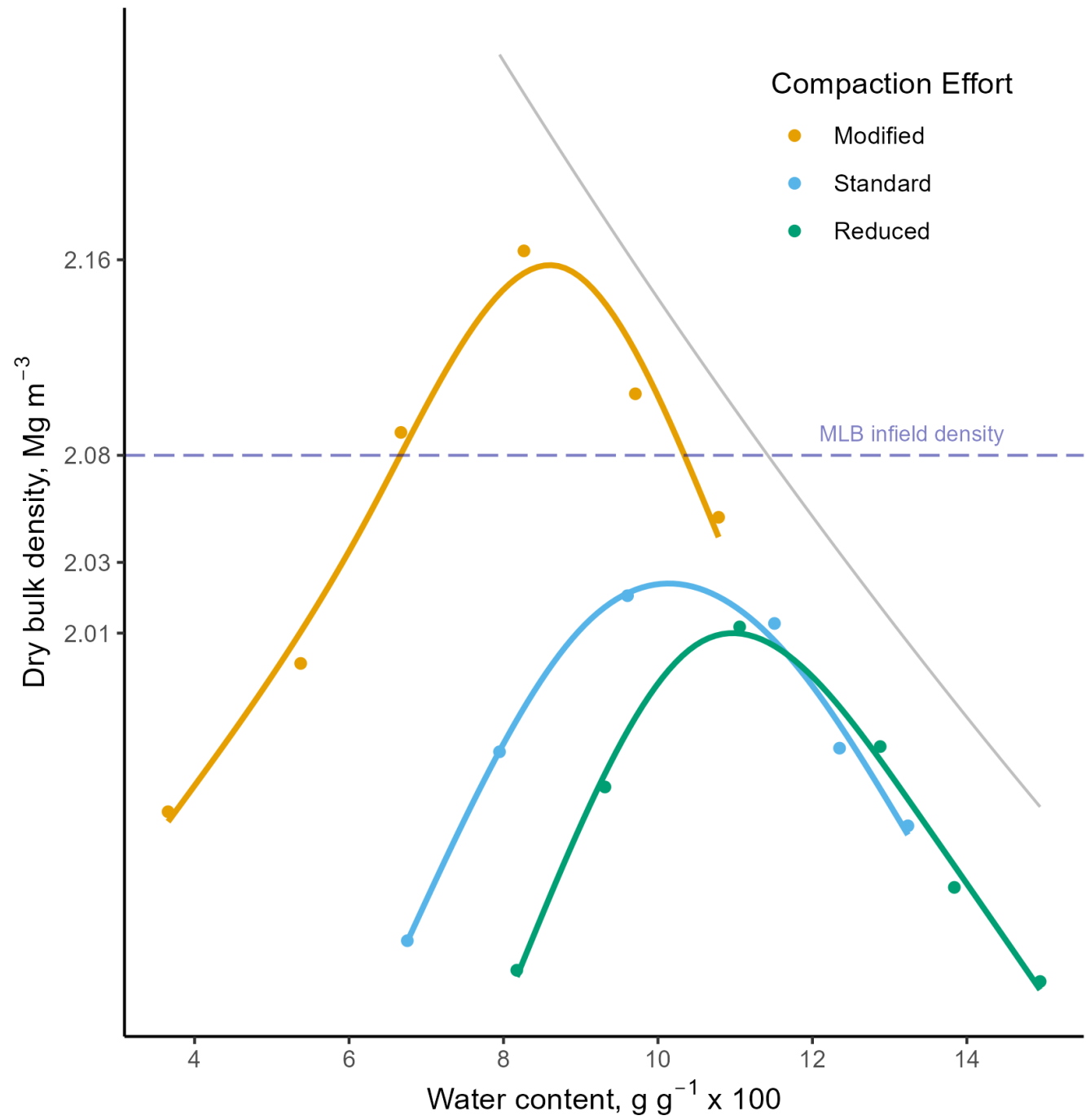
Water content



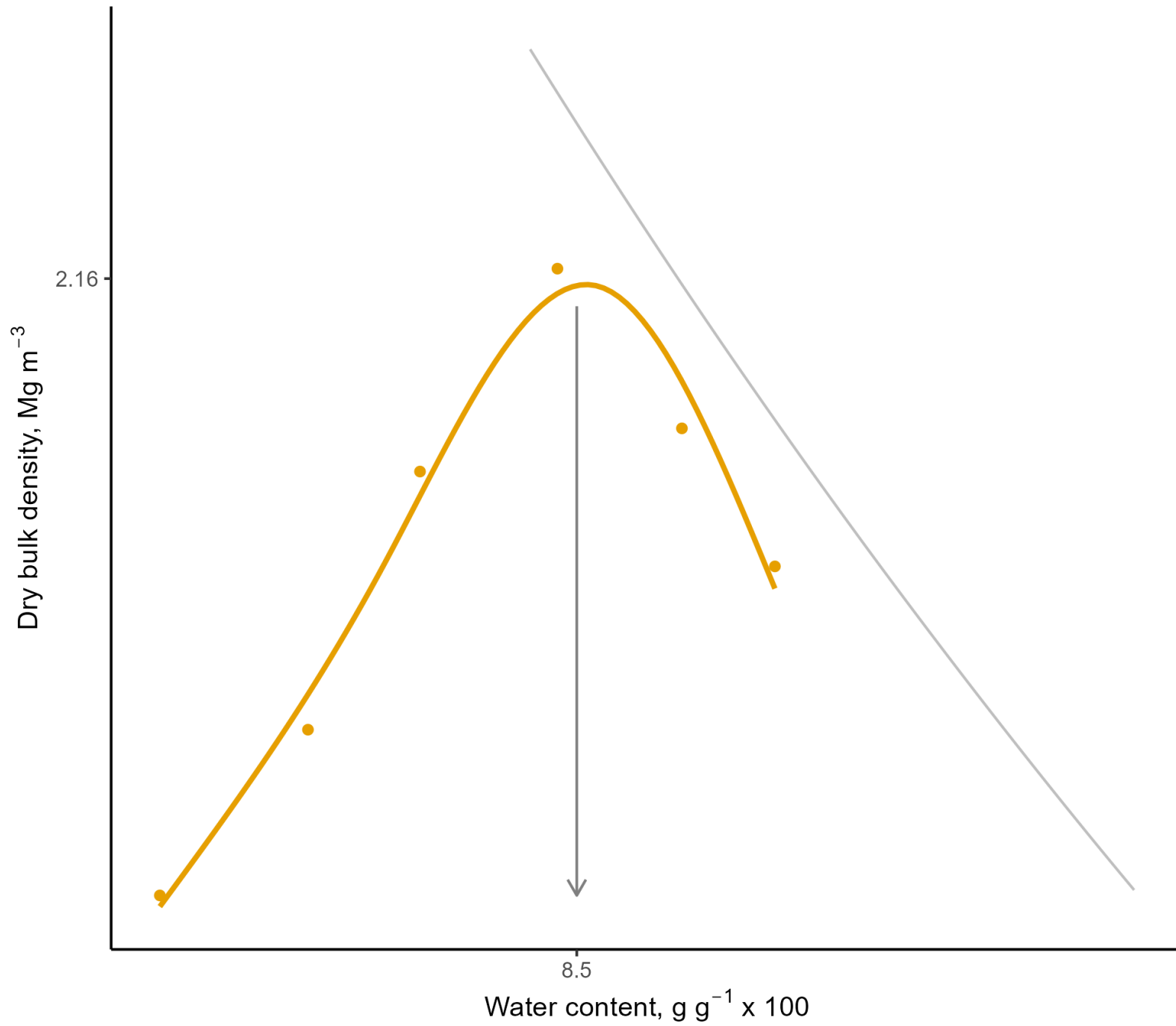
Proctor compaction test



Dry density of an infield mix at 3 compaction efforts



Dry density of an infield mix at 3 compaction efforts





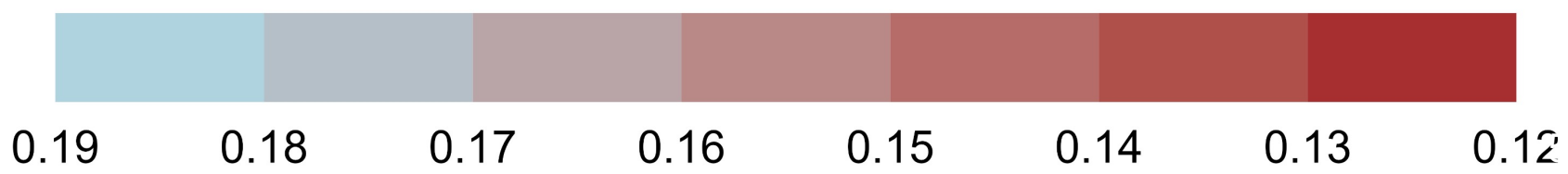
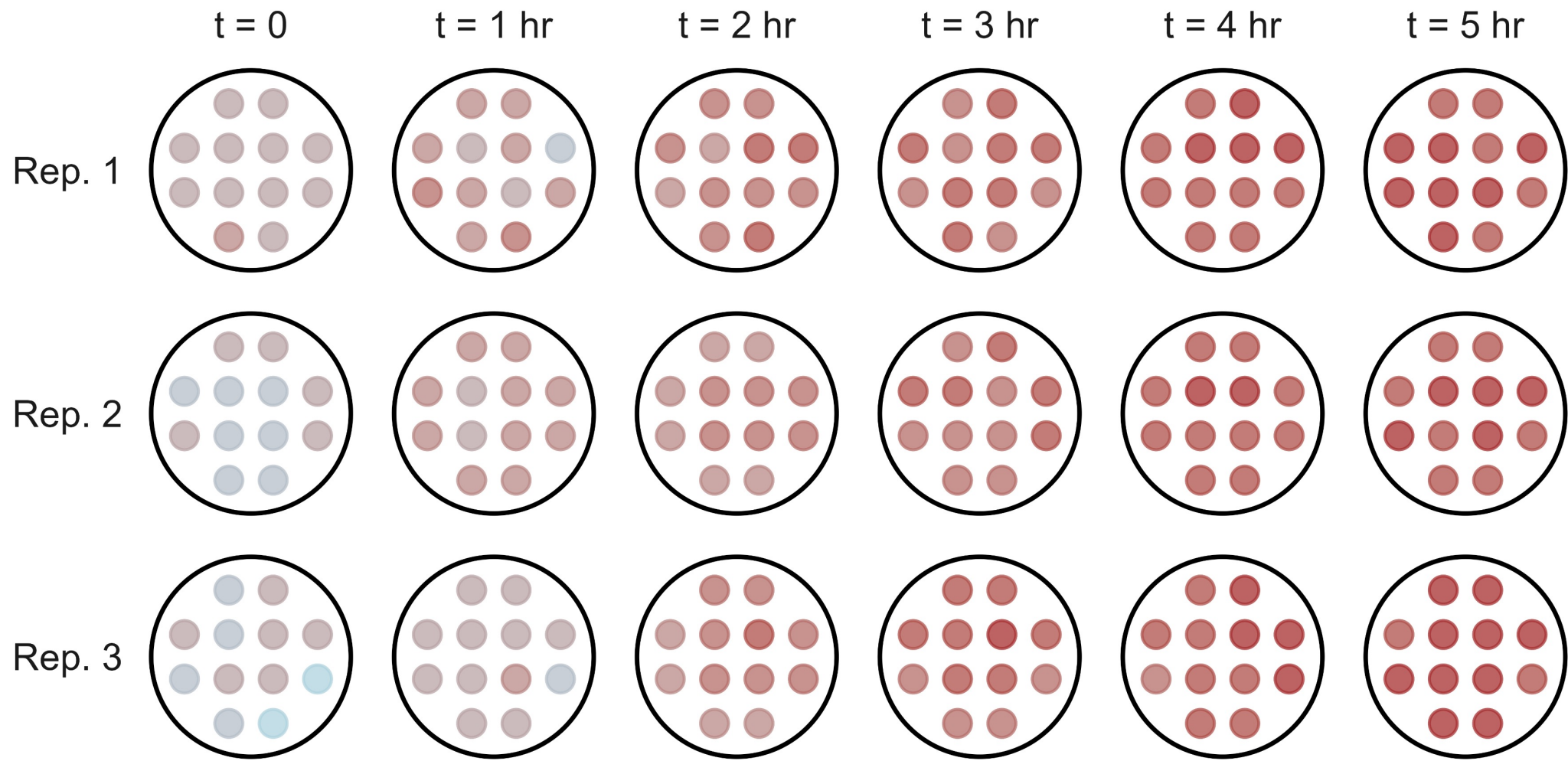
Air temp. = 31° C
Surface temp. = 36° C



Air temp. = 22° C
Surface temp. = 37° C







Water content, g g^{-1}

Ductile



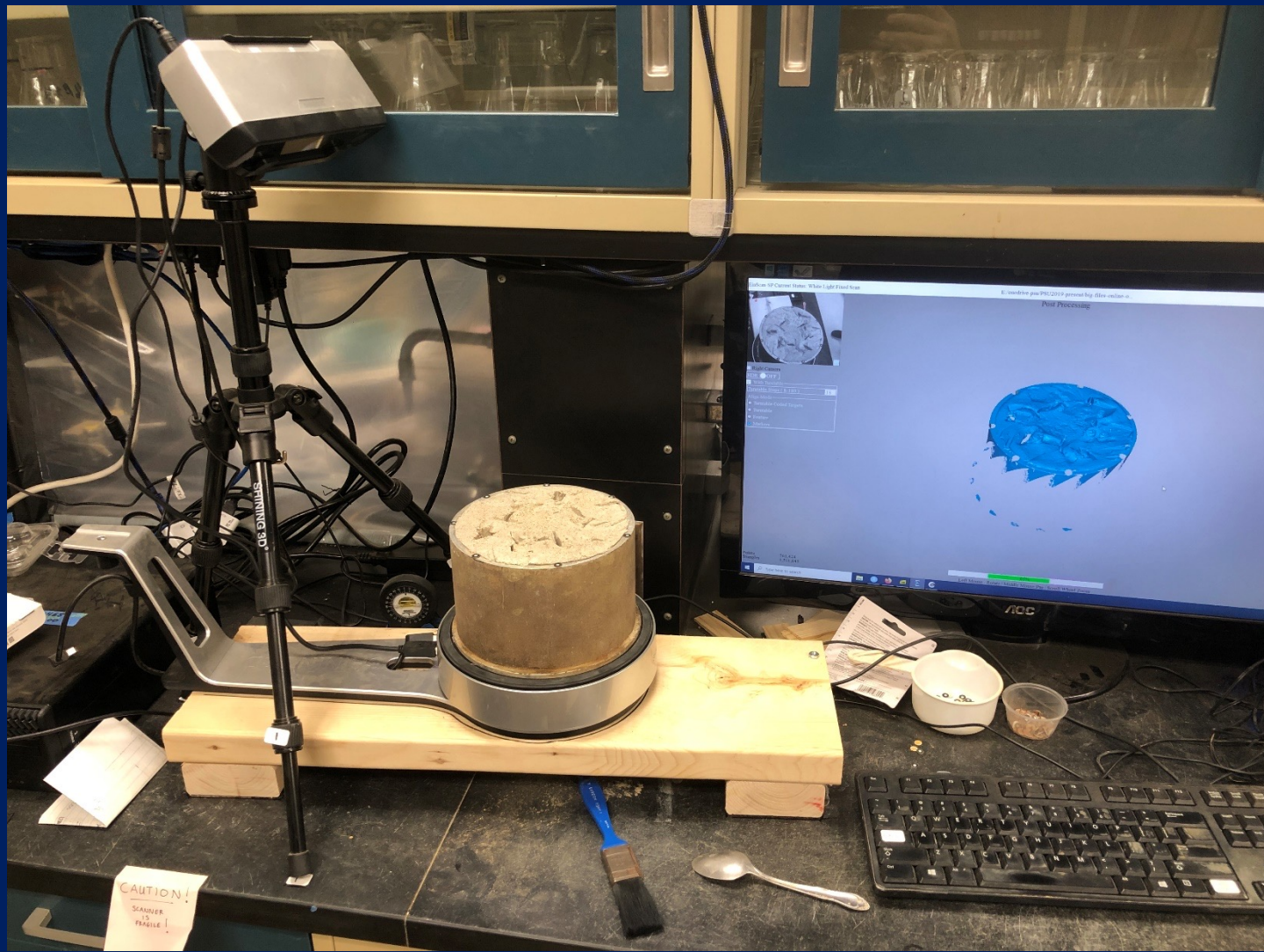
Intermediate



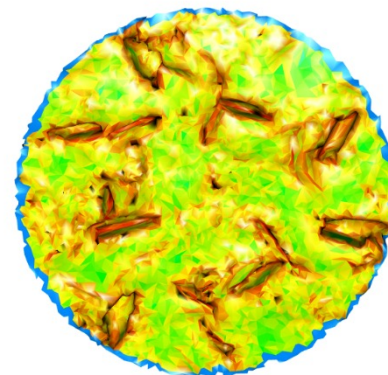
Brittle



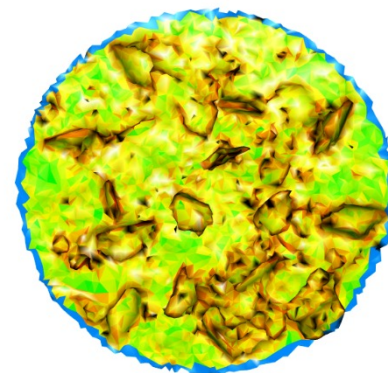




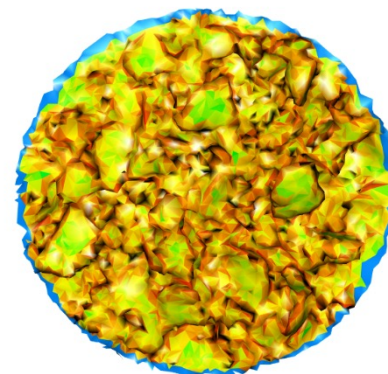
DNE = 1,810



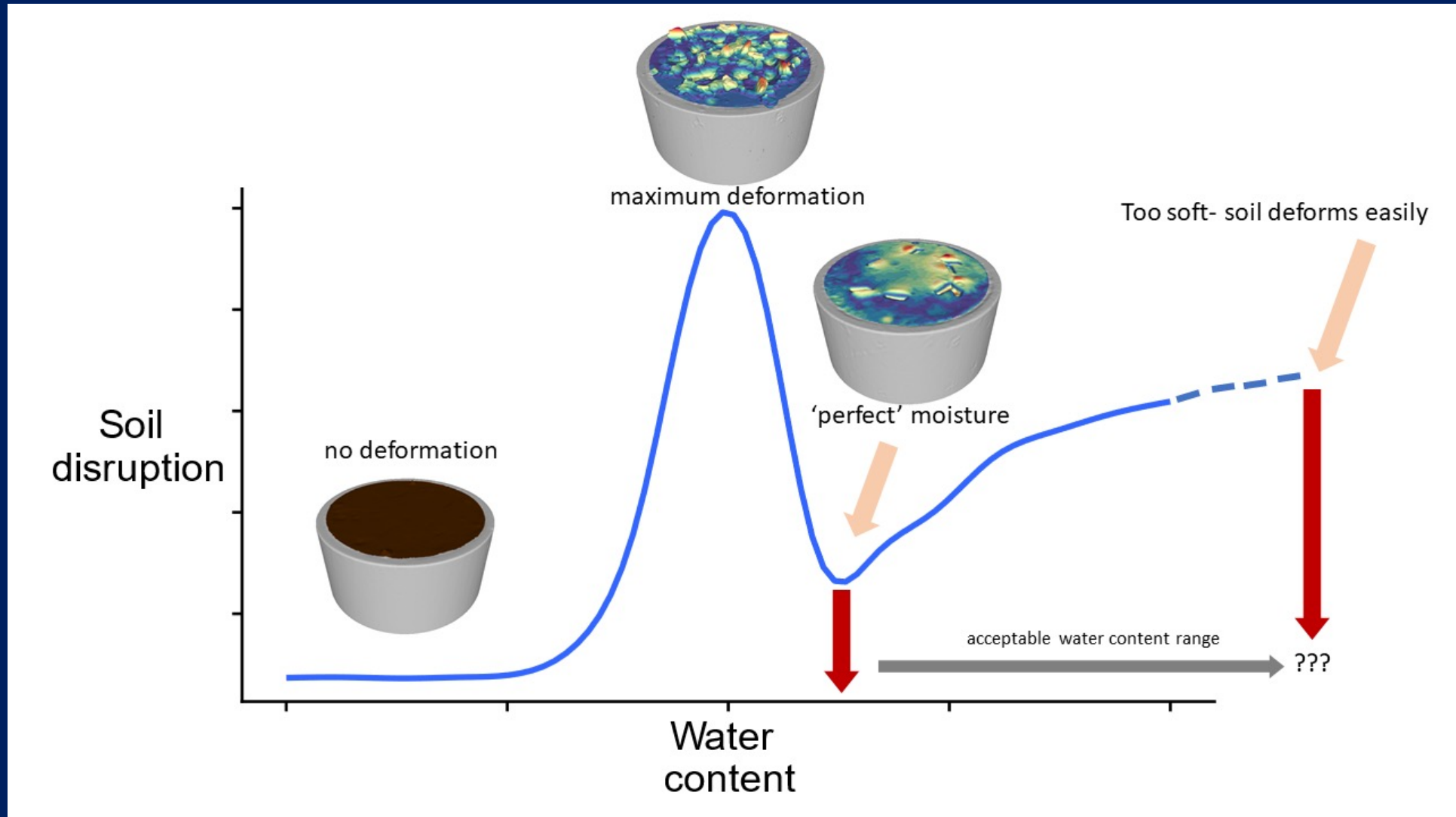
DNE = 2,900



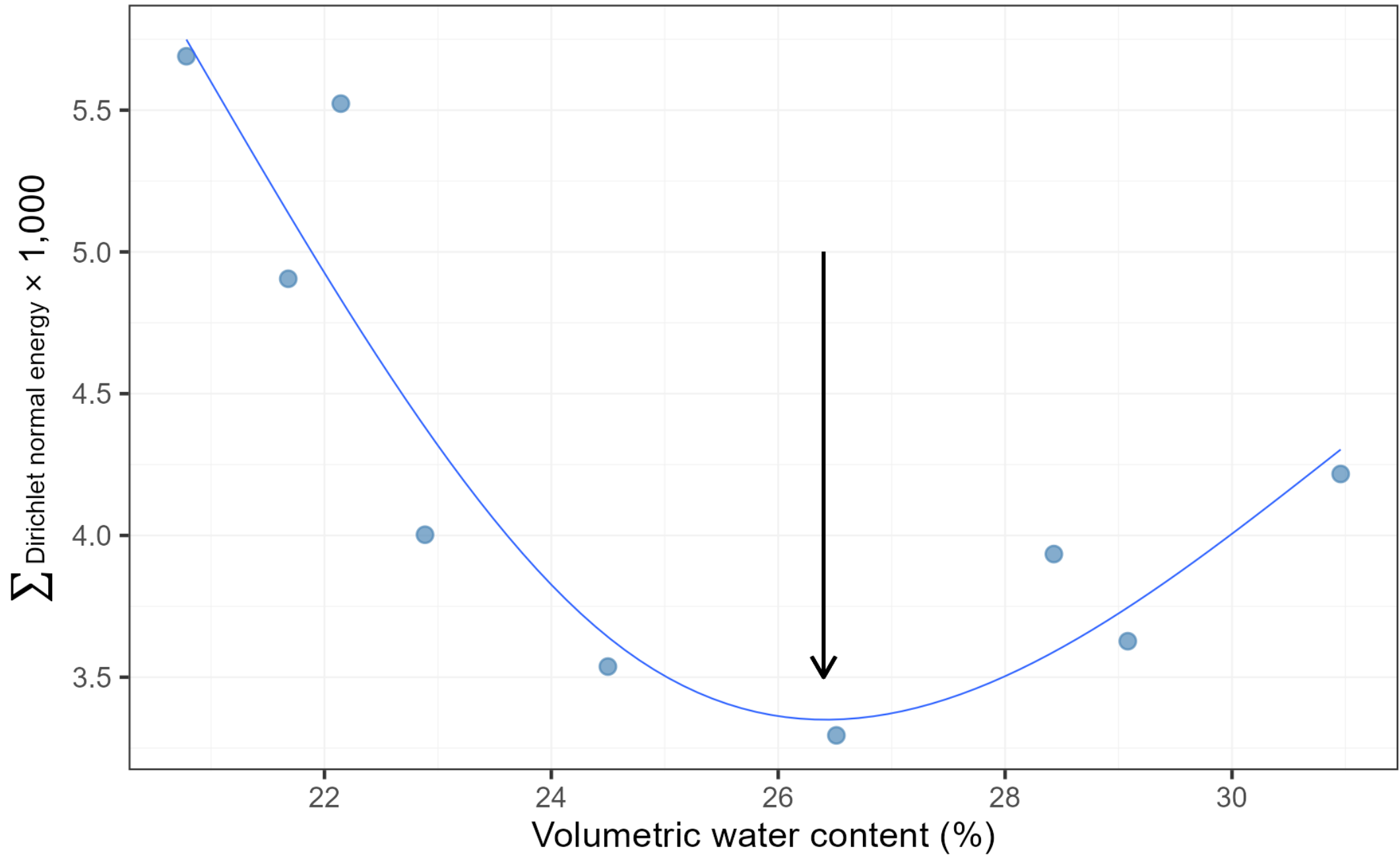
DNE = 4,280



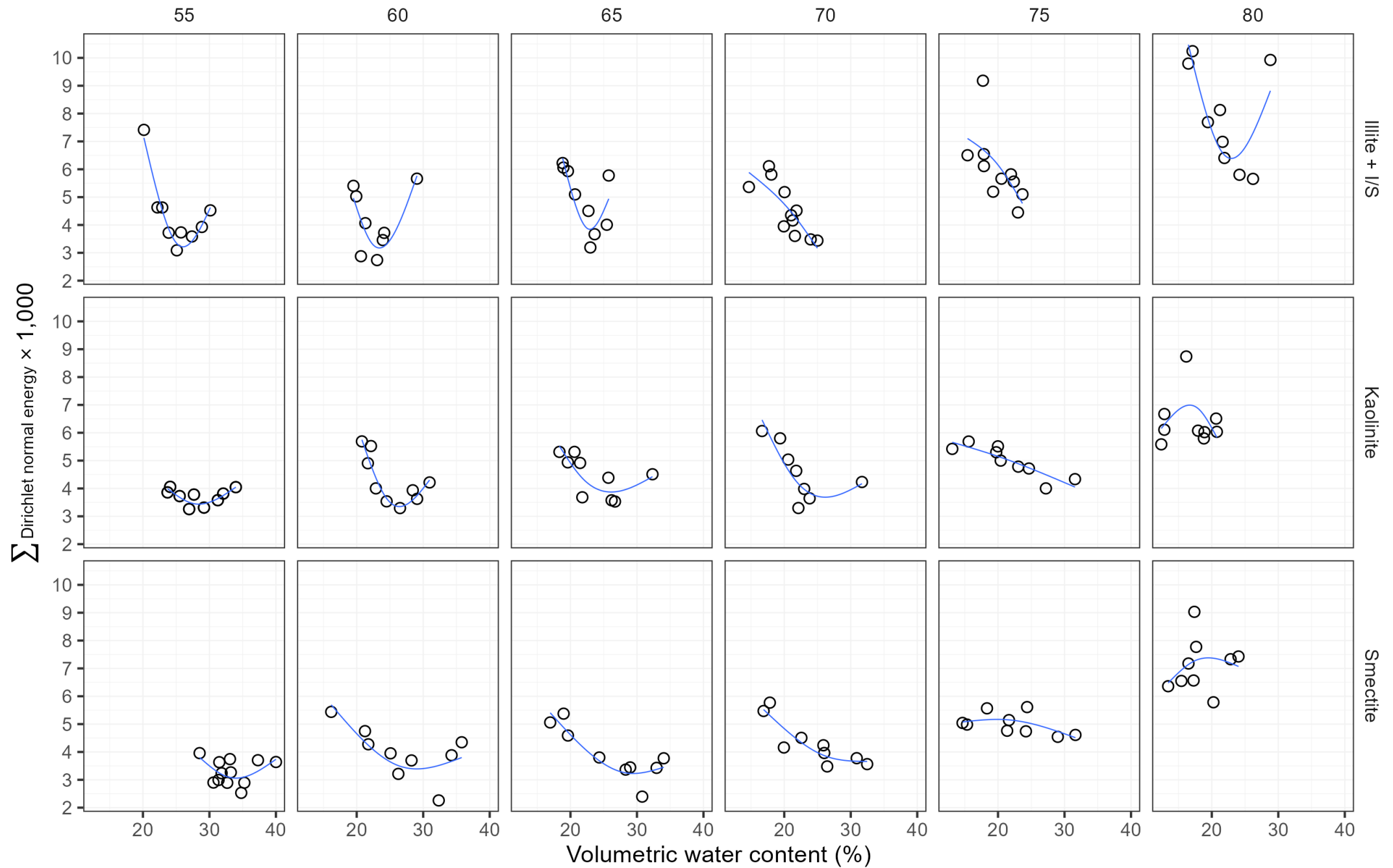
Hypothesized soil response



Chunking-out threshold of an experimental infield mix

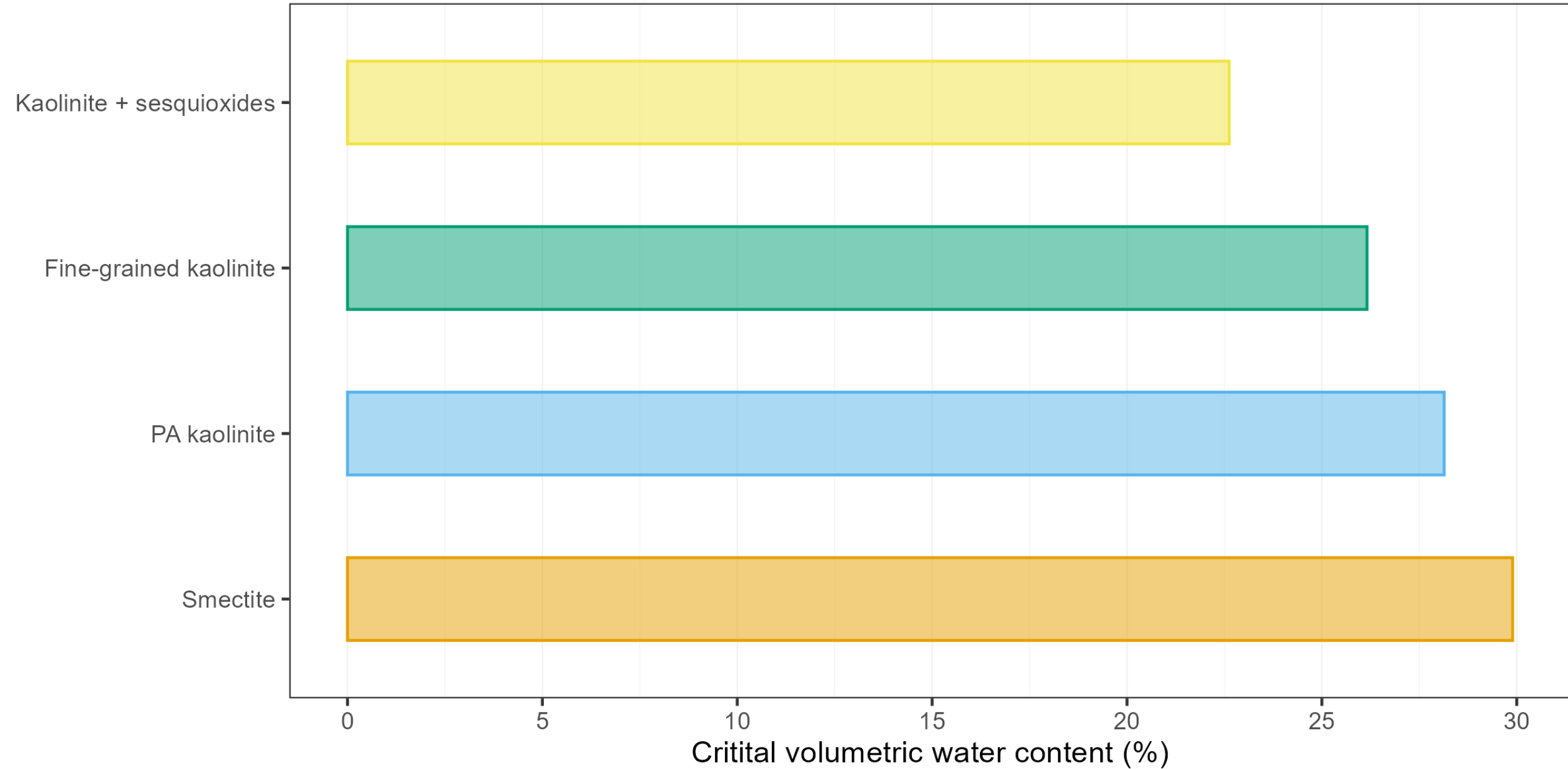


Surface performance of experimental infield mixes



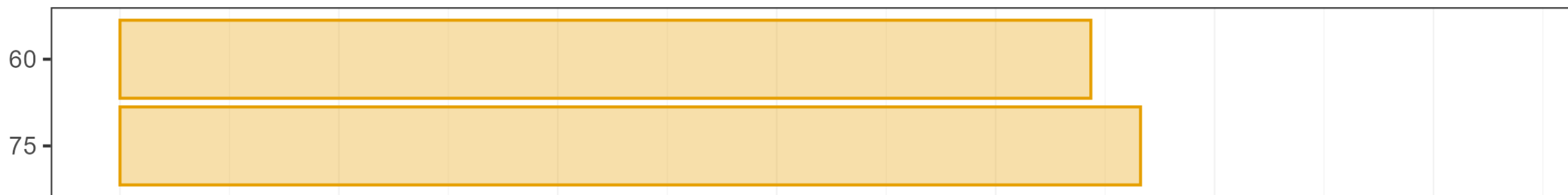
Surface performance of four 60-20-20 infield mixes

Mixes contain different clay + added quartz silt

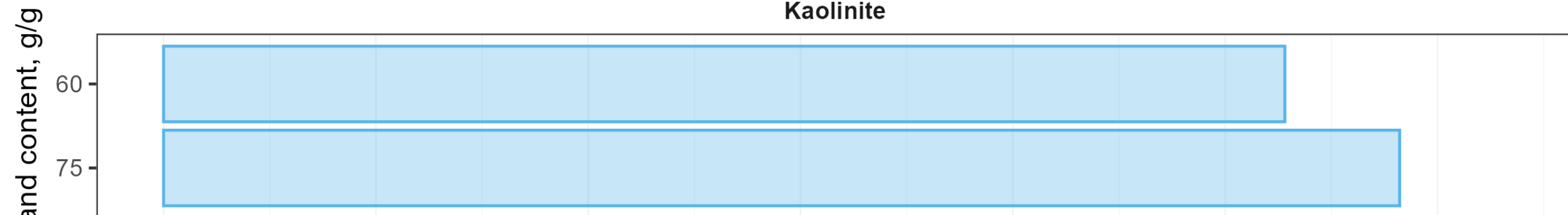


Clay type affects θ_{crit} more than sand content

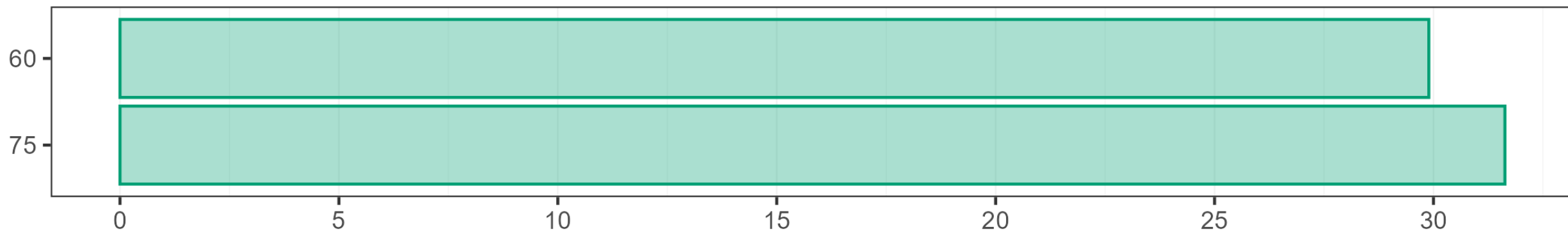
Illite + I/S



Kaolinite



Smectite



Critical volumetric water content, m/m³

Summary: Part II

- Lower water content boundary – soil starts chunking/chipping
- Direct measurement of behavior change w/ water content
- Plasticity varies for soils with same PSA
- Clay minerals affect behavior

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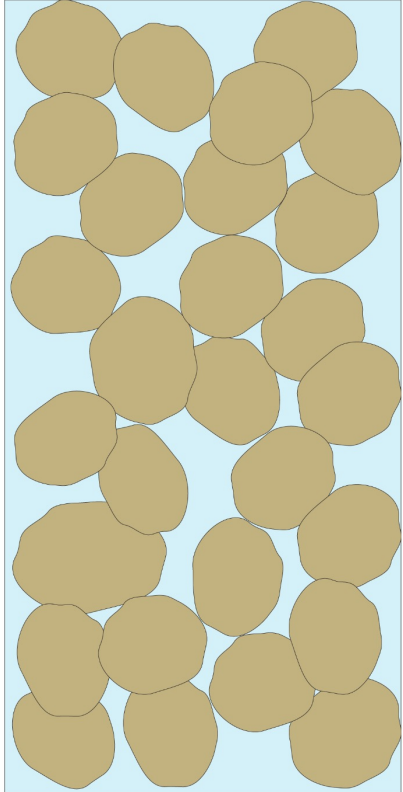
Part II b: Cleat-in/cleat-out fundamentals

What conditions must be present for cleat-in/cleat-out playability?

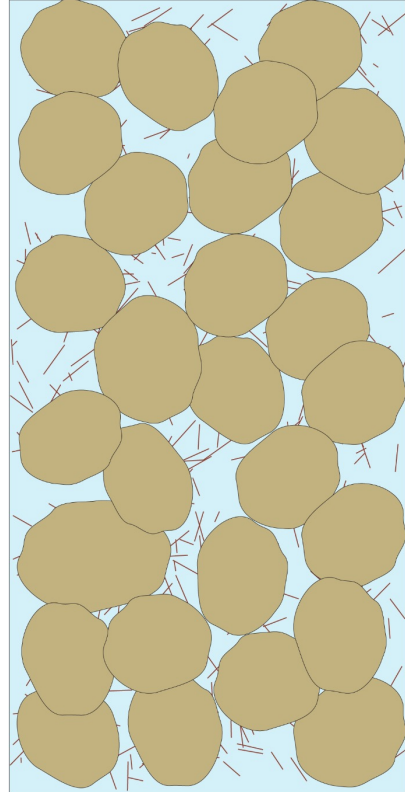
An infield mix is a 4-phase system



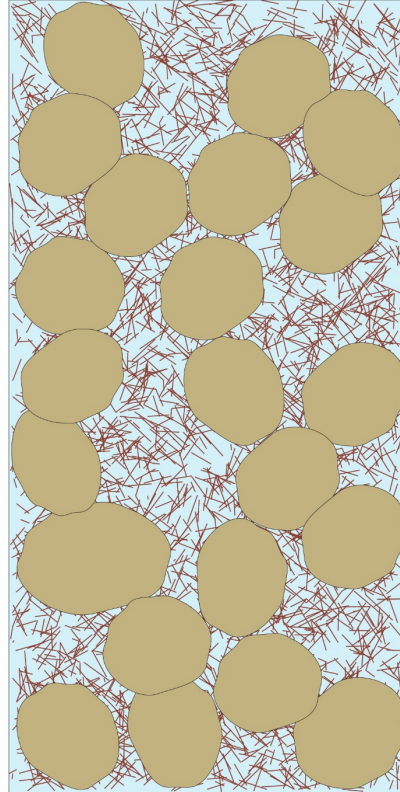
$$m_{\text{sand}} = 1$$



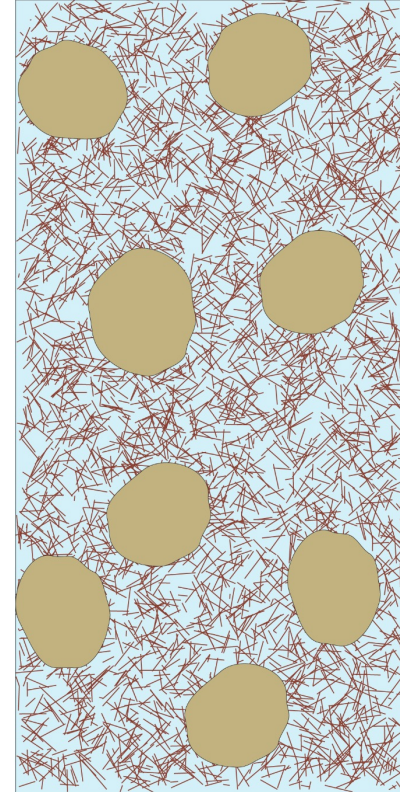
$$m_{\text{sand}} > \text{TSC}$$



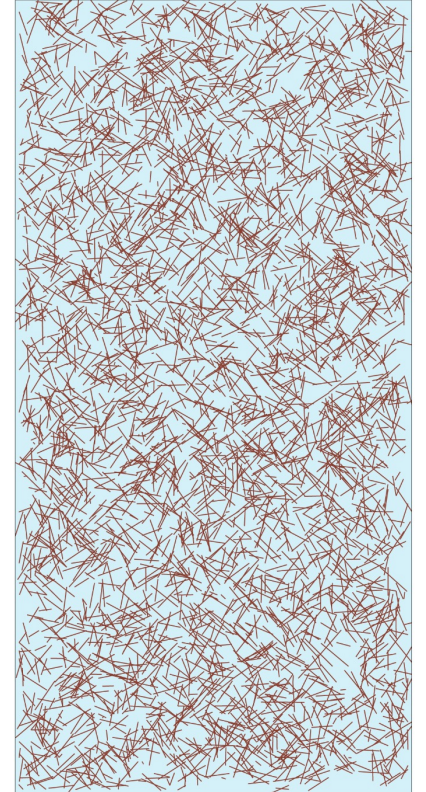
$$m_{\text{sand}} = \text{TSC}$$



$$m_{\text{sand}} < \text{TSC}$$



$$m_{\text{sand}} = 0$$

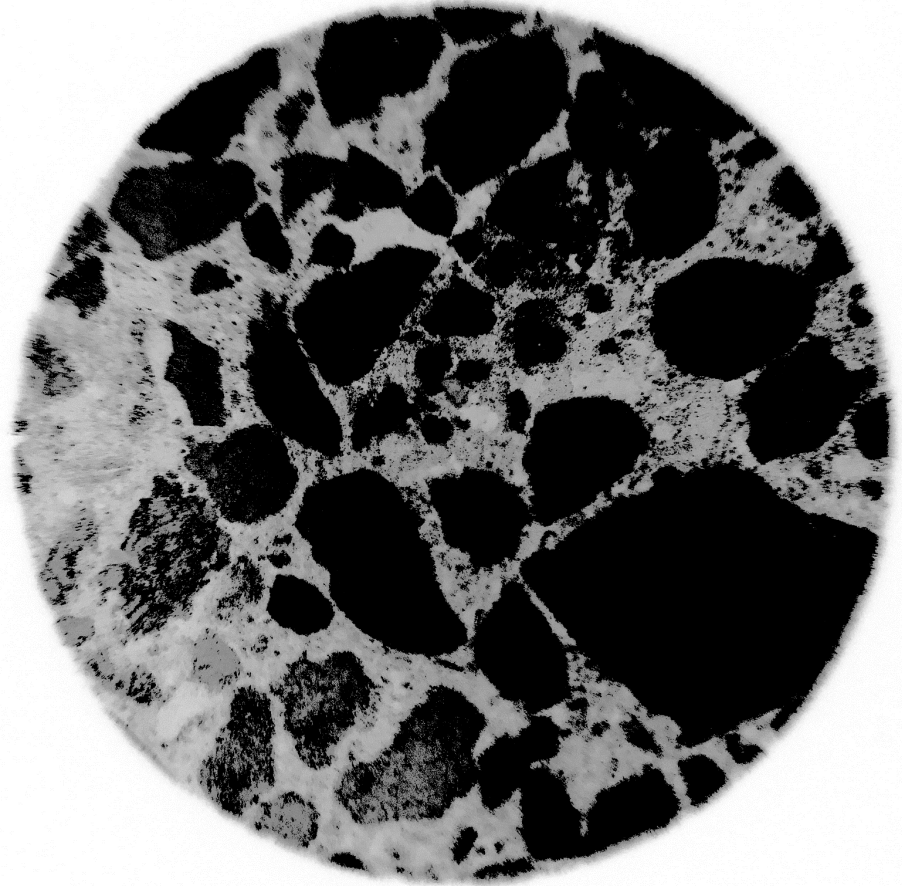
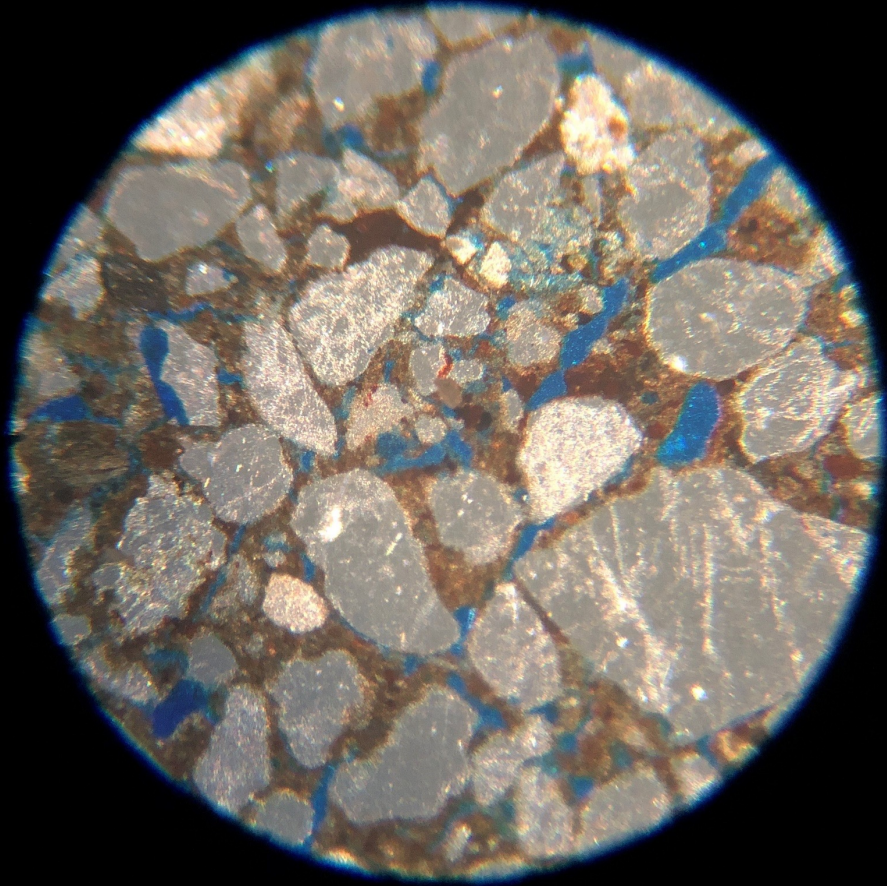


Transitional sand content

$$m_{sa} = \frac{1 + \left(\frac{\frac{wG_c}{G_w}}{S_e} \right)}{1 + \frac{e_{sa}G_c}{G_{sa}}}$$

Transitional sand content

Clay mineral	Calculated sand content from equation	Maximum sand content to provide cleat-in/cleat-out
Illite/I-S	72.2	70-75
Kaolinite	75.3	75-80
Smectite	78.2	75-80

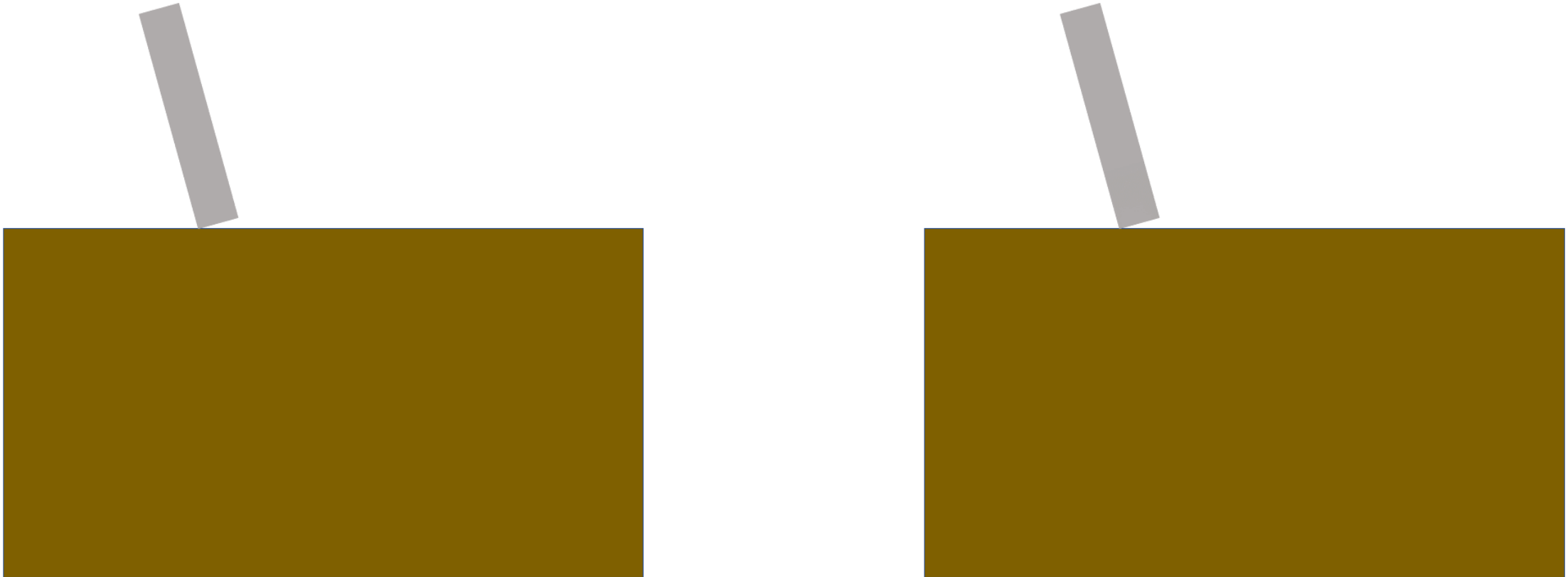


Illite, 75% sand

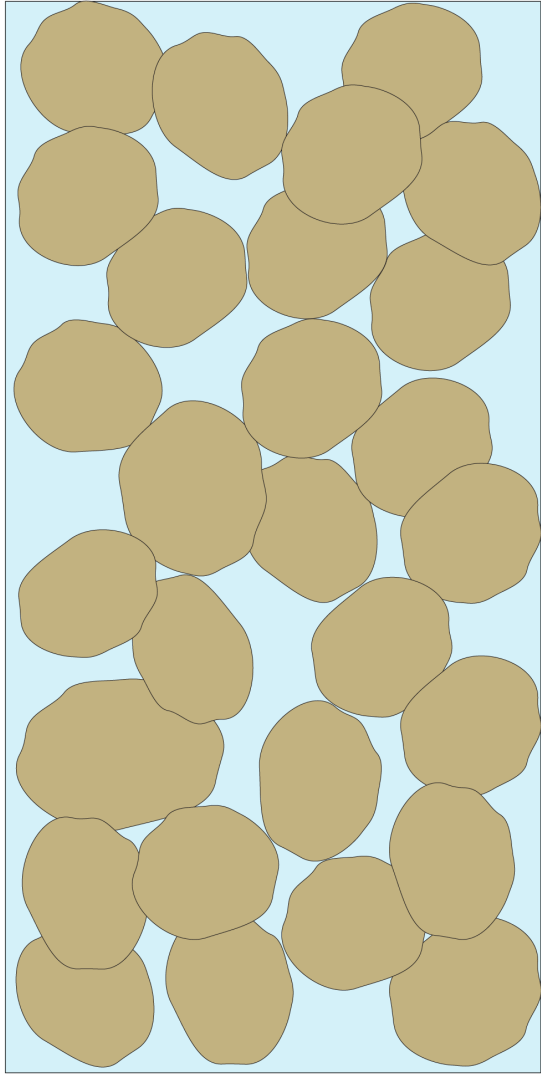
An infield mix is a 4-phase system



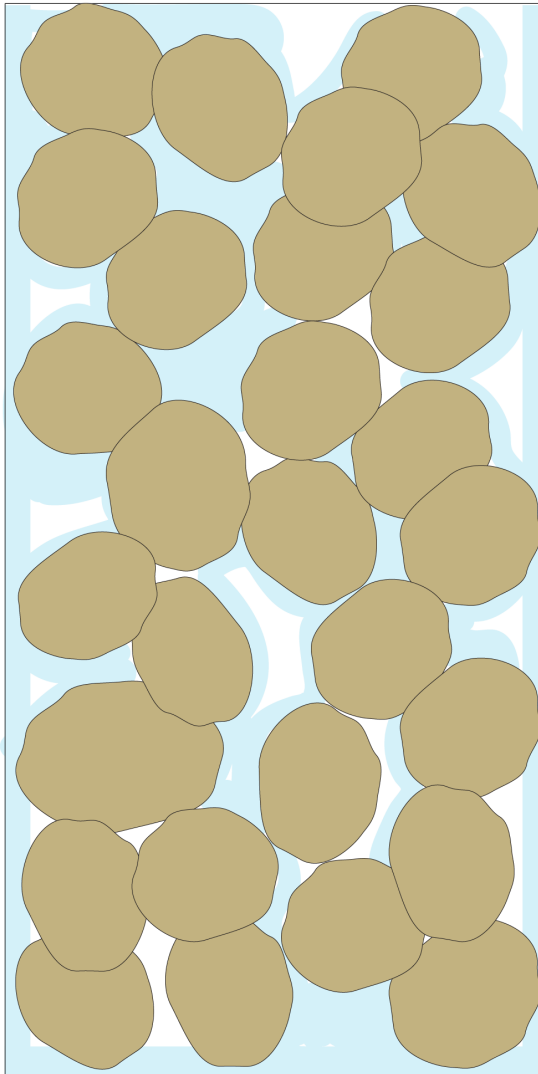
How does chipping/chunking happen?



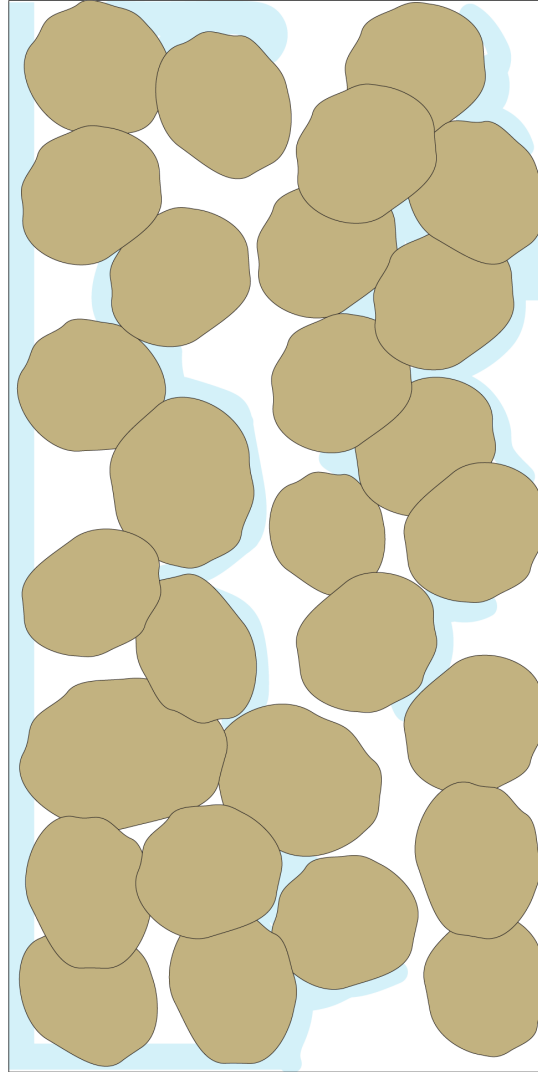
Capillary



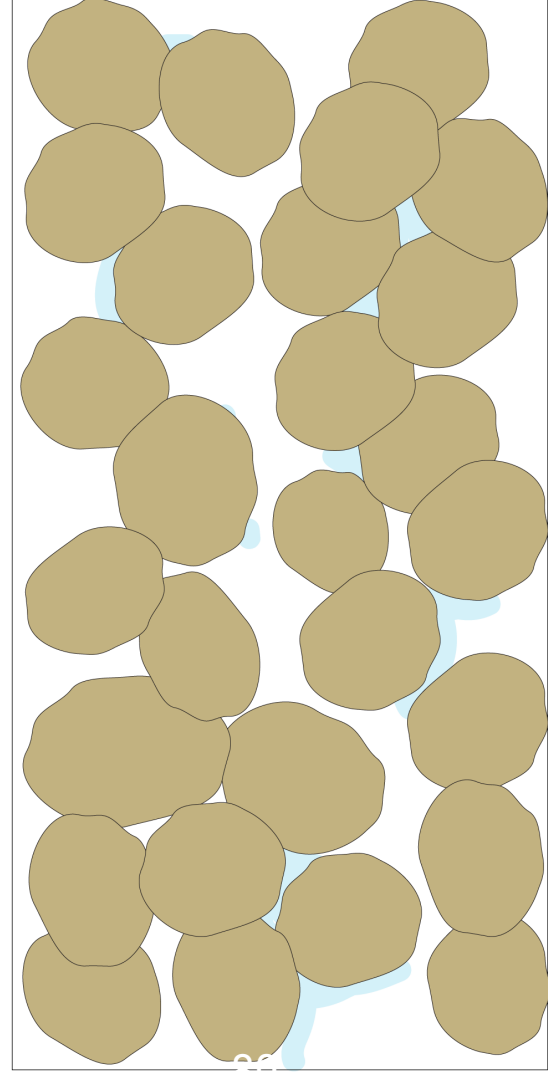
Funicular



Pendular



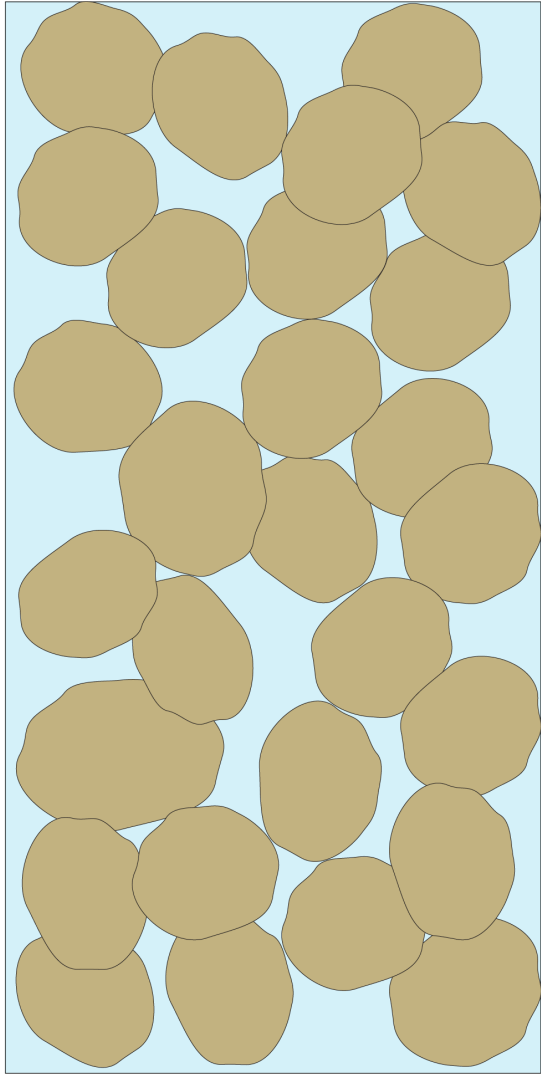
Residual



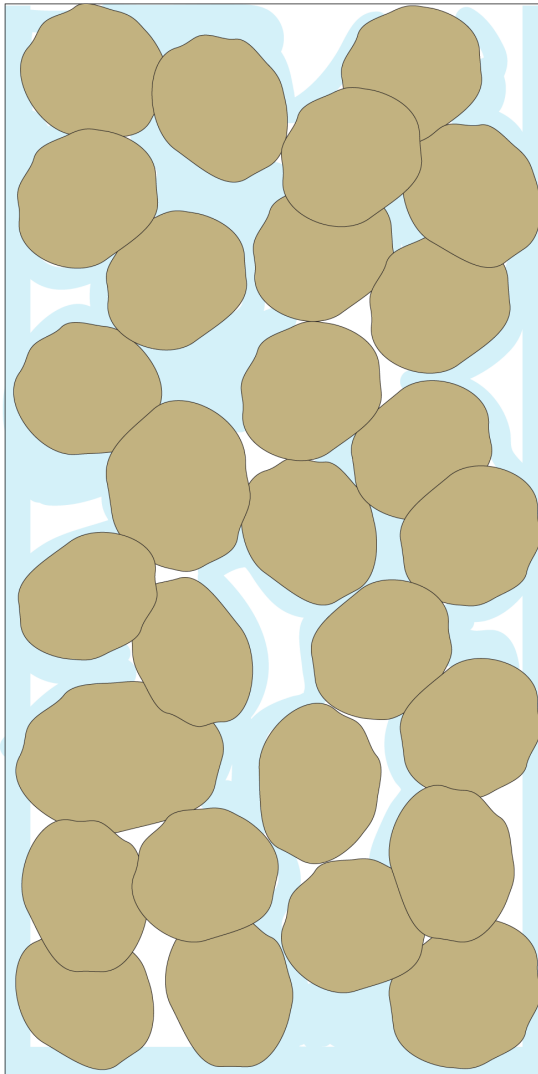
Drying



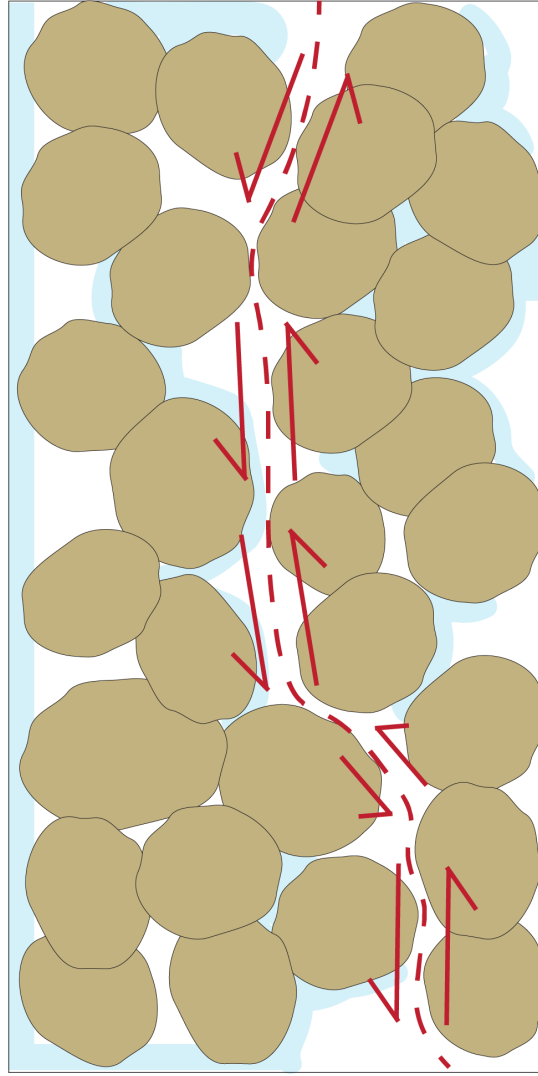
Capillary



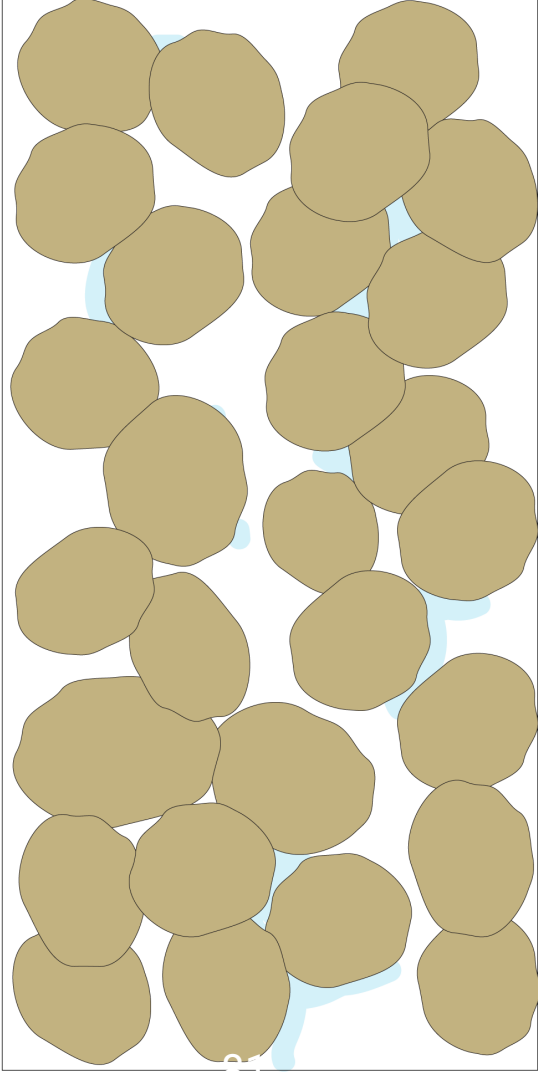
Funicular



Pendular



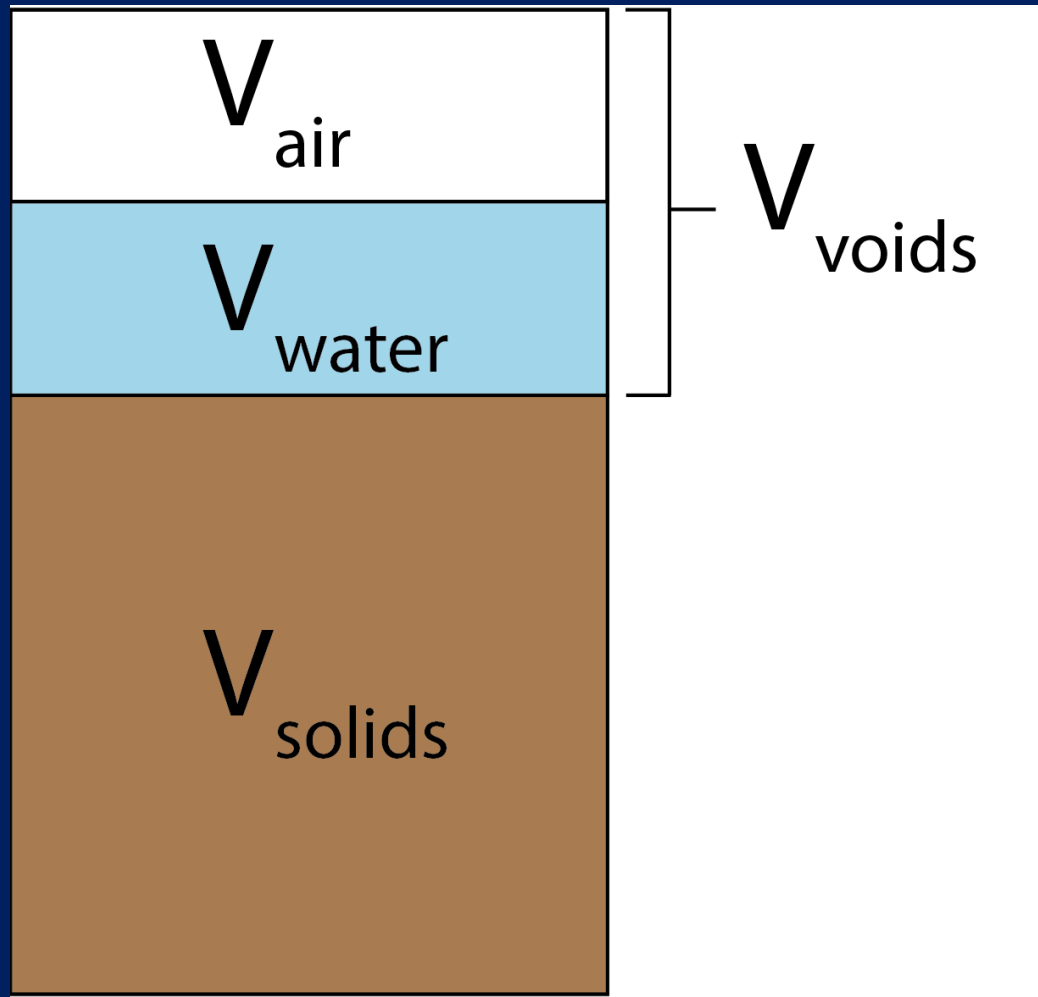
Residual



Drying



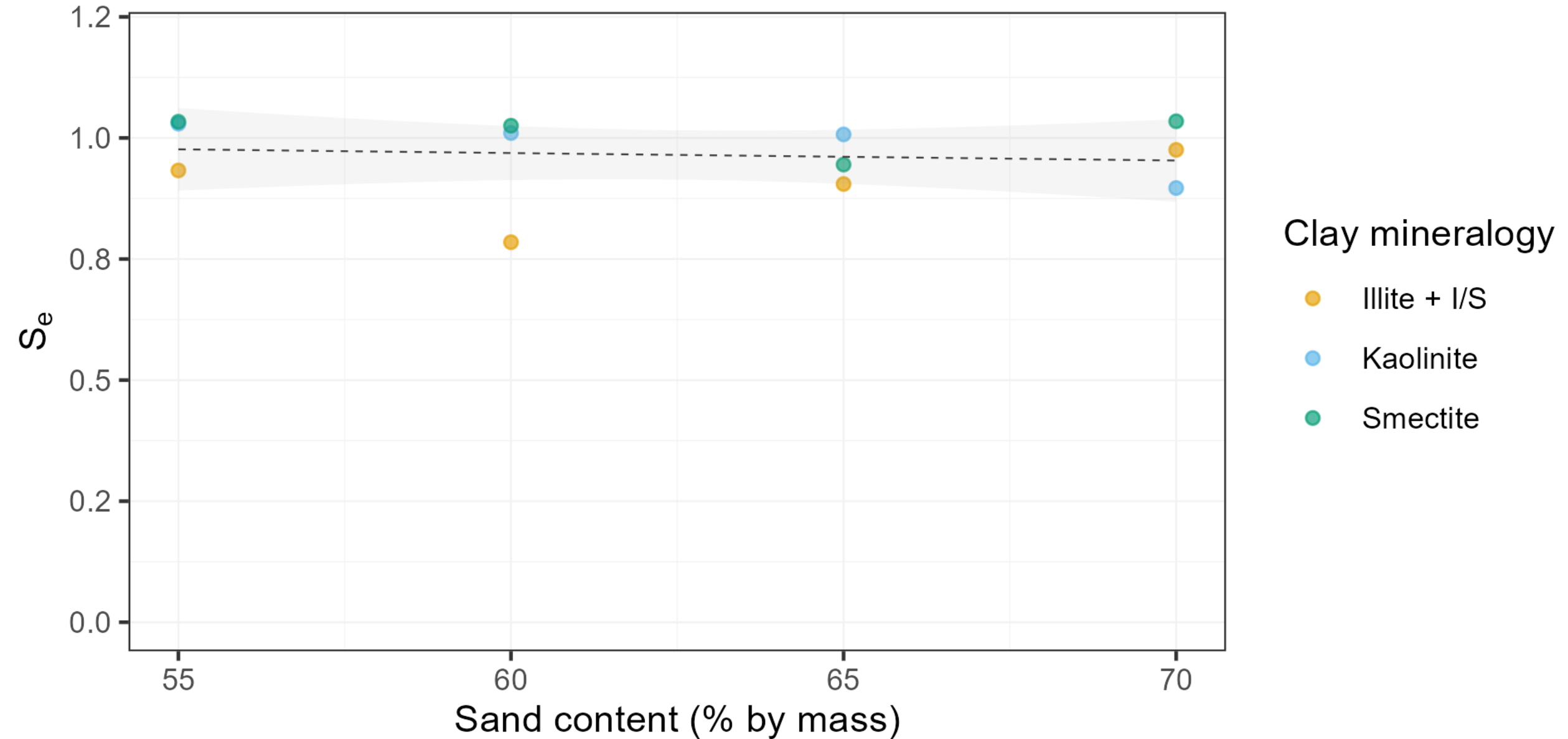
Effective saturation



$$S_e = \frac{V_w}{V_v} = \frac{\theta}{n}$$

θ_{critical} occurs at $S_e \approx 1$.

Relationship holds regardless of sand content or clay mineralogy.



Summary

- PSA is OK, but clay type matters too

What happens when the dirt gets wet?

Thresholds can be measured

Stay tuned for more on soil stiffness

Summary

- PSA is OK, but clay type matters too
- What happens when the dirt gets wet (or dries out)?

Thresholds can be measured

Stay tuned for more on soil stiffness

Summary

- PSA is OK, but clay type matters too
- What happens when the dirt gets wet (or dries out)?
- Cleat-in/cleat-out requires sand content $< TSC$ & $Se \sim 1$

SAFE

The Foundation for Safer Athletic Fields



PENNSYLVANIA
TURFGRASS COUNCIL

Thank you !

ecm200@psu.edu
evan-soil.io