Infield Mixes – The Science Behind the Art

Dr. Norman Hummel

Hummel & Co. Inc.

www.turfdoctor.com


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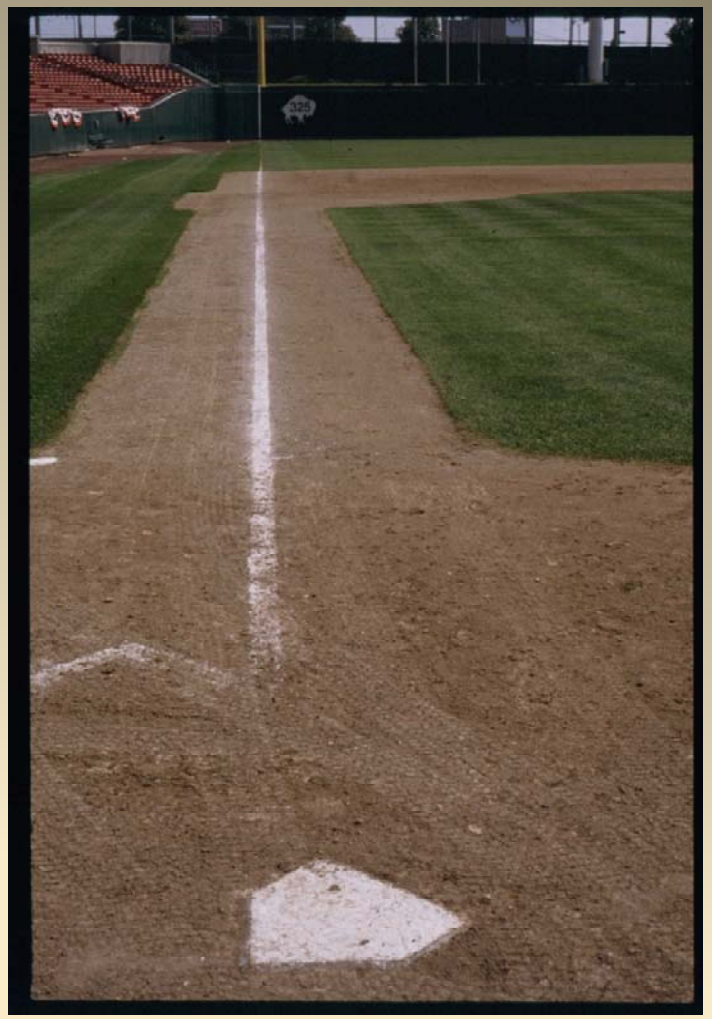


Goals

- To understand testing behind infield and pitcher's mound mixes
- To learn how soil texture influences performance, including water retention
- To understand that there are different types of clays
- Evaluate amendments for increasing water retention

Outline

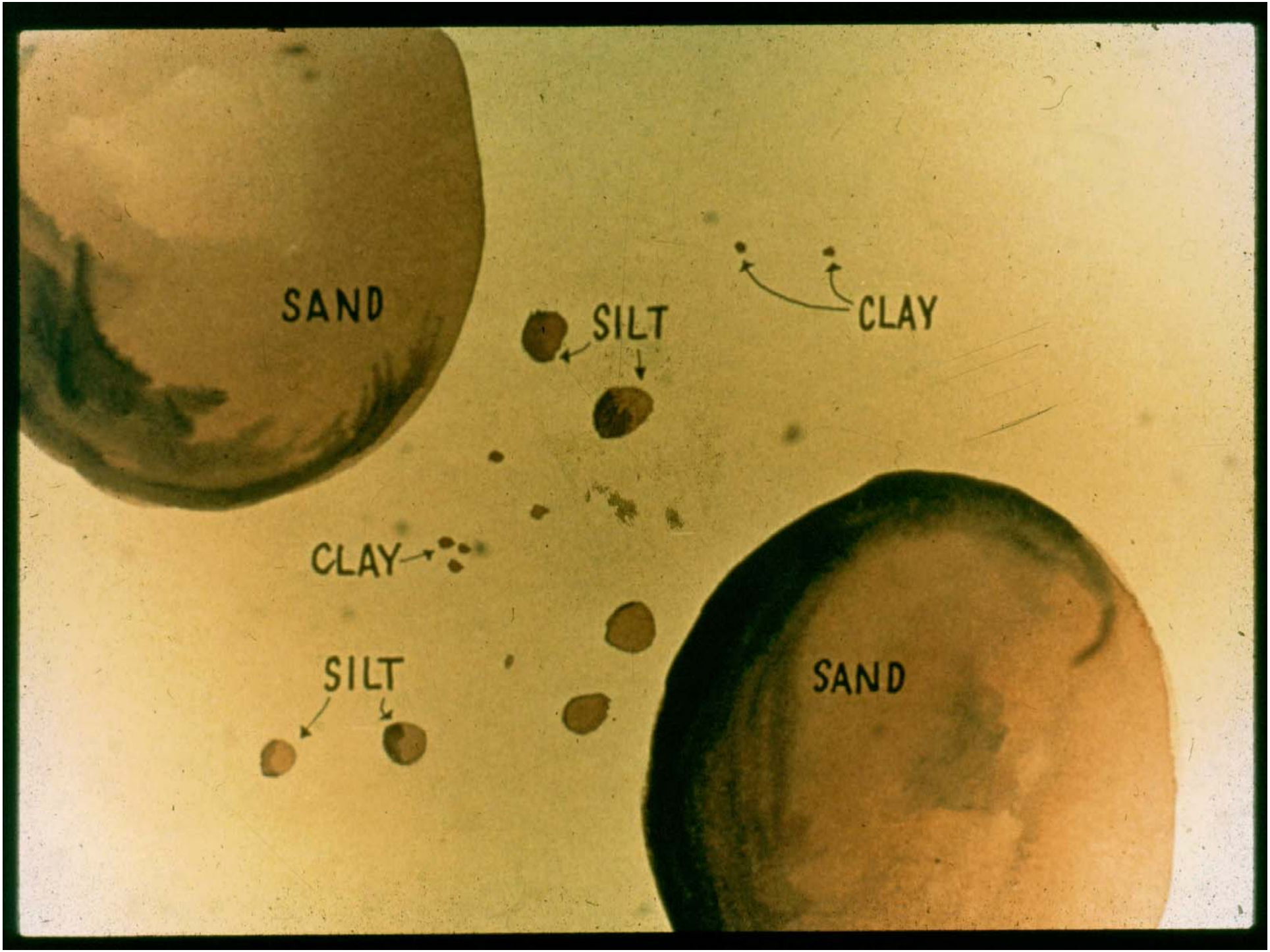
- What makes up infield mixes, how they are tested
- Types of clay
- Water retention in infield mixes

Where to Find Guidelines

- Distributors
- ASTM F2107 Standard Guide for Construction and Maintenance of Skinned Areas on Baseball and Softball Fields
  - 19 – 40% silt and clay, specify sand size. no minimum clay, no silt to clay ratio
- University of Missouri
  - 60-20-20 (sand – silt – clay)
  - 50-20-20-10 (sand – silt – clay – calcined clay)

Soil Texture

- Division of soil particles according to size: sand, silt, clay.
- Textural classes determined by percentage of each.
- Influences physical properties of the soil: porosity, playability, compressibility, water retention, and drainage characteristics.


SAND
SILT
CLAY
CLAY
SILT
SAND

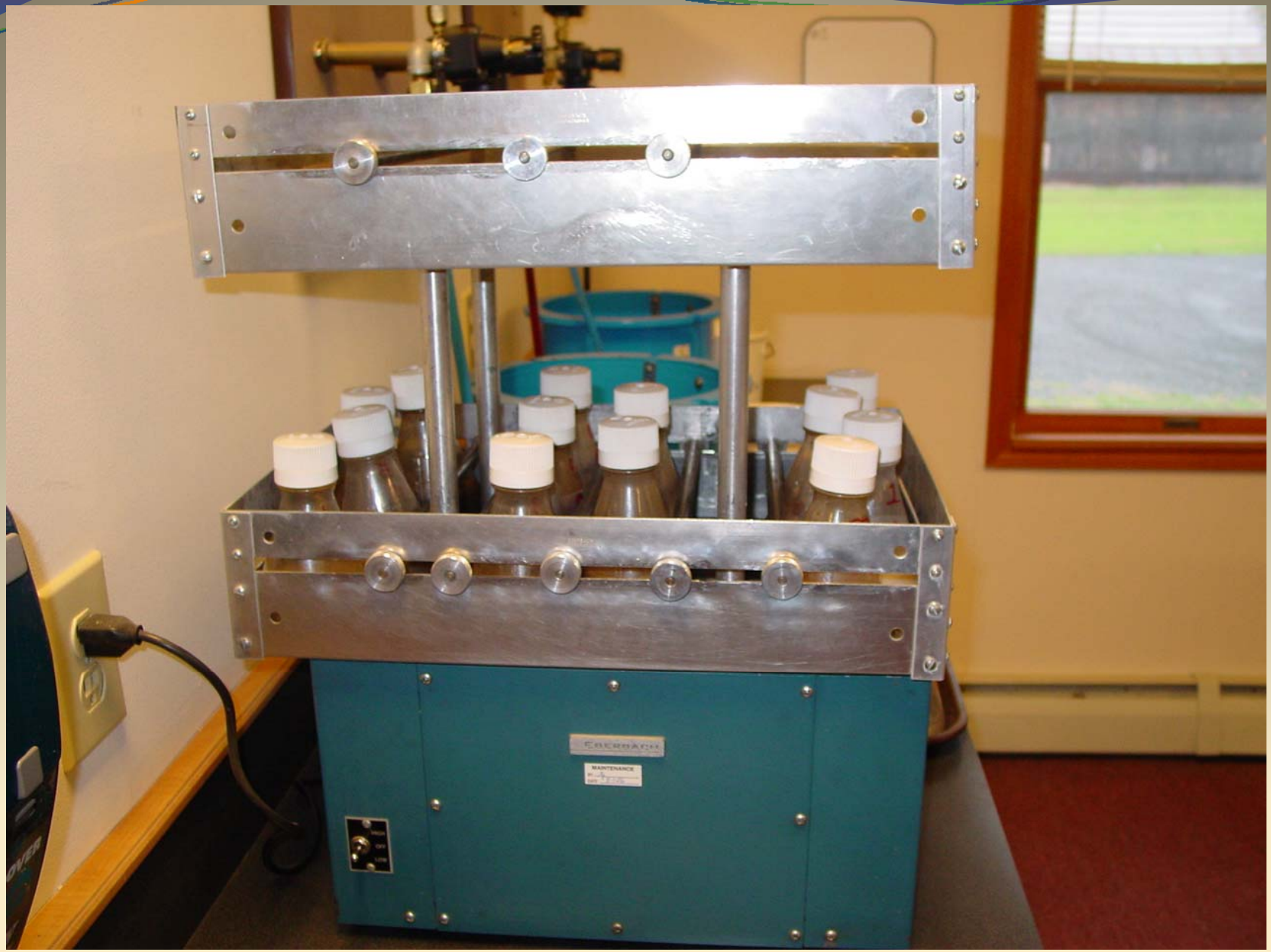
Soil Texture

- Gravel - > 2 mm
  - Minimize amounts. No value to infield mix.
- Sand – 0.05 – 2 mm.
  - Main component of infield mix
  - Sand size matters
- Silt – 0.002 – 0.05 mm
  - Least desirable
- Clay - < 0.002 mm
  - Second in quantity, major influence on performance

Jar Test

Particle Size Analysis ASTM F1632

- Dry samples are weighed
- Dispersant added (sodium poly-phosphate)


LABORATORY
MAINTENANCE

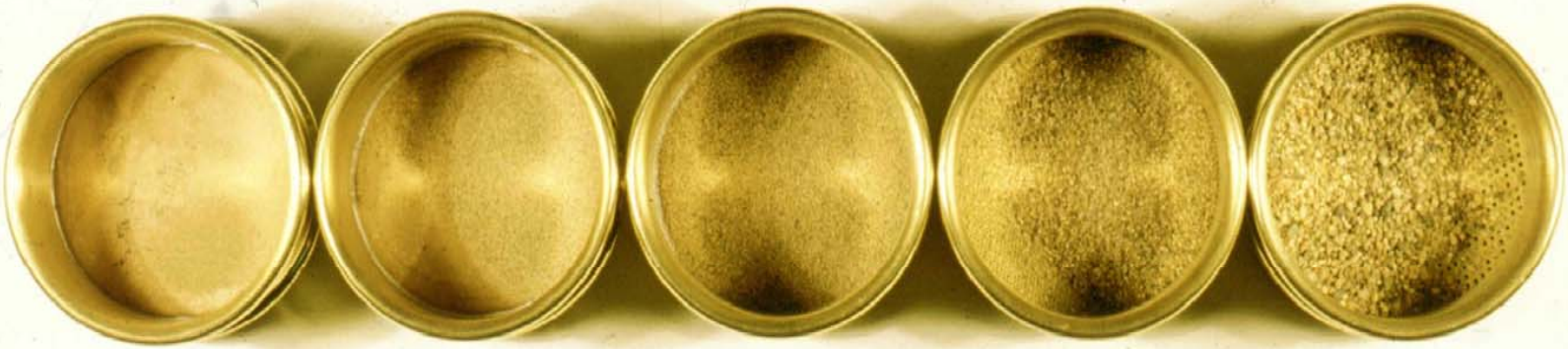

4
5

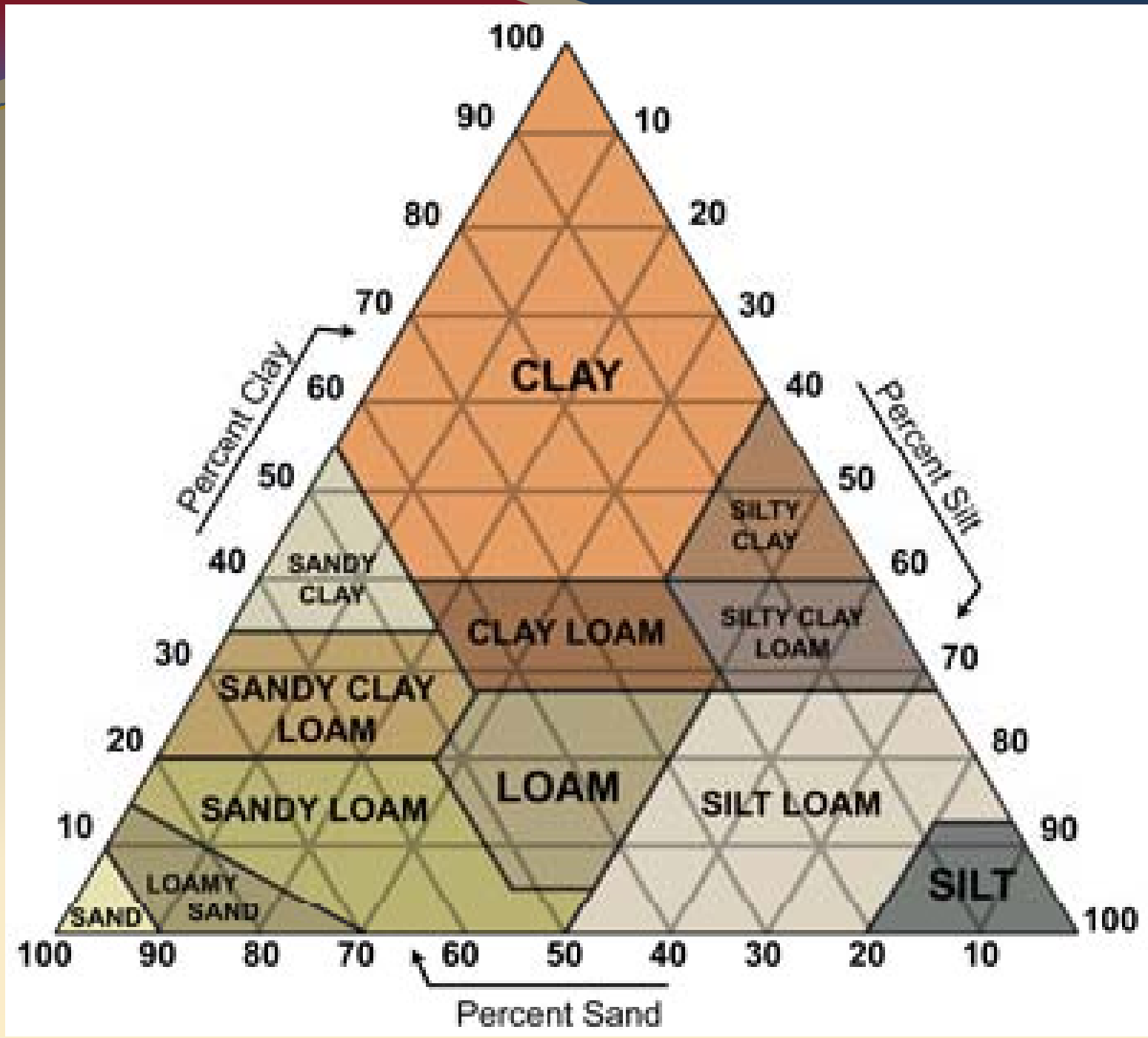
Particle Size Analysis - Drying


4
5

Particle Size Analysis - sieving


RX-29
ROTAP
RO-TAP


VERY FINE
FINE
MEDIUM
COARSE
VERY COARSE


100
90
10
80
20
70
30
60
40
50
50
40
60
30
70
20
80
10
90
100
Percent Clay
Percent Silt
Percent Sand
CLAY
SILTY CLAY
SANDY CLAY
CLAY LOAM
SILTY CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
SILT
LOAMY SAND
SAND
100 90 80 70 60 50 40 30 20 10

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TESTING
#0775-01

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BALL DIAMOND MIX TEST REPORT FOR
MLB Field

REPORT TO: *client name*
client address
client address
client address

DATE RECEIVED: March 16, 2012
TEST DATE: March 16 - 21, 2012
REPORT DATE: March 22, 2012
CONDITION OF SAMPLE: Normal

PARTICLE SIZE ANALYSIS (ASTM F-1632)

		Gravel (%)		Soil Separate %			Sieve Size/Sand Fraction Sand Particle Diameter % Retained				
Lab ID No.	Sample	No. 5 4 mm	No. 10 2 mm	Sand	Silt	Clay	No. 18 V. coarse 1 mm	No. 35 Coarse 0.5 mm	No. 60 Medium 0.25 mm	No. 140 Fine 0.10 mm	No. 270 V. fine 0.05 mm
30535-1	Sample A	0.0	1.2	63.1	15.6	21.3	6.0	19.1	27.0	9.3	1.7
30535-2	Sample B	0.1	2.0	62.3	17.0	20.4	4.2	19.5	25.5	11.2	2.0
Hummel & Co, Guidelines[1]		**≤ 3%**		**65 - 75**		**≥ 10%**					

1 In addition, a silt to clay ratio of less than 1.

PARTICLE SHAPE/TEXTURAL CLASS /COLOR/SCR

Lab ID No.	Sample	Silt to clay ratio	Color	Textural Class
30535-1	Sample A	0.73	7.5YR 5/4 Brown	Sandy clay loam
30535-2	Sample B	0.83	7.5YR 5/4 Brown	Sandy clay loam

Hydrometer Method


13
14
16

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ACCREDITED TESTING #0775-01

BALL DIAMOND MIX TEST REPORT FOR
MLB Field

REPORT TO: *client name*
client address
client address
client address

DATE RECEIVED: December 26, 2012
TEST DATE: December 26 - January 4
REPORT DATE: January 4, 2013
CONDITION OF SAMPLE: Normal

PARTICLE SIZE ANALYSIS (ASTM D-422)

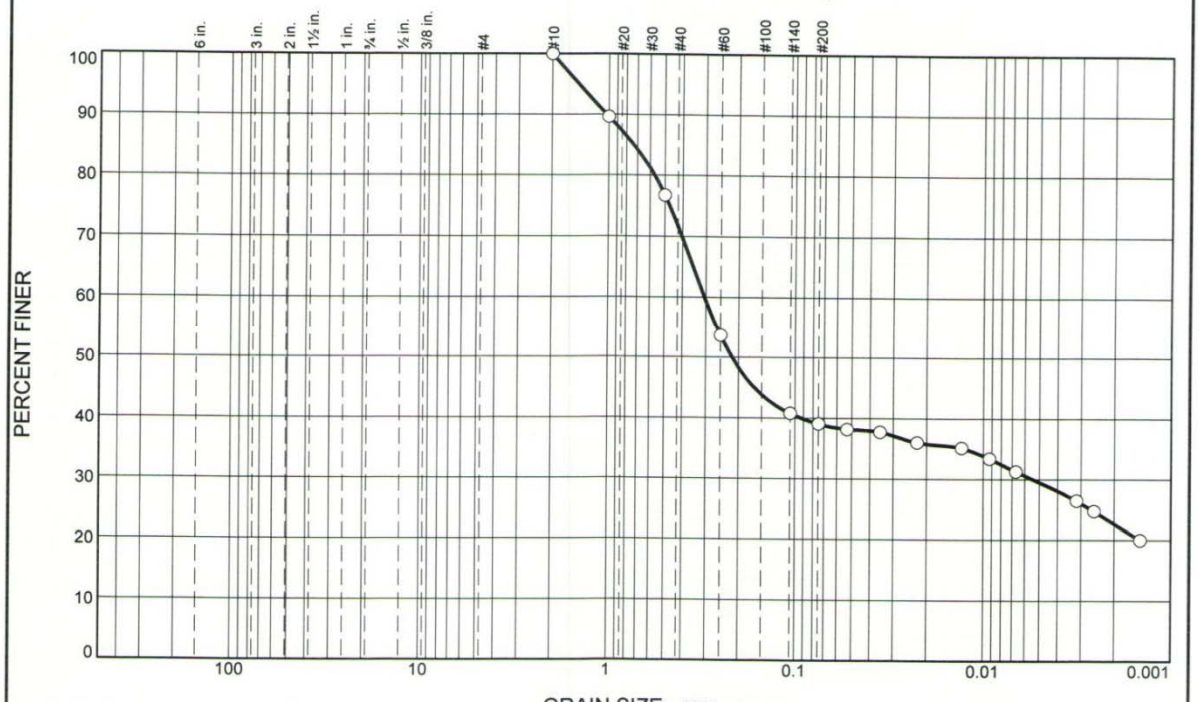
Lab ID No.	Sample	Gravel (%)		Soil Separate %			Sieve Size/Sand Fraction Sand Particle Diameter % Retained				
		No. 5 4 mm	No. 10 2 mm	Sand	Silt	Clay	No. 18 V. coarse 1 mm	No. 35 Coarse 0.5 mm	No. 60 Medium 0.25 mm	No. 140 Fine 0.10 mm	No. 270 V. fine 0.05 mm
32021-1	Infield Mix	0.0	4.7	61.9	15.4	22.7	10.4	12.9	23.1	13.2	2.3
Hummel & Co. Guidelines[1]		**0%**	**≤ 3%**	**65 - 70**		**≥ 10%**					

1 In addition, a silt to clay ratio of less than 1.

SCR/COLOR/TEXTURAL CLASS

Lab ID No.	Sample	Silt/Clay Ratio	Color	Textural Class
32021-1	Infield Mix	0.68	7.5 YR 5/4 Brown	Sandy clay loam

Particle Size Distribution Report



% Stones	% +3"	% Gravel			% Sand					% Silt		% Clay
		Coarse	Medium	Fine	V. Crs.	Crs.	Med.	Fine	V. Fine	Crs.	Fine	
0.0	0.0	0.0	0.0	0.0	10.4	12.9	23.1	13.2	2.3	2.3	13.1	22.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#18	89.6		
#35	76.7		
#60	53.6		
#140	40.8		
#200	39.1		
#270	38.2		
0.0354 mm.	37.7		
0.0225 mm.	36.0		
0.0130 mm.	35.1		
0.0093 mm.	33.4		
0.0067 mm.	31.3		
0.0032 mm.	26.5		
0.0026 mm.	24.8		
0.0015 mm.	20.0		

* (no specification provided)

Soil Description

Infield Mix

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= 1.0295 D_{85}= 0.7342 D_{60}= 0.3051
D_{50}= 0.2167 D_{30}= 0.0054 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D422

Date: 1/11/13

Client:

INFIELD GUIDELINES

Pro

- ☑ Water Access

Maintenance

- ☑ Regular/Daily
- ❑ Limited
- ❑ Volunteer

SAND (overall) 58-65%
SAND (medium) 38-45%
(of total mix)

SILT & CLAY 35-42%
(Combined)

SCR 0.5 – 1.0
(Silt ÷ Clay)

Major /Minor League Ballparks, Division I Colleges/Universities

INFIELD GUIDELINES

Intermediate

- ☑ Water Access

<u>Maintenance</u>

- ❑ Regular/Daily
- ☑ Limited
- ❑ Volunteer

SAND (overall) 65-69%
SAND (medium) 45-50%
(of total mix)

SILT & CLAY 31-35%
(Combined)

SCR 0.5 – 1.0
(Silt ÷ Clay)

Most Colleges/Universities, Some High Schools, Some Complexes

INFIELD GUIDELINES

Recreational

- ❑ Water Access

<u>Maintenance</u>

- ❑ Regular/Daily
- ❑ Limited
- ☑ Volunteer

Most Schools, Most Parks

SAND (overall) 70-75%

SAND (medium) >50%
(of total mix)

SILT & CLAY 25-30%
(Combined)

SCR 0.5 – 1.0
(Silt ÷ Clay)

What's In Professional Fields?

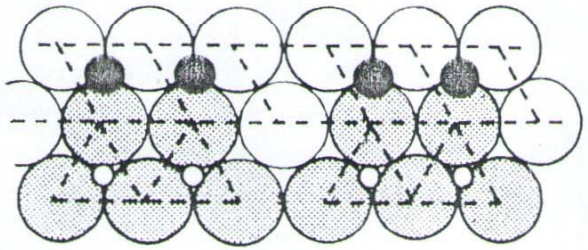
	Sand	Silt	Clay	Silt/Clay Ratio
The Big Leagues - MLB				
Average	60.1	18.7	21.2	0.9
Range	50.3 – 70.7	9.6 – 26.1	15.7 – 24.8	0.48 – 1.38
AAA, AA, Training Facilities				
Average	63.6	18.6	17.8	1.05
Range	52.5 – 80.0	9.3 – 34.7	4 – 20.3	0.65 – 8.68

What's In Collegiate, Schools, and Municipal Fields?

	Sand	Silt	Clay	Silt/Clay Ratio
Collegiate Fields				
Average	66.2	21.2	12.5	4.27
Range	61 – 78.2	8.9 – 38.7	1 – 27.1	0.53 – 20.9
Schools and Parks				
Average	65.1	27.9	7.0	4.9
Range	38 – 77.2	14.1 – 42.5	1.9 – 19.8	0.7 - 11

Clay – what is it?

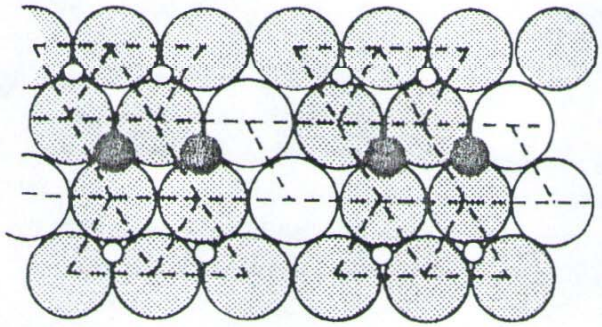
- Secondary mineral – byproduct of weathering of primary rocks and minerals.
- Defined by size - < 2 μ
  - Microscopic to sub-microscopic in size
- High surface area
- Plastic qualities



6 OH
4 Al
4 O + 2 OH
4 Si
6 O

Octahedral sheet

Tetrahedral sheet

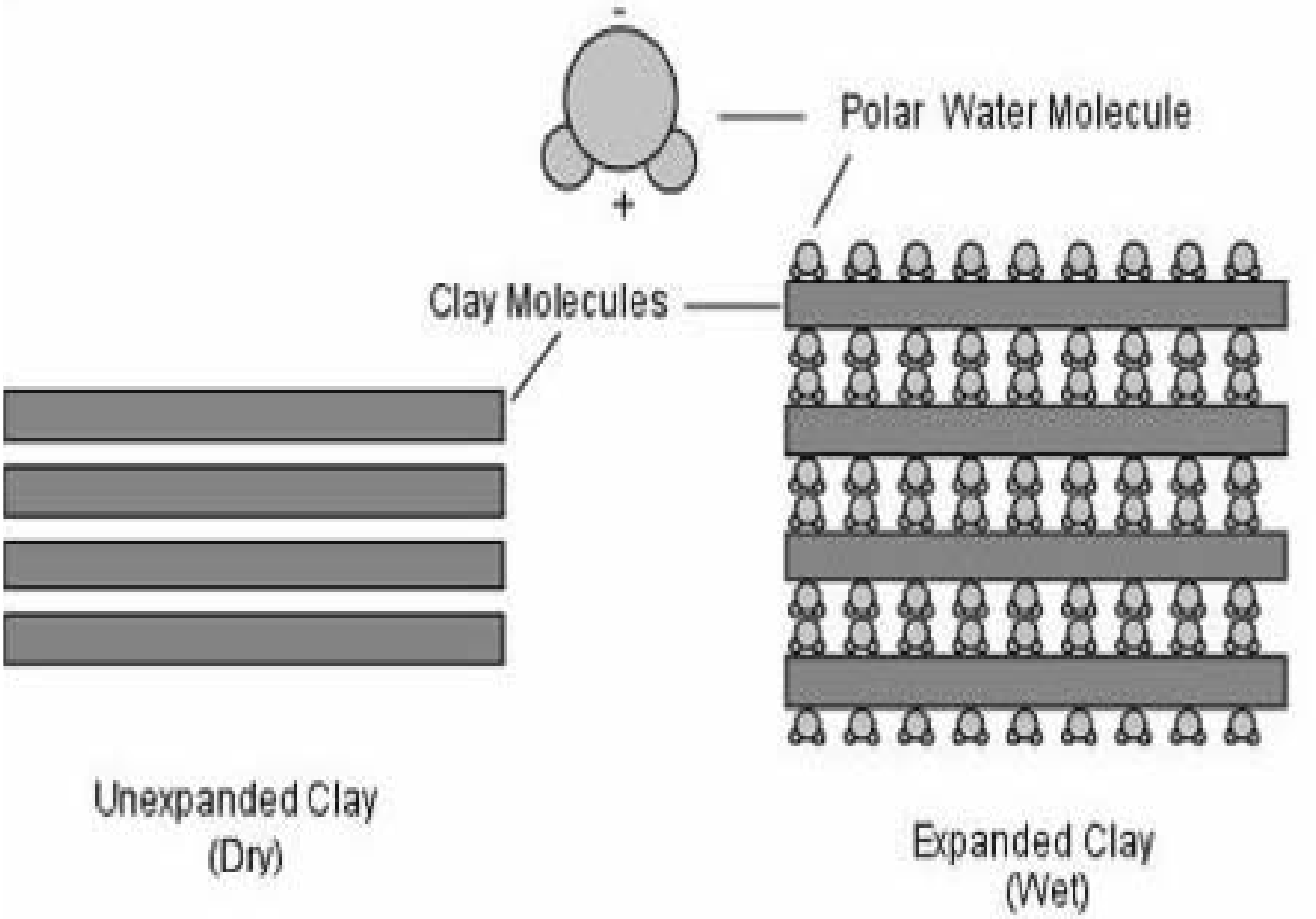


6 O
4 Si
4 O + 2 OH
4 Al
4 O + 2 OH
4 Si
6 O

Tetrahedral sheet

Octahedral sheet

Tetrahedral sheet

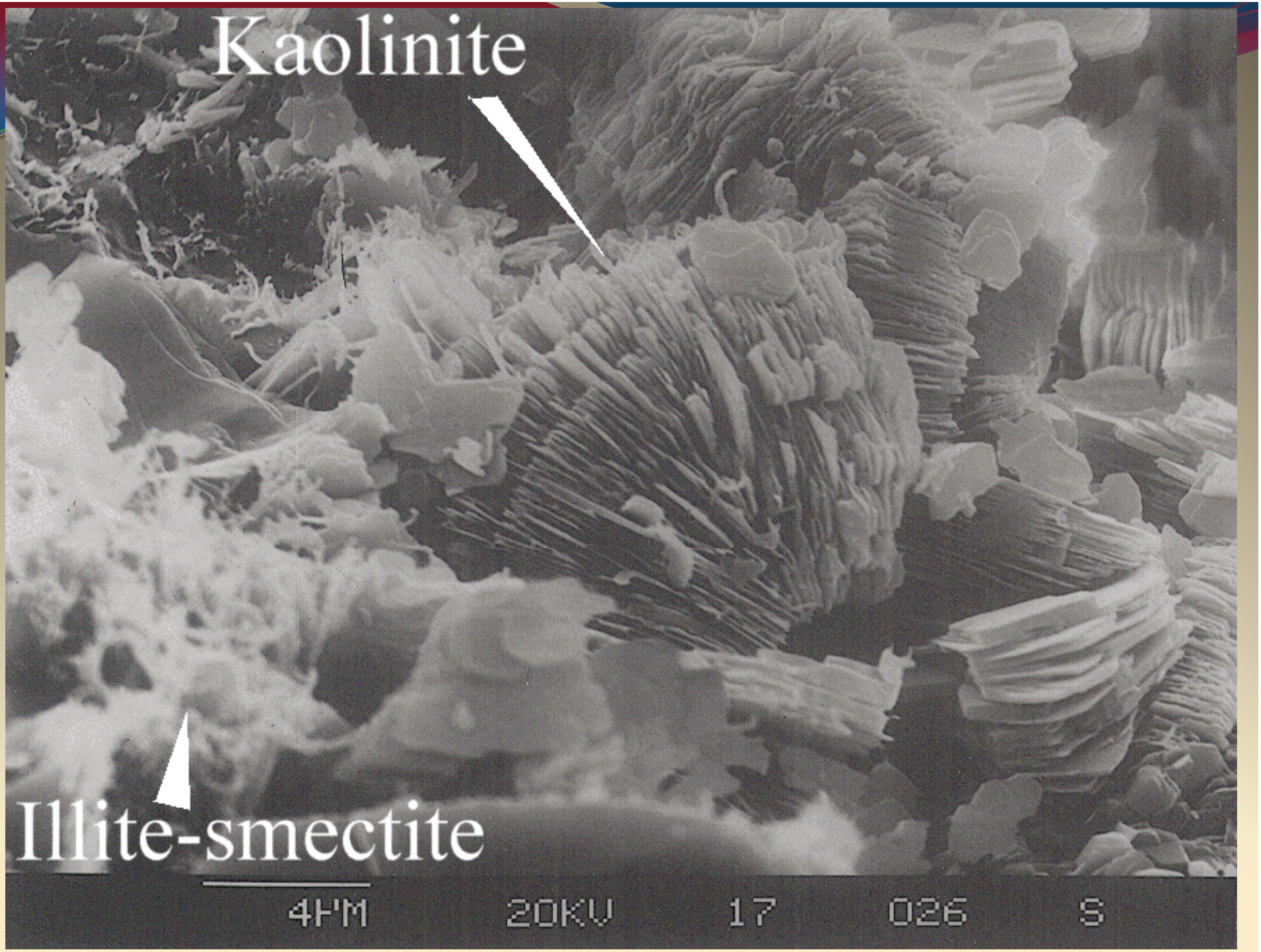

-
+
Polar Water Molecule
Clay Molecules
Unexpanded Clay
(Dry)
Expanded Clay
(Wet)

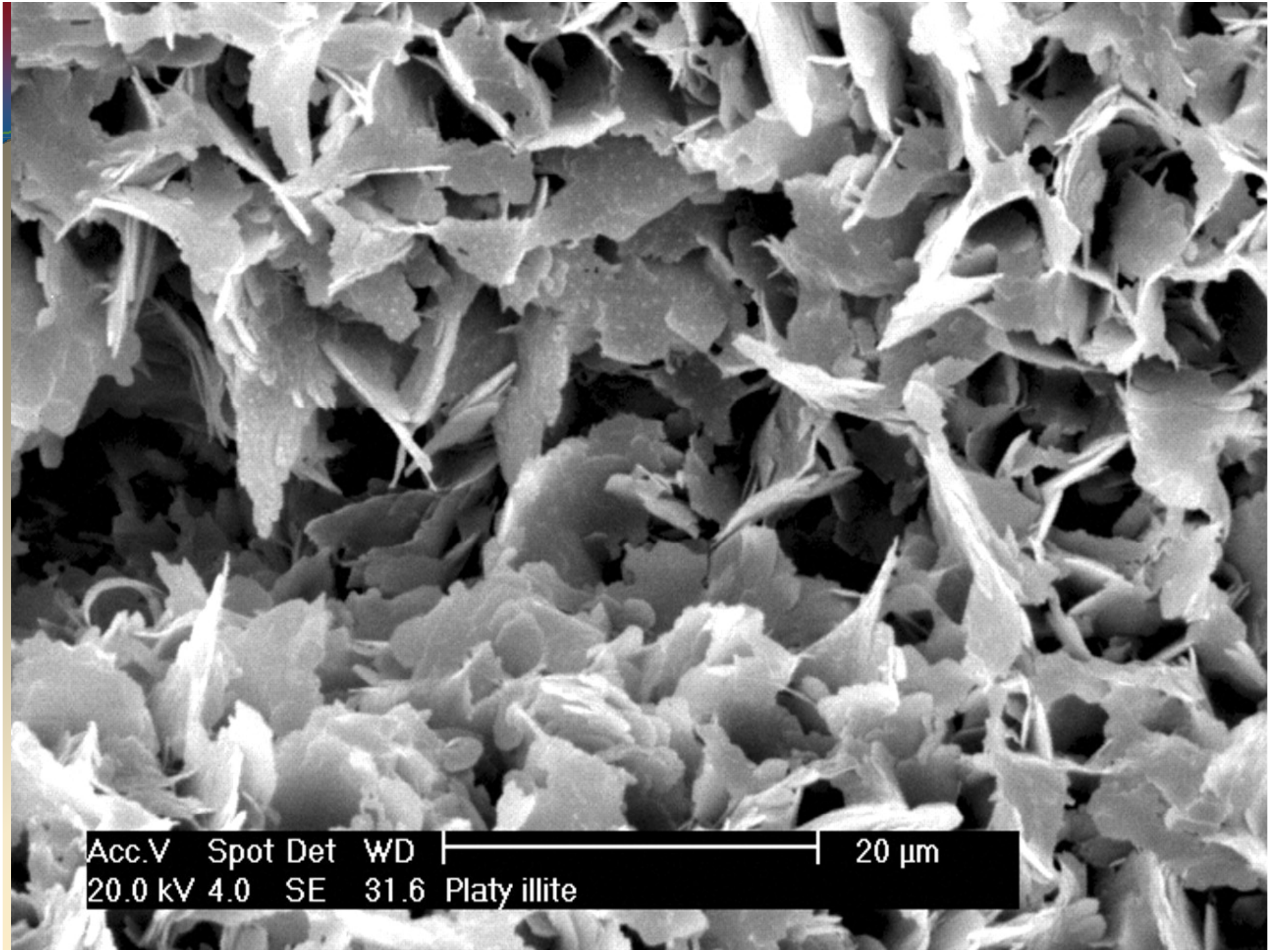
Types of clays - groups

- Kaolin
  - 1:1 crystal lattice, non expanding
- Illite
  - 2:1 crystal lattice, usually marine origin
  - Non-expanding because of potassium between lattices
- Montmorillite/Smectite
  - 2:1 crystal lattice, Mg substitute for 1/8 of Al, causes negative charge
  - Highly expansive on wetting, shrinks on drying
  - Very sticky when wet, hard clods when dry

Types of clays - Groups

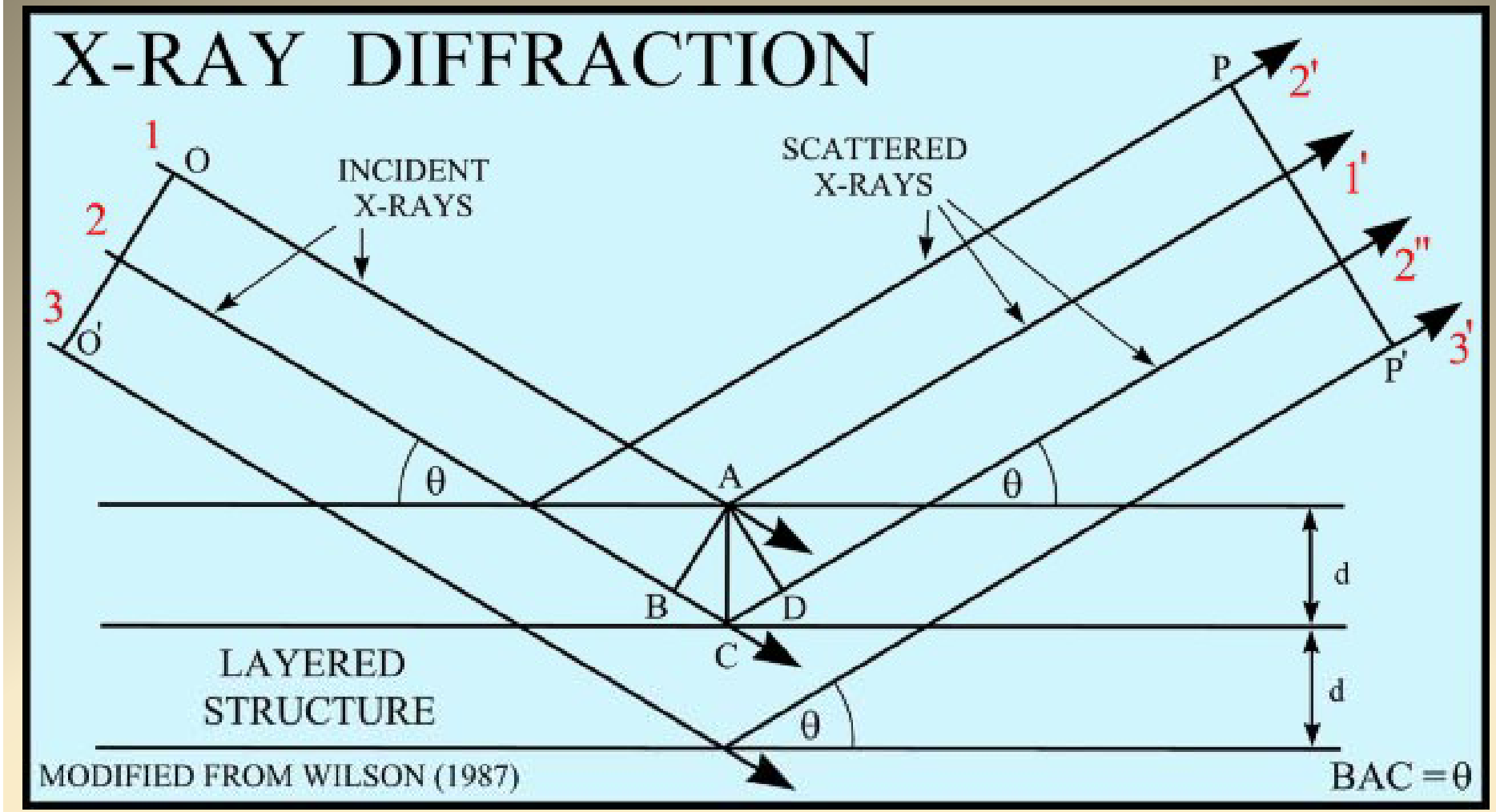
- Chlorite
  - 2:1 Lattice, but non-expanding.
  - Cations (Fe, Mn, Ni, or Mg) sandwiched between 2:1 lattices
- Sequioxides
  - Oxides and hydroxide compounds of Fe and Al.
  - Maybe crystalline or amorphous
  - Red (hematite) or yellow (limonite) in color


Kaolinite
Illite-smectite
4PM
20KV
17
026
S


Acc.V Spot Det WD
20.0 kV 4.0 SE 31.6 Platy illite
20 µm

Clay Makeup of Two Infield Mixes

X-Ray Diffraction of Clays



Clay Makeup of Two Infield Mixes

Mineral	% of Mineral in Infield Mix	
	Northern Clay	Southern Clay
Mixed Layer Illite/Smectite (70-30)	46.1%	0.0%
Illite & Mica	16.2%	3.2%
Kaolinite	13.0%	38.4%
Chlorite	11.1%	33.8%
Quartz	6.8%	11.8%
Calcite	1.3%	0.0%
Hematite	0.0%	12.8%
Pyrite	5.5%	0.0%

Clays – take home message

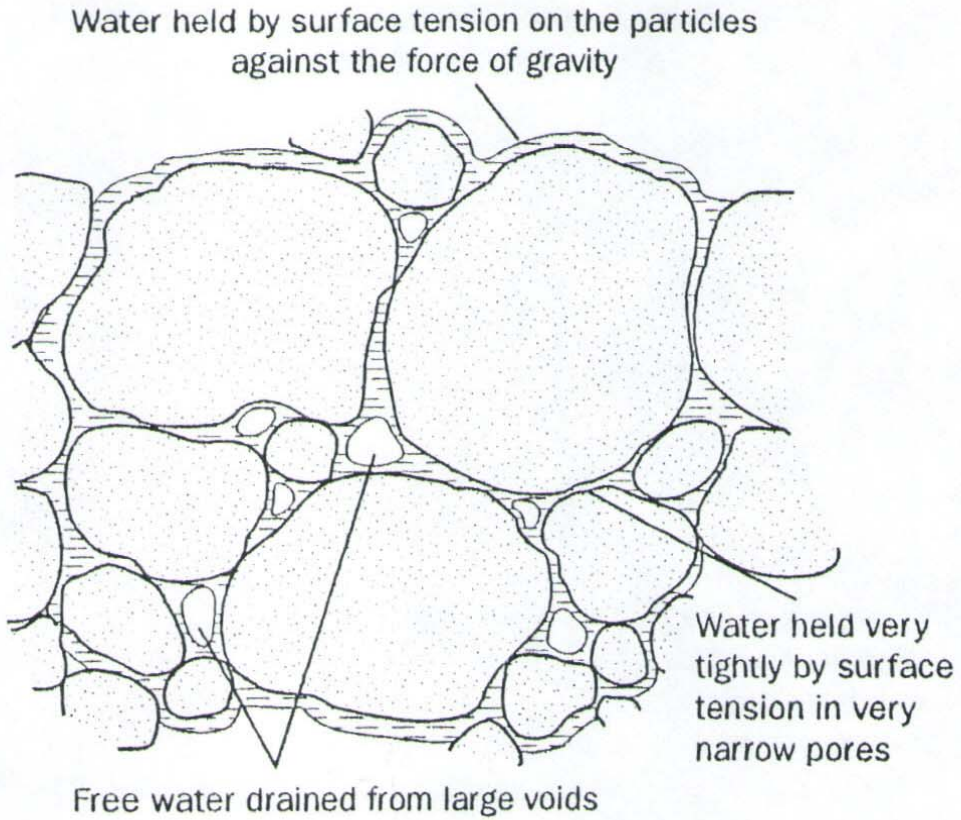
- That there are different types of clays with distinct properties.
- Unknown which are best suited for infield mixes or mound clays
- The art of infield mix maintenance

Infield Mixes and Water Retention

- Why is this important?
- Want to maintain optimum moisture content
  - Cleat in, cleat out clean
- Want to maintain optimum moisture content for duration of game (ideally)

Infield mixes and water retention

- Forces acting on water in infield mix
  - Gravity
  - Matric or surface forces
    - Attraction of water to surfaces (adhesive forces)
    - Attraction of water molecules to each other (cohesive forces)

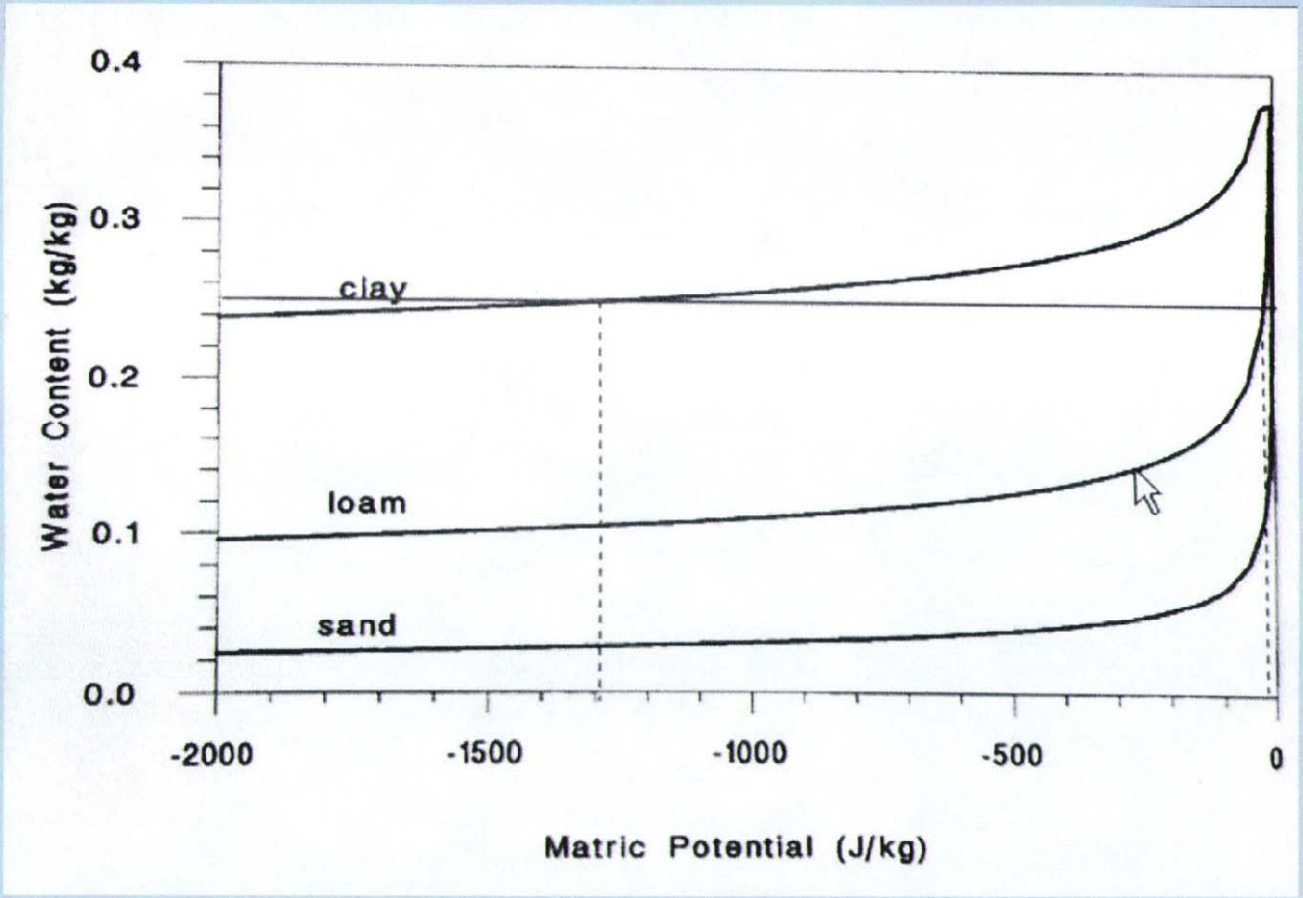

Water held by surface tension on the particles
against the force of gravity
Water held very
tightly by surface
tension in very
narrow pores
Free water drained from large voids

Infield mixes and water retention

- Water content
  - Actual amount of water held in the soil
  - Expressed as percent by weight or volume
- Water potential
  - The amount of energy required to removed water from the soil.
  - Measure of strength of capillary forces holding water in the soil.

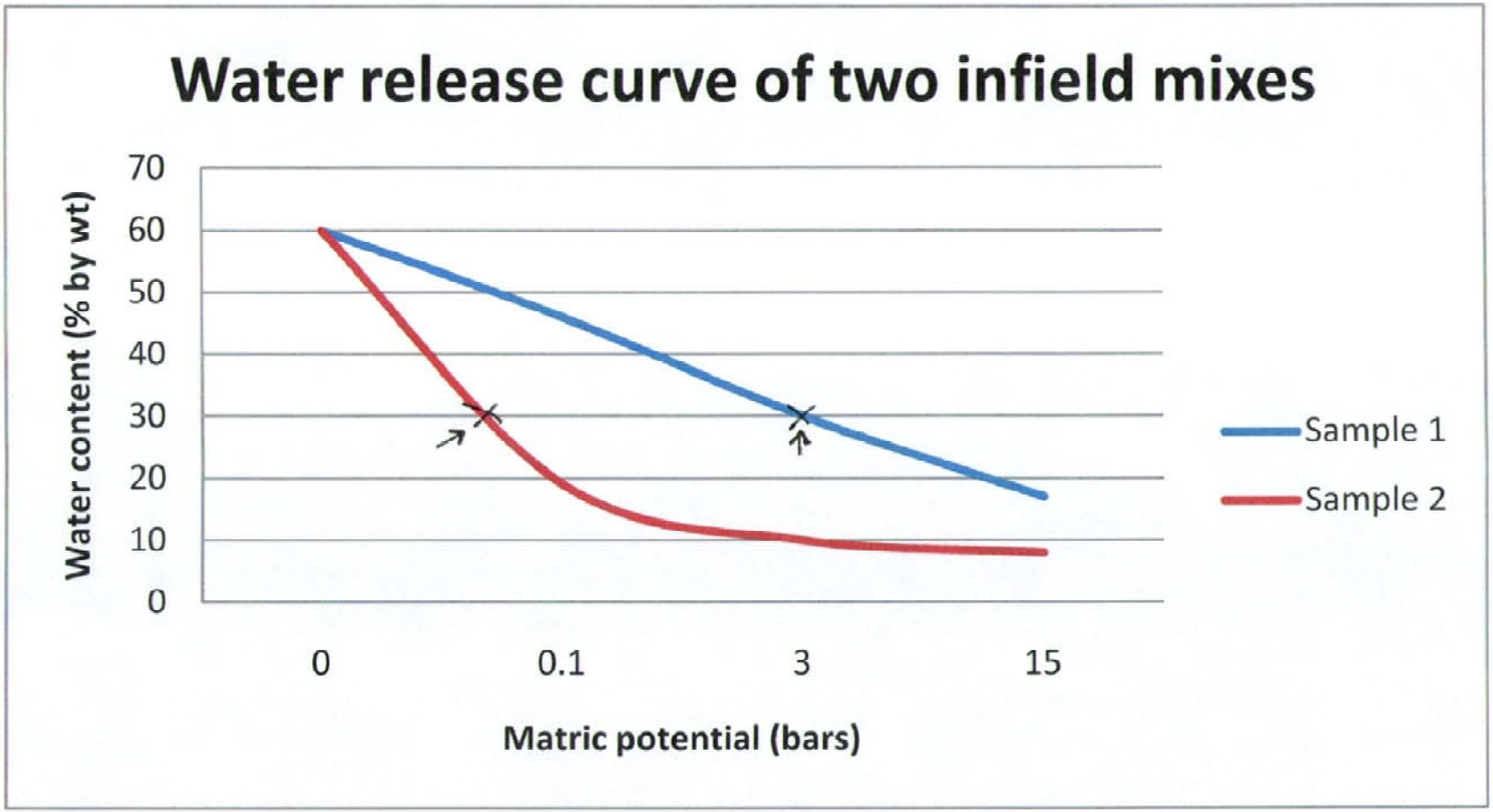

TORO

Texture, Water Content and Water Potential



Why?

Higher surface area and negative charge of clays means more water is held onto tighter…a little clay goes a long way!


Water release curve of two infield mixes
Water content (% by wt)
70
60
50
40
30
20
10
0
0
0.1
3
15
Matric potential (bars)
Sample 1
Sample 2

Water Retention of Mixes

- Water retention at 1/10 bar
  - 2 psi
  - Field capacity
- Water retention at 15 bars
  - 220 psi
  - Permanent wilting point

Water retention of infield mixes

Sand	Silt	Clay	Silt/clay Ratio	Water content at 1/10 bar	Water content at 15 bars	% of water loss
68.2	10.3	21.5	0.48	17%	10%	41%
66.5	27.5	6.0	4.6	13%	3%	77%
70.7	9.6	19.7	0.49	29%	8%	72%
50.3	26.1	23.6	1.11	46%	17%	63%
58.3	19.1	22.5	0.85	19%	8%	58%
62.5	23.1	14.4	1.60	31%	12%	61%

Water Retention in Infield Mixes

- Function of:
  - Sand content
  - Sand size
  - Clay content
  - Clay type
  - Silt to clay ratio?
  - All of the above

Increasing Water Retention In Infield Mixes

- Decrease sand content
- Increase clay, reduce silt to clay ratio
- Calcined clay products
- Hydrogels

Conclusions

- MLB infield mixes are predominately sandy clay loams with silt to clay ratios slightly less than 1.
- Good Infield mixes can fall into sandy loam class.
- Different types of clays are likely to perform differently
- Different methods can be used to evaluate infield mixes for particle size:
  - Pipette
  - Hydrometer – better for high clay mixes
  - Jar test – really??

Conclusions (general)

- Mixes with higher clay (and silt) had higher water retention
- Mix high in calcined clay held water at lower tensions, but released it as the mix dried out
- Testing technology may exist to design mixes with amendments that have higher and more durable water retention capacities.


Questions?
NO SMOKING