Demystifying Soils and Fertilizers

Dr. Dave Franzen

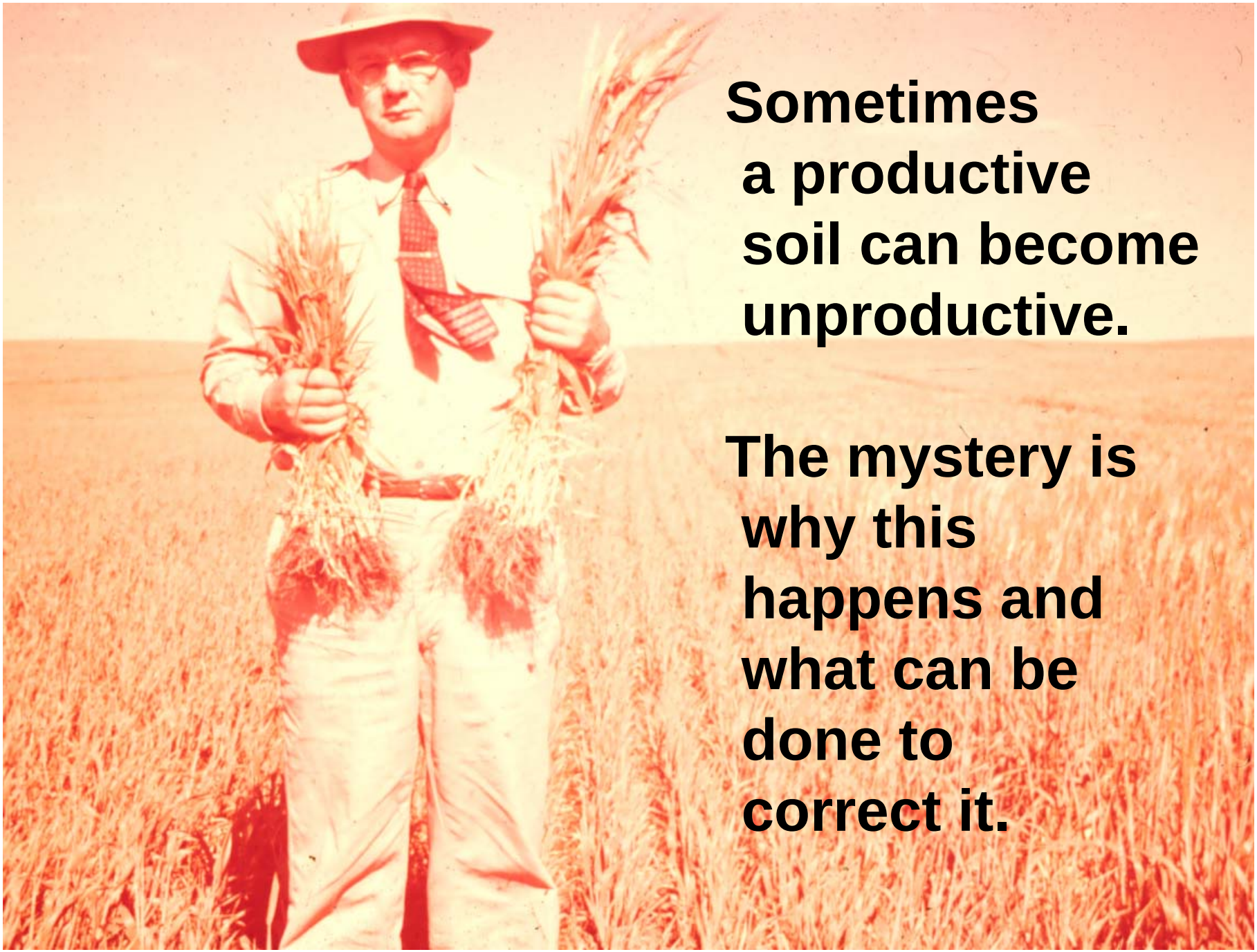
NDSU Extension Soil Specialist

Fargo, ND


Soils have secrets!

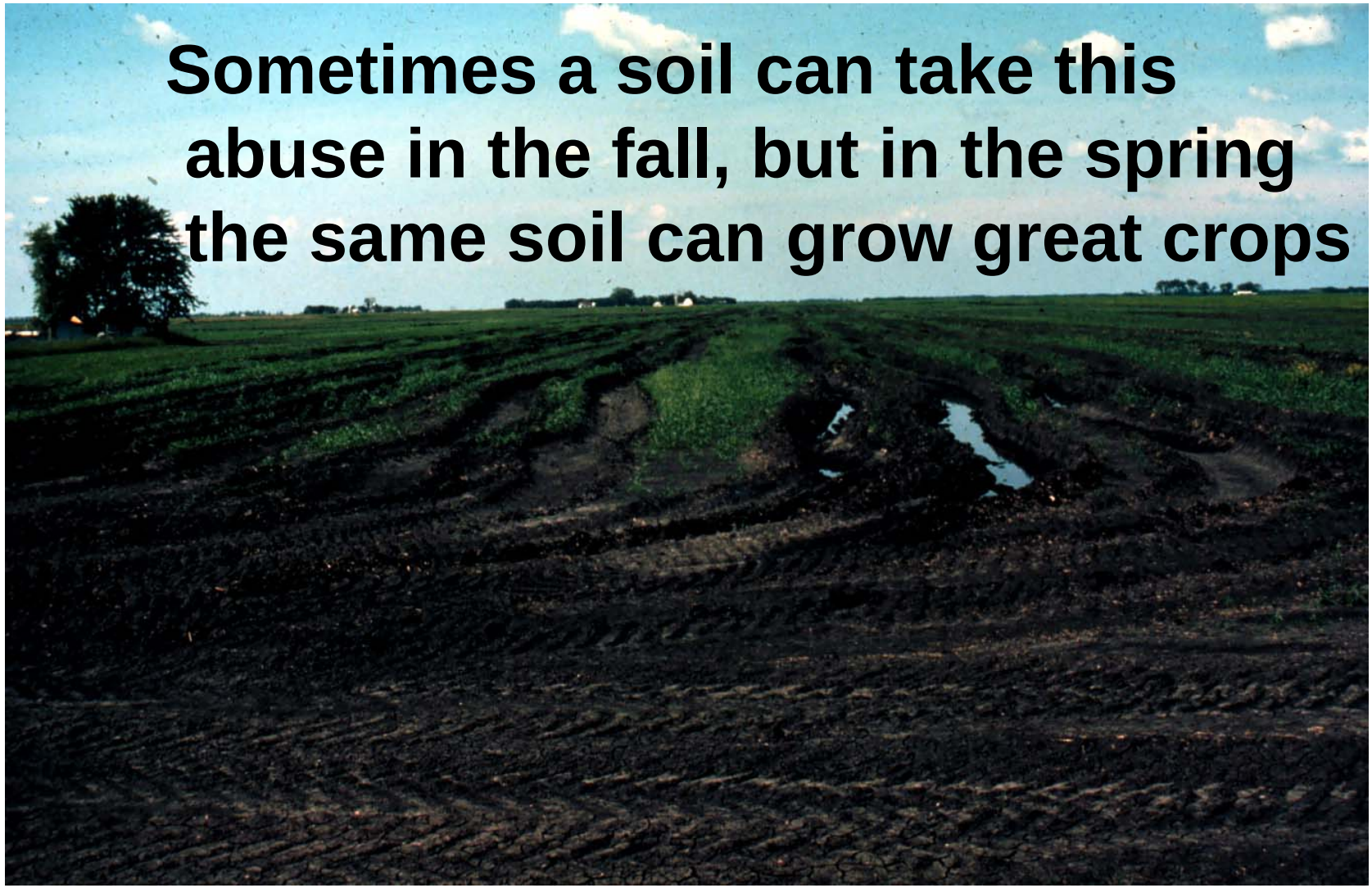
Sometimes a soil allows crops to grow well…

and other soils prevent crops from growing well.



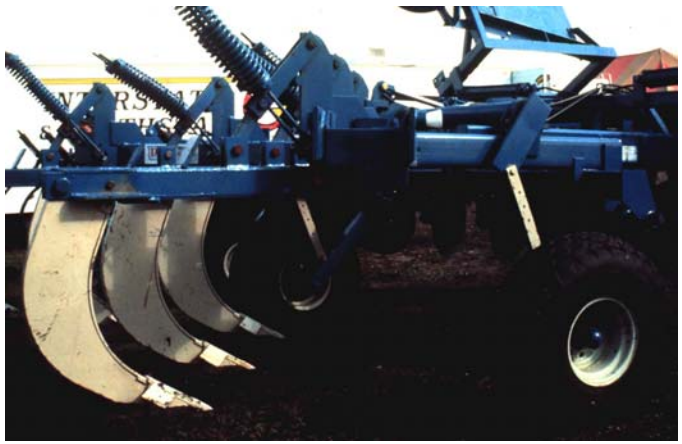
Sometimes a productive soil can become unproductive.

The mystery is why this happens and what can be done to correct it.


Sometimes a soil can take this abuse in the fall, but in the spring the same soil can grow great crops

In other soils, deep tillage may be needed after every crop to ensure good root growth.

The mystery is why NDSU doesn't recommend deep tillage as a normal part of farming practices.



Are we stupid?

Do we go to church on Sunday AM instead of watching TV?

Both?

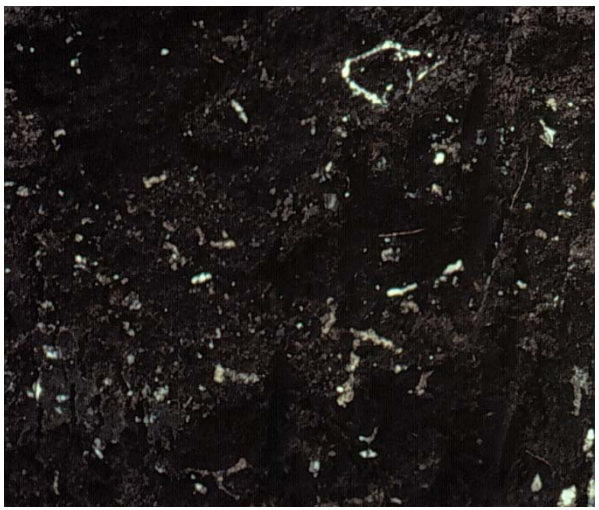
Neither?

To unlock soil mysteries, we can look beneath the surface and examine the soil both physically and chemically.

To unlock a mystery, don't be afraid to dig a hole!

(after calling Dakota one-call)

Might see evidence of spring compaction.



Evidence of salts.

You might find that your soil has special problems like sodium.

General information about your soils and often-times a picture are available at

www.mo10.nrcs.usda/mlras

If the mystery is plant nutrition, there is no better way to solve it than with a soil test!

SOIL TEST REPORT

SOIL TESTING LAB WALDRON HALL P.O. BOX 5575 NORTH DAKOTA STATE UNIVERSITY FARGO, ND 58105
Phone: (701) 231-8942

To: [redacted]

Copy To: [redacted]

County Agent: [redacted]
County: [redacted]
Lab No.: [redacted]
Date Sampled: 10/31/2007
Date Received: 11/1/2007
Date Reported: 11/1/2007

Sample Notes:

SOIL TEST RESULTS

Sample Number	pH	Nitrogen NO3-N lb/acre			Organic Matter OM	P ppm	K ppm	Soluble Salts mmhos/cm			Zinc Zn ppm	Iron Fe ppm	Mn ppm	Copper Cu ppm	Sulfur SO4-S lb/acre		Chloride Cl lb/acre	
	0-6"	0-6"	0-24"	2-4'	0-6"	0-6"	0-6"	0-6"	6-24"	24-48"	0-6"	0-6"	0-6"	0-6"	0-6"	0-24"	0-6"	0-24"
HEN36-2	7.9	9	21			9	220	1.16	2.12									

SOIL TEST LEVELS

Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (Occasional) (Response)	Very High (No) (Response)

SOIL TEXTURE: Your soil has a FINE texture.
Fine textured soils include sandy clays, silty clays and clays.

pH: The Soil in this field is MODERATELY ALKALINE

NITROGEN: NNNNNNNNNNN

PHOSPHORUS: PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP

POTASSIUM: KKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKK++

SOLUBLE SALT: The 0-6 inch layer of the soil is SALINE.

RECOMMENDATIONS AND COMMENTS

For a 60 bu/acre goal of Wheat, apply:
130 lbs of N per acre
30 lbs of P2O5 per acre
0 lbs of K2O per acre

If your soil test is very low in phosphorus and/or potassium a band application of 2/3's the above broadcast rate could be more efficient than broadcasting.

On the average the recommendation can be reduced by 10 lb of N, 5 lb of P2O5 and 10 lb of K20 for each ton of cattle or hog manure applied per acre. Poultry and sheep manure contain about twice the nutrients as cattle and hog manure.

UREA (46-0-0): Do not apply more than 10-15 lb N as urea per acre through a drill with 6 or 7 inch row spacing. For crops with a wider row spacing do not apply any urea in contact with the seed.

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pH in water;NO3-N(lb/acre)extracted with water;OM(%)by ignition;P=Phosphorus;P(ppm) by 0.5M sodium bicarbonate;K=Potassium;K(ppm) by 1N ammonium acetate;soluble salts(mmhos/cm)in 1:1 soil:water; Mn=Manganese;Zn,Fe,Cu, and Mn (ppm) by DTPA; SO4-S (lb/acre) extracted with 500ppm P as monobasic calcium phosphate; Cl (lb/acre) extracted with K2SO4.

pH
NO_3-N
Organic Matter
P, ppm
K, ppm
Soluble Salts (EC)
Zinc
Iron
Manganese
Copper
Sulfur
Chloride

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PHOSPHORUS PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
POTASSIUM KKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKK++
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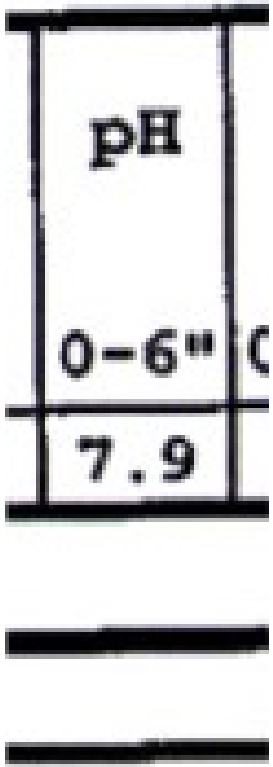
Other tests might be

CCE
B
Mo
SAR

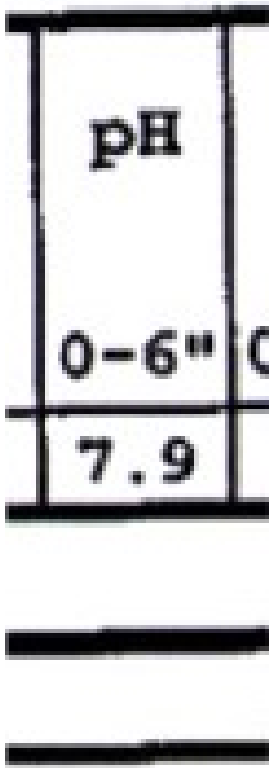


pH ?

A measure of the acidity of the soil.

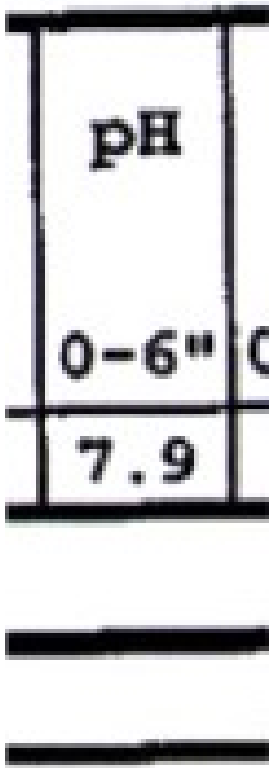
Plants grow fine in pH from 5.5 to about 7

Above 7, carbonates or the pH itself restrict availability of iron, phosphate.



pH ?

Below 6.5, availability of phosphate is also restricted. Some other nutrients, particularly Mn are increased with lower pH.



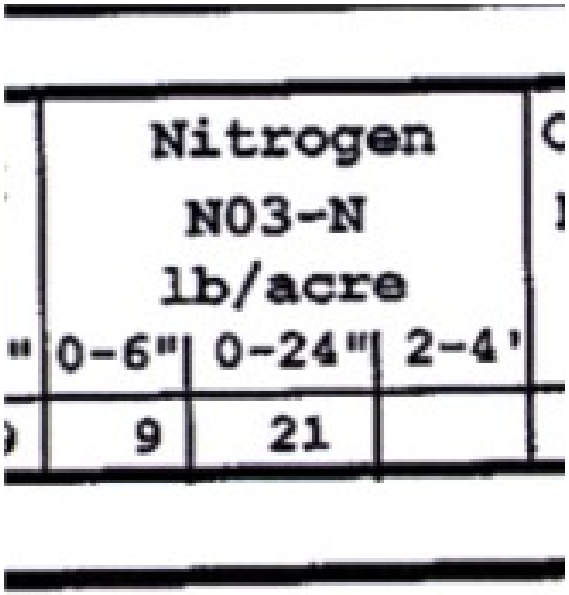
pH ?

pH below about 4.5 can be increased with gypsum or lime (calcium/magnesium carbonates)

pH from 4.5 to 7 can be increased by adding lime (not gypsum).

pH above 7 can be decreased by adding an acid, or something that turns into an acid through biological activity in the soil (S or NH3)

NO3-N?

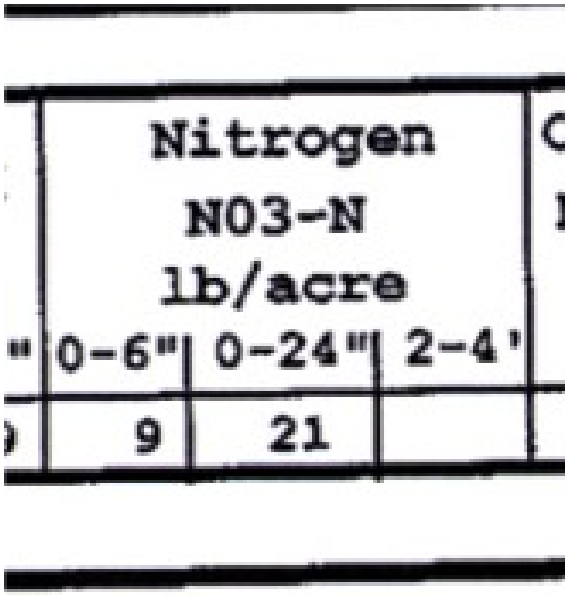


Nitrogen NO3-N lb/acre			
"	0-6"	0-24"	2-4'
	9	21	

The only nitrogen we can measure in the soil that has immediate value to a growing crop.

In all of our recommendations, nitrate-N is subtracted.

NO3-N?



Nitrogen NO3-N lb/acre			
"	0-6"	0-24"	2-4'
	9	21	

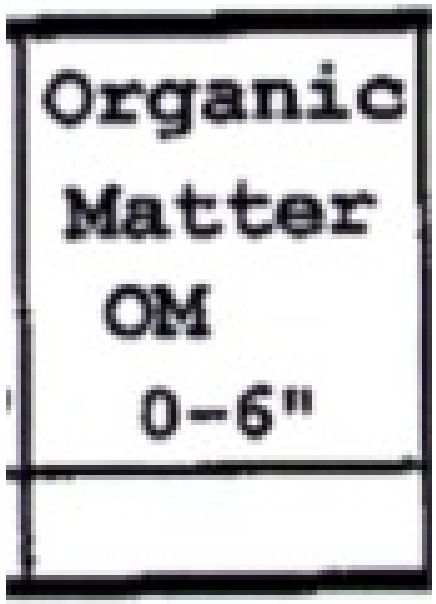
We use a 0-24” depth for most crops

(but we assume 30 lb/a at the 2-4 foot depth)

Nitrate-N is not the only source of soil N available-

OM, parts of OM, ammonium-N.

Residue decomposition- Previous Crop Credit

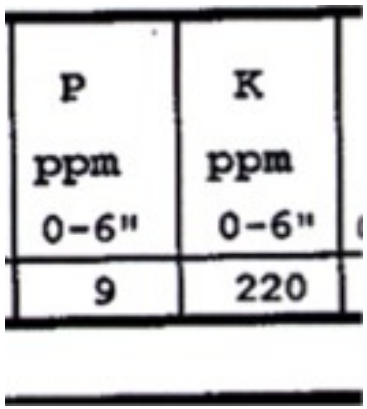


Organic matter (OM)

Right now, it has no direct published role in our soil recommendations.

It’s possible that could change.

Most useful in pesticide application rates.

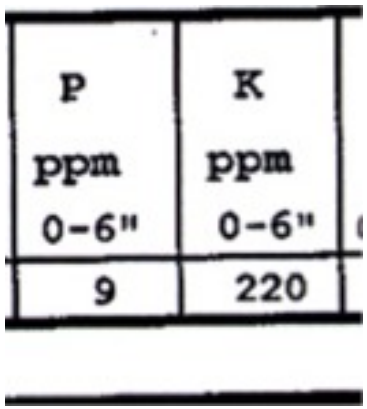


P ppm 0-6"	K ppm 0-6"
9	220

P (phosphate)
K (potassium)

Both essential elements.

P is most often low.
K will be with more corn/soybean production.



P ppm 0-6"	K ppm 0-6"
9	220

P (phosphate)
K (potassium)

Difference between test labs is interpretation-

NDSU- enhanced sufficiency
Others- maybe maintain/buildup

NDSU recs are economically superior to industry recs.

Maintenance approach results in buildup.

Soluble Salts mmhos/cm		
0-6"	6-24"	24-48"
1.16	2.12	

Soluble Salts
EC
mmhos/cm

Low salts are good.
High salts are bad.

Salts below 0.5, usually not a problem.
Salts above 0.5, can be a problem.

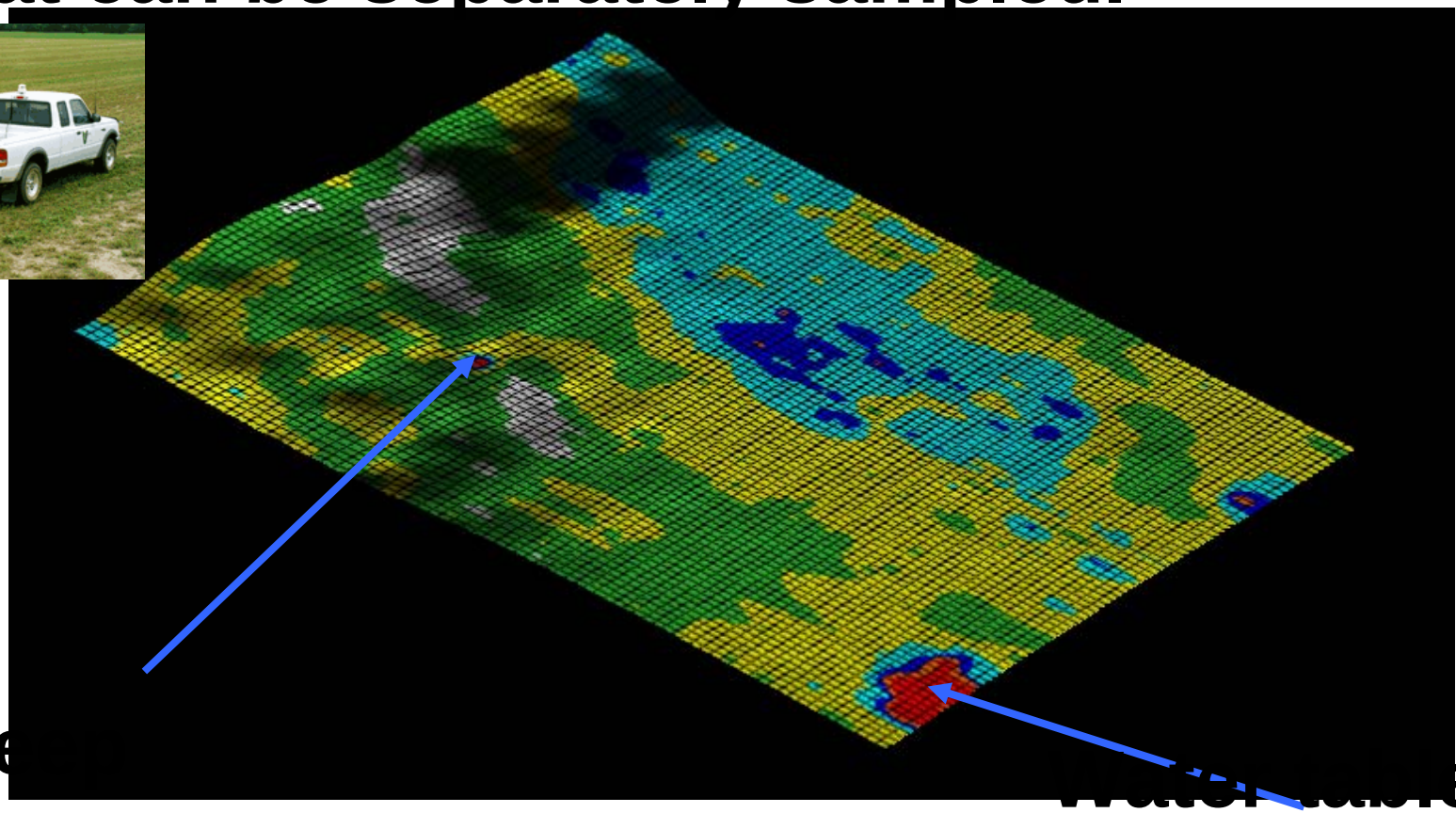
Soluble Salts mmhos/cm		
0-6"	6-24"	24-48"
1.16	2.12	

Soluble Salts
EC
mmhos/cm

Lower at depth is a good thing.
Higher at depth means that it will be harder or impossible for crops to grow out of salt stress.

Salts vary on a small spatial scale.

An EC map can identify problem areas that can be separately sampled.



Se

Water table

salts

28 24 20 16 12 8 4

Apparent EC mmohs/cm

Zinc Zn ppm 0-6"	Iron Fe ppm 0-6"	Mn ppm 0-6"	Copper Cu ppm 0-6"

Zinc, Iron, Manganese, Copper-

The 4 Amigos!

Zinc useful for corn, potato, flax, dry bean
Copper for wheat/barley

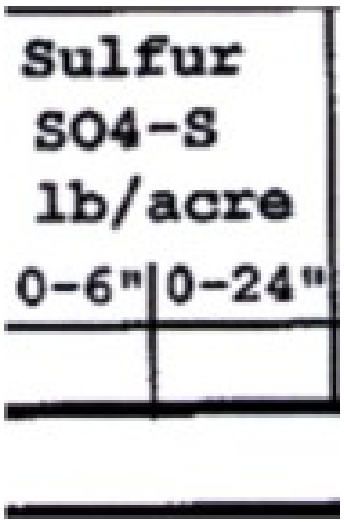
Iron- maybe beets on sand (?)
Manganese- for people who sell manganese

Zinc Zn ppm 0-6"	Iron Fe ppm 0-6"	Mn ppm 0-6"	Copper Cu ppm 0-6"

Zinc, Iron, Manganese, Copper-

Why all four?
Because the same extractant and lab instrument can easily analyze all four!

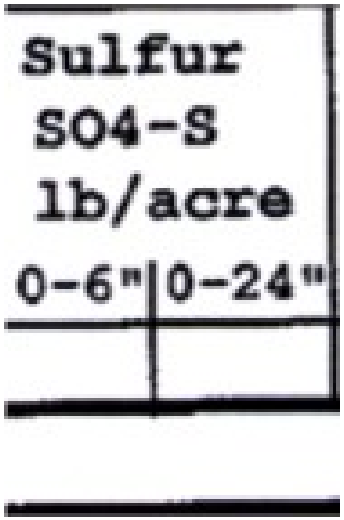
Only Zn and Cu are at all useful right now in ND, and only for some crops.



The most singularly useless test ever devised.

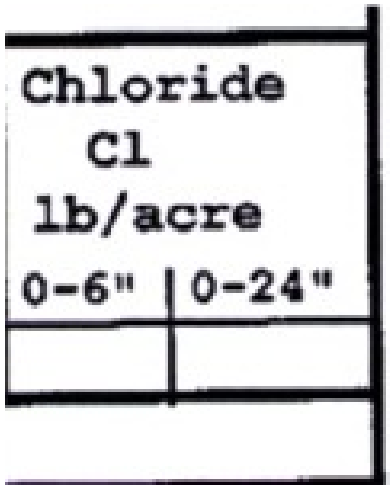
Works great for alfalfa in WI.

Universally under-estimates S availability in higher OM soils, soils with higher water tables, soils with residues, and anything not a low-organic matter sand.



A better predictor of response is good knowledge of your soil and recent weather.

If you have a low organic matter sand (2% or below OM, sandy loam or coarser) and rainfall in the fall, heavy snow or rain in the spring, it's a good bet you need to add S (preferably a soluble sulfate form, because elemental S of any kind works poorly here for some reason).



Chloride is a test run when seeding wheat or barley.

Application helps yield about ½ the time.

It's a useless test for other crops.

Chloride can leach, so it's not good to test more than the fall before seeding small grains.

SOIL TEXTURE	Your soil has a FINE texture. Fine textured soils include sandy clays, silty clays and clays.
pH	The Soil in this field is MODERATELY ALKALINE
NITROGEN	NNNNNNNNNNN
PHOSPHORUS	PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
POTASSIUM	KKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKK++
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UREA (46-0-0): Do not apply more than 10-15 lb N as urea per acre through a drill with 6 or 7 inch row spacing. For crops with a wider row spacing do not apply any urea in contact with the seed.

The comments at the bottom provide useful general hints prompted by certain soil test numbers.

Other special items-

For IDC in soybeans, growers are encouraged to test for CCE (Calcium Carbonate Equivalence)

If soil pH is less than 7, CCE is always zero or nearly zero.

If soil pH is greater than 7, CCE could be anywhere from 1 to 30.
The higher the number the greater chance of having IDC, and the more severe it will be.

Boron-

If you are growing sugarbeets in the sand on the edge of the Valley, and OM is less than 2%, B may be an issue.

Recent micronutrient studies have shown a significant response at more than one location in sugarbeets.

Look for B levels less than 1 ppm, on sandy soils low in OM.

Molybdenum-

One would not expect a Mo problem in this region-

Our soils are derived partially from ancient ocean sediments (shales) high in Mo.

Our pH is generally above 7 and Mo is more available at higher pH.

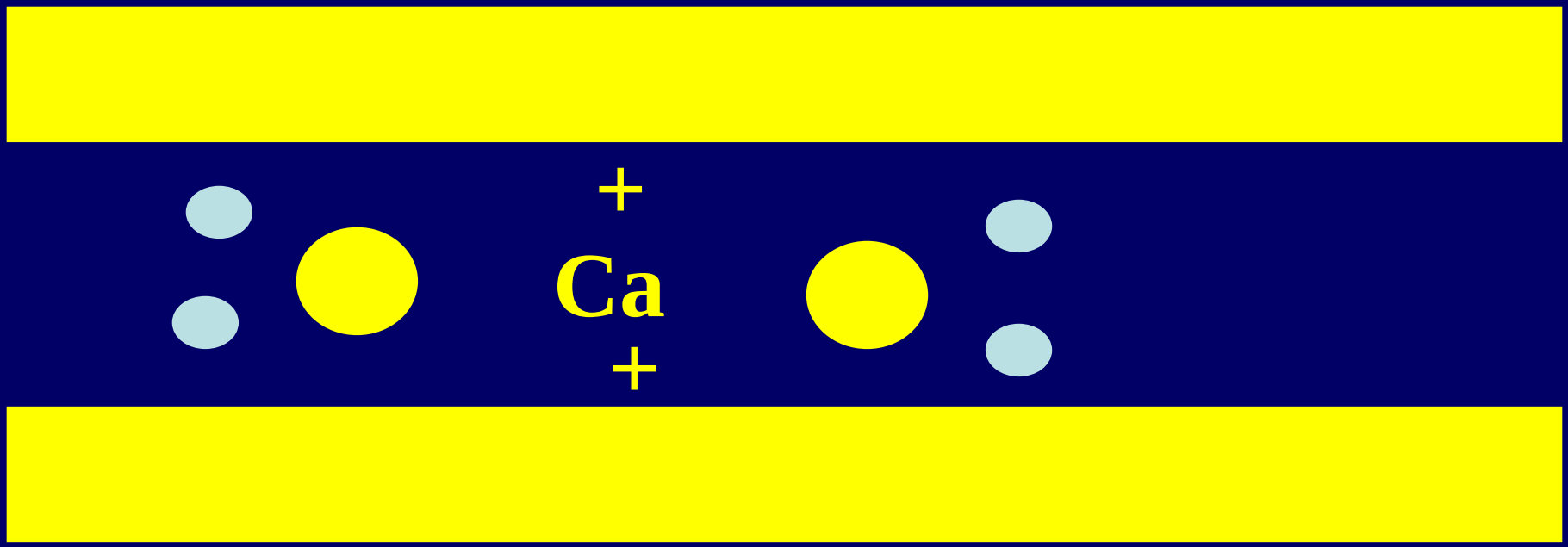
Deficiency symptoms would look like N.

SAR- Sodium Absorption Ratio

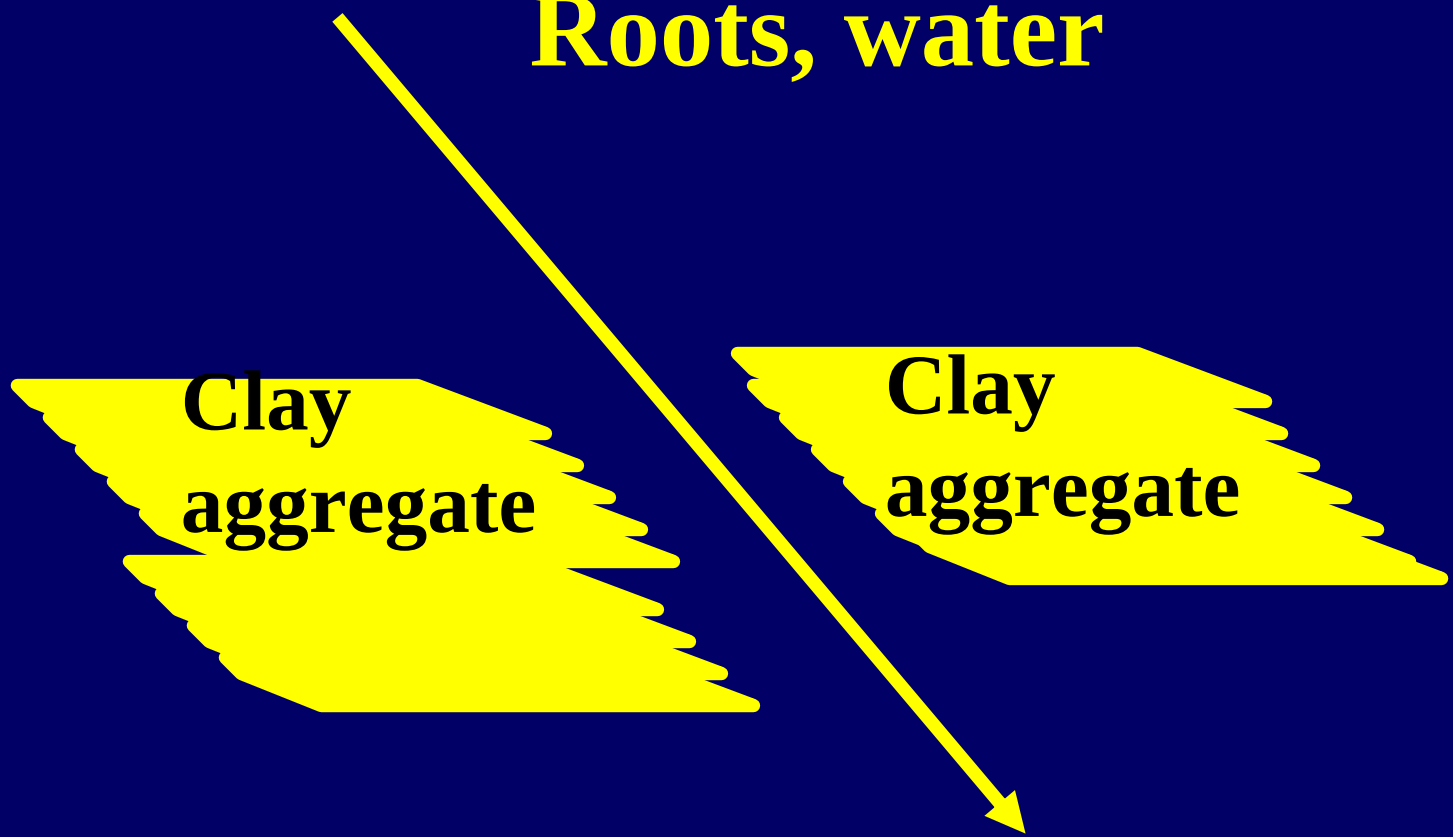
If soils are hard when dry and water sits at the surface and doesn't drain well, sodium could be a problem.

To find out, have the lab run a test for Ca, Mg, K and Na and most labs can calculate the SAR.

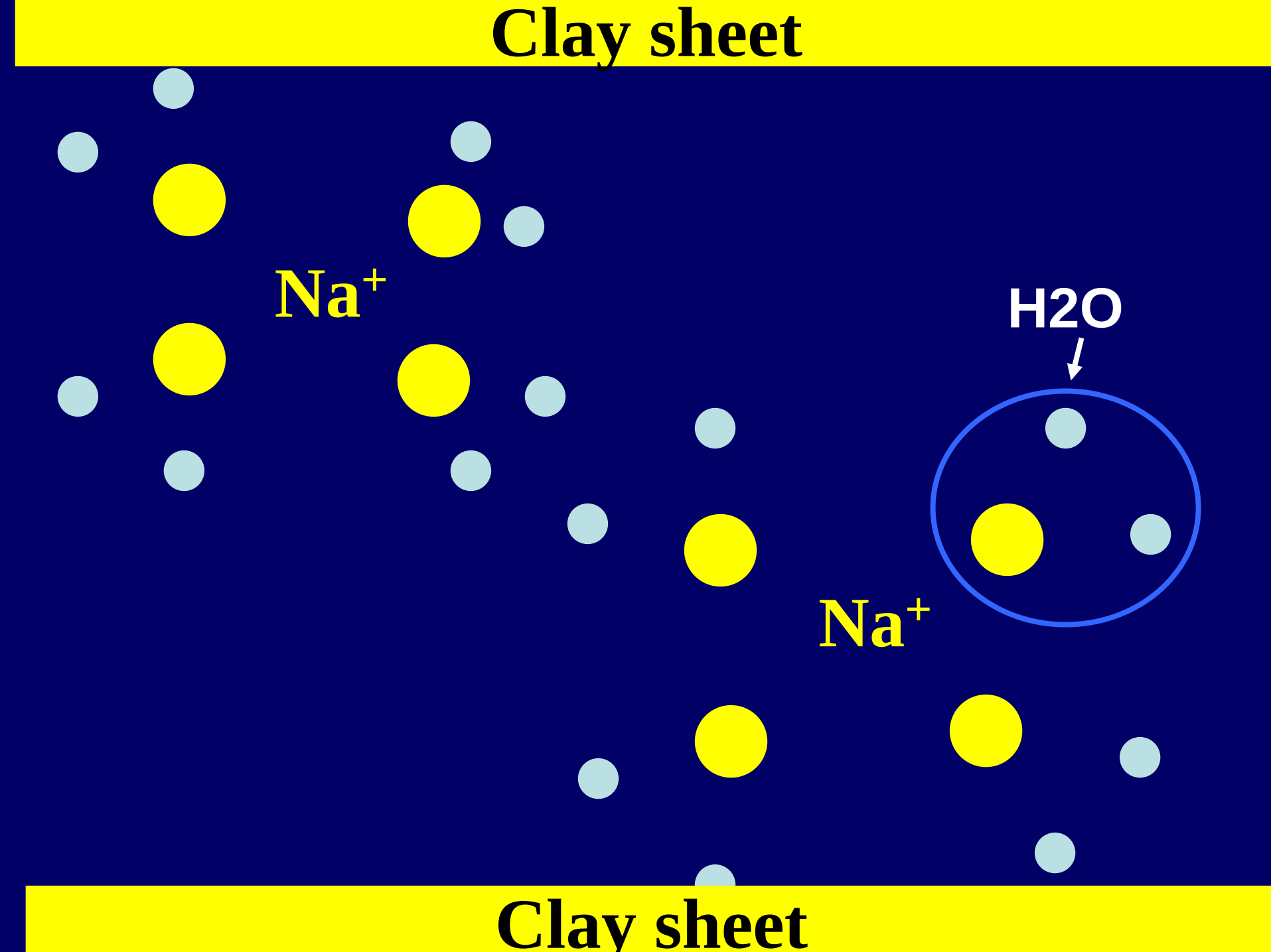
$$SAR = (Na^{+})/(((Ca2^{+})+(Mg^{2+}))/2)^{1/2}$$



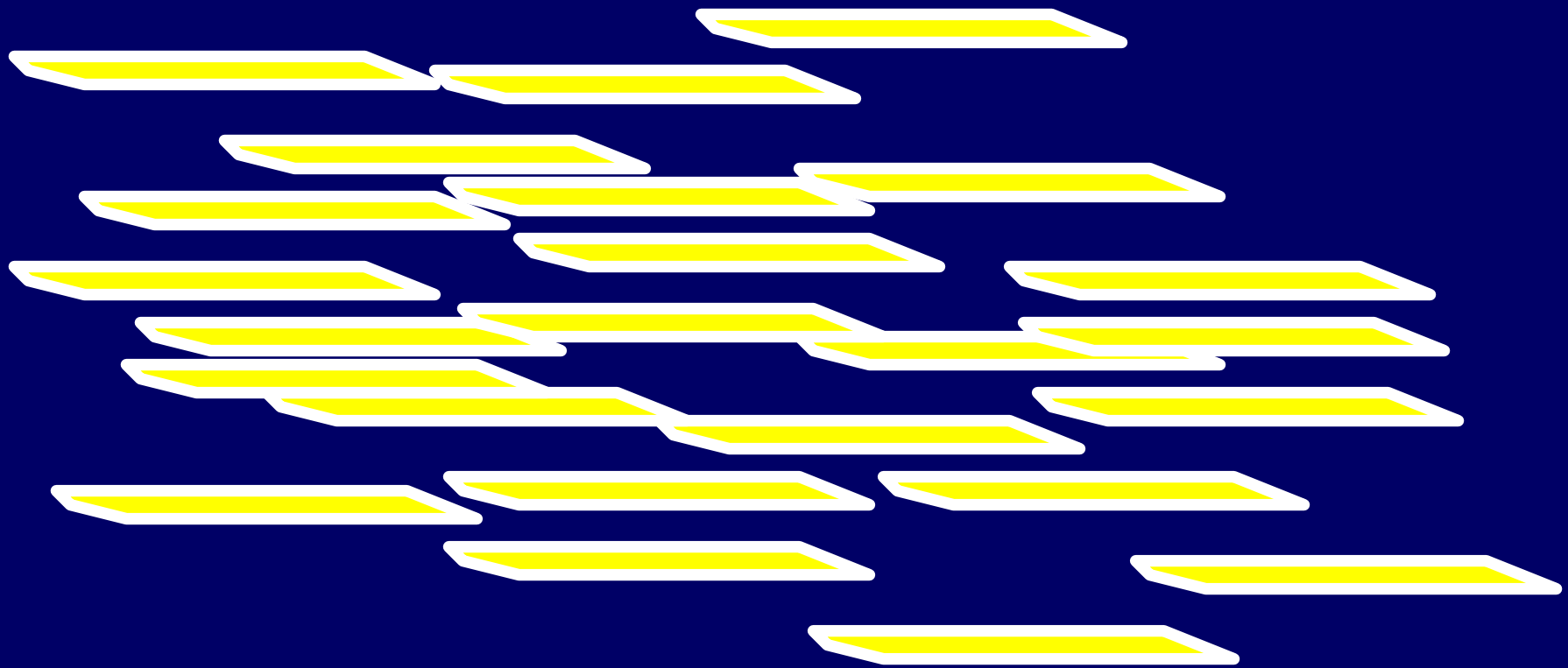
Flocculation by calcium ions



Aggregation result of calcium dominance (low sodium)


Clay sheet
Na+
H2O
Na+
Clay sheet

Dispersion with sodium ion direction



	EC	SAR
Saline soils	>4	<13
Saline-sodic	>4	>13
Sodic soils	<4	>13

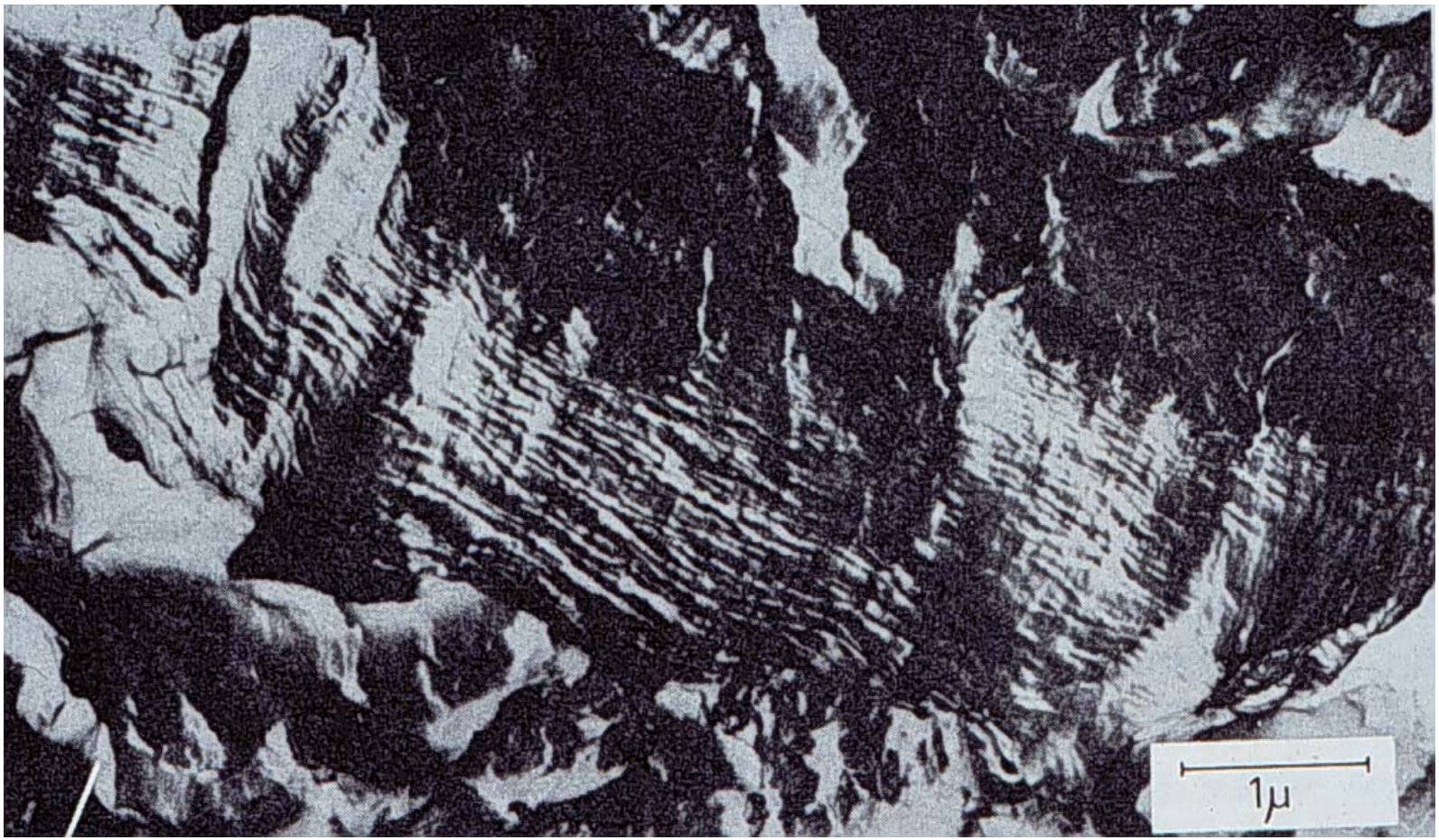
Sodium at SAR of as low as 5 can increase crusting and poor soil condition

Speaking of soil and physical problems, let's look at the mystery of soil compaction and the phrase-

"soil, heal thyself!"

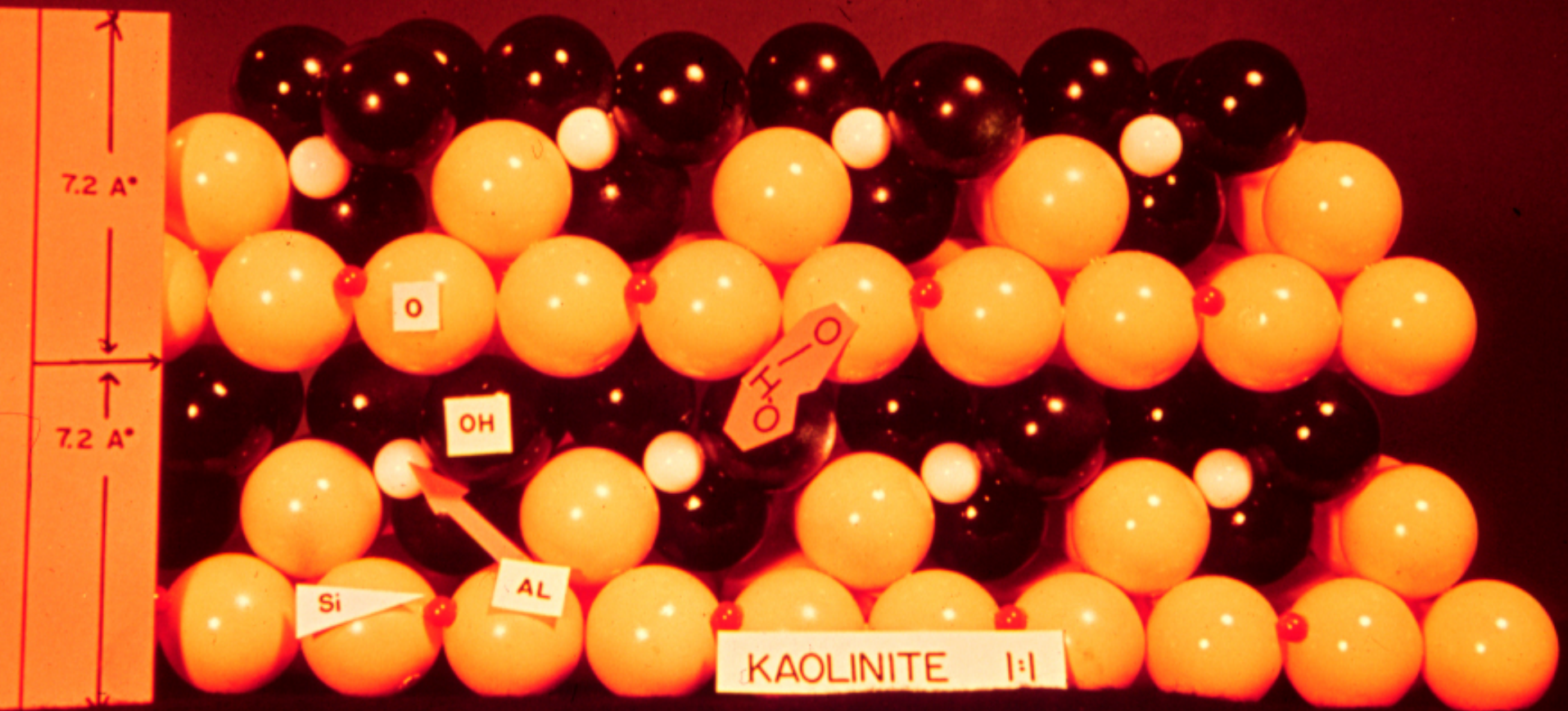
(If Shakespeare had been a soil scientist living in North Dakota)

Clays are not just small particles. They are mineral sheets in close proximity to each other.

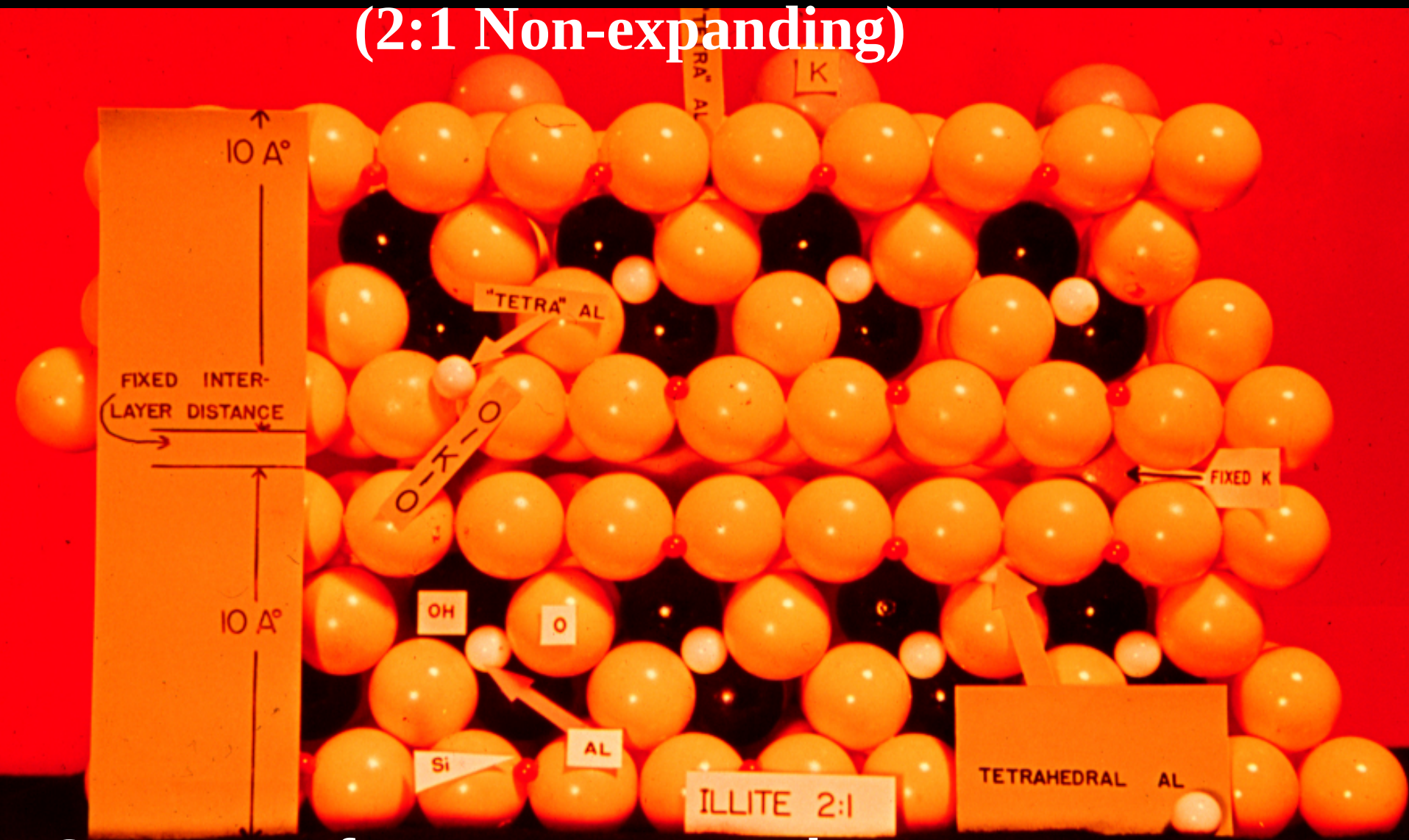


Kaolinite (1:1 Non-expanding)

A common clay from S. IL south to the Gulf.

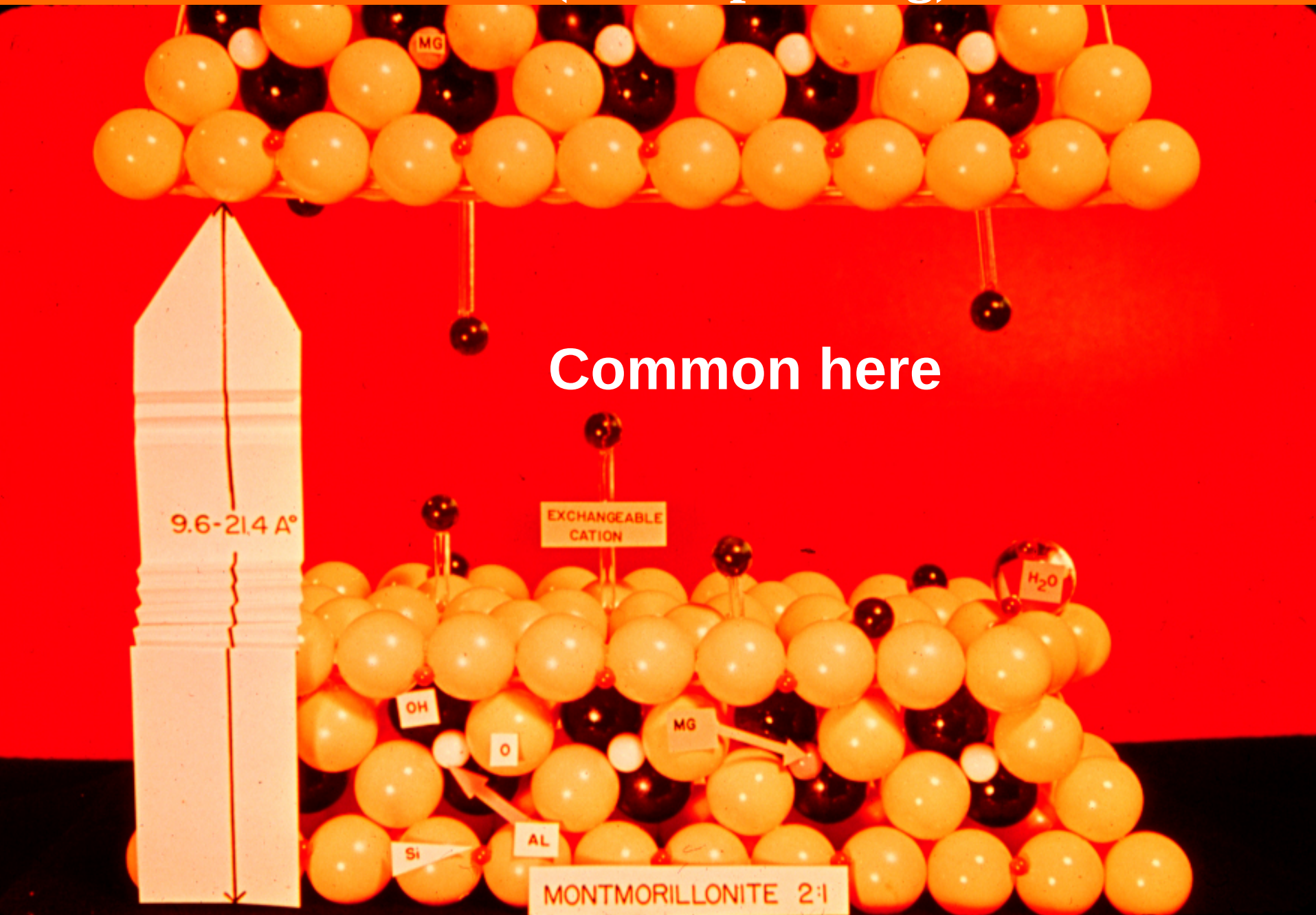


Hydrous mica
(2:1 Non-expanding)



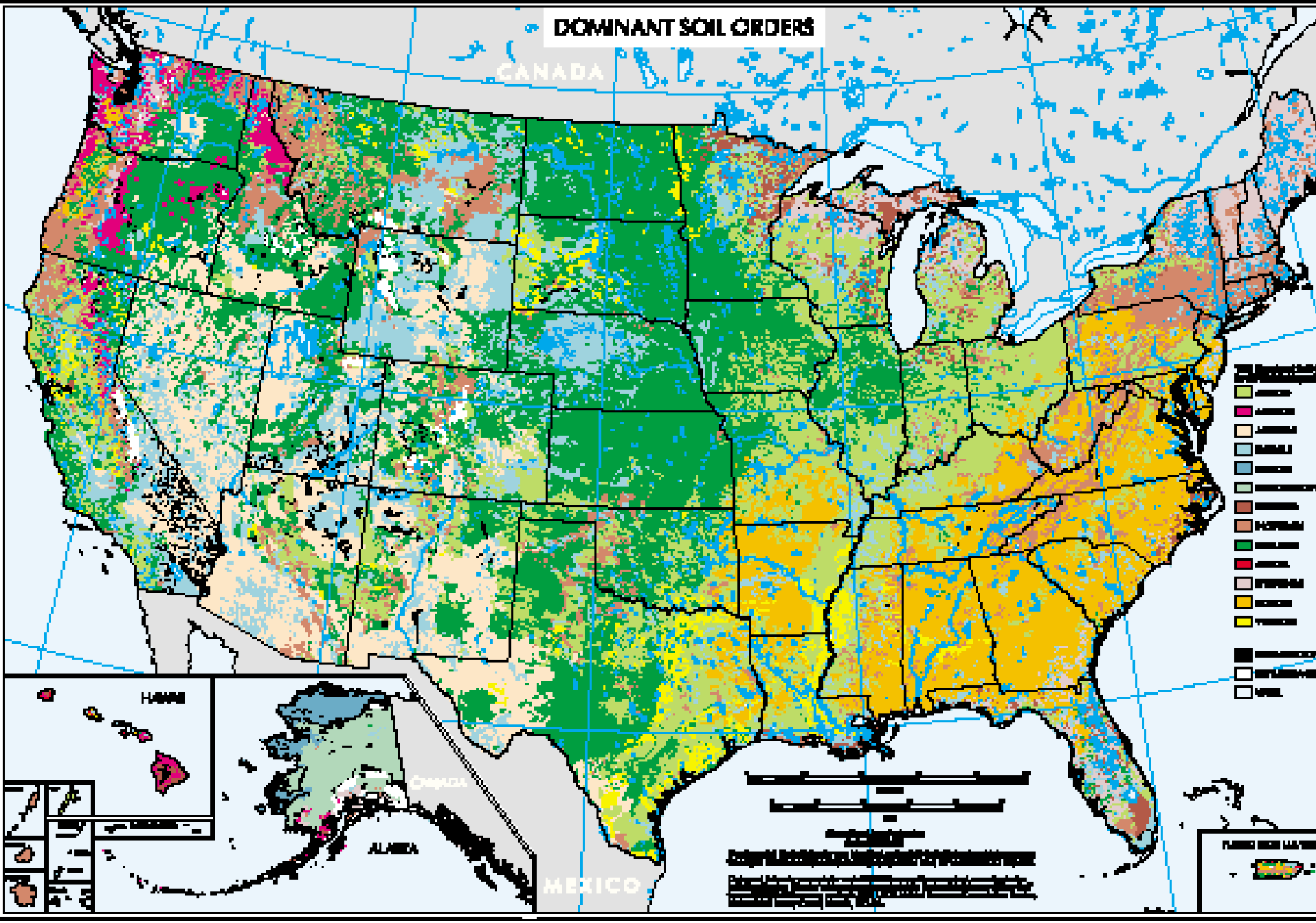
Common from IL east to the coast

Smectite (2:1 Expanding)



Common here

The Valley clay soils are the best examples of smectitic action, but nearly all ND soils of loam or heavier texture have small cracks due to clay type.


DOMINANT SOIL ORDERS
CANADA
MEXICO
HAWAII
ALASKA

Mollisols (aquolls)

Lindaas	ND, MN	Fine, Smectitic, Frigid Typic Argiaquolls
Parnell	ND, MN	Fine, Smectitic, Frigid Vertic Argiaquolls
Dovray	ND, MN	Fine, Smectitic, Frigid Cumulic Vertic Epiaquolls
Danielson	MN	Fine, Smectitic, Mesic Cumulic Vertic Epiaquolls
Harriet	ND, SD	Fine, Smectitic, Frigid Typic Natraquolls
Rosedell	MN	Fine, Smectitic, Mesic Vertic Endoaquolls
Haverhill	MN	Fine, Illitic, Calcareous, Mesic Typic Epiaquolls

Mollisols (udolls)

Doran	ND, MN	Fine, Smectitic, Frigid Aquertic Argiudolls
Gwinner	ND, MN	Fine, Smectitic, Frigid Pachic,Vertic Argiudolls
Mekinock	ND	Fine, Smectitic, Frigid Lepic Natrudolls
Olga	ND	Fine, Smectitic, Frigid Alfic Vertic Argiudolls
Rollett	ND	Fine, Smectitic, Frigid Alfic Vertic Argiudolls
Strout	MN	Fine, Smectitic, Mesic Vertic Hapludolls

Mollisols (ustolls)

Belfield	ND, MT	Fine, Smectitic, Frigid Glossic Natrustolls
Cedarpan	ND	Clayey, Smectitic, Frigid, Shallow, Natric Durustolls
Grail	ND, MT	Fine, Smectitic, Frigid Vertic Argiustolls
Janesburg	ND	Fine, Smectitic, Frigid Typic Natrustolls
Moreau	ND, MT	Fine, Smectitic, Frigid Vertic Haplustolls
Regent	ND, MT	Fine, Smectitic, Frigid Vertic Argiustolls

It is possible to compact smectites to the point that normal shrink/swell will not bring them back to production, but it's mostly related to:

-End-rows where traffic is heavy
-Road construction

Higher density does not = crop-growth-hindering-compaction

If you're still mystified, you can contact me at:

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