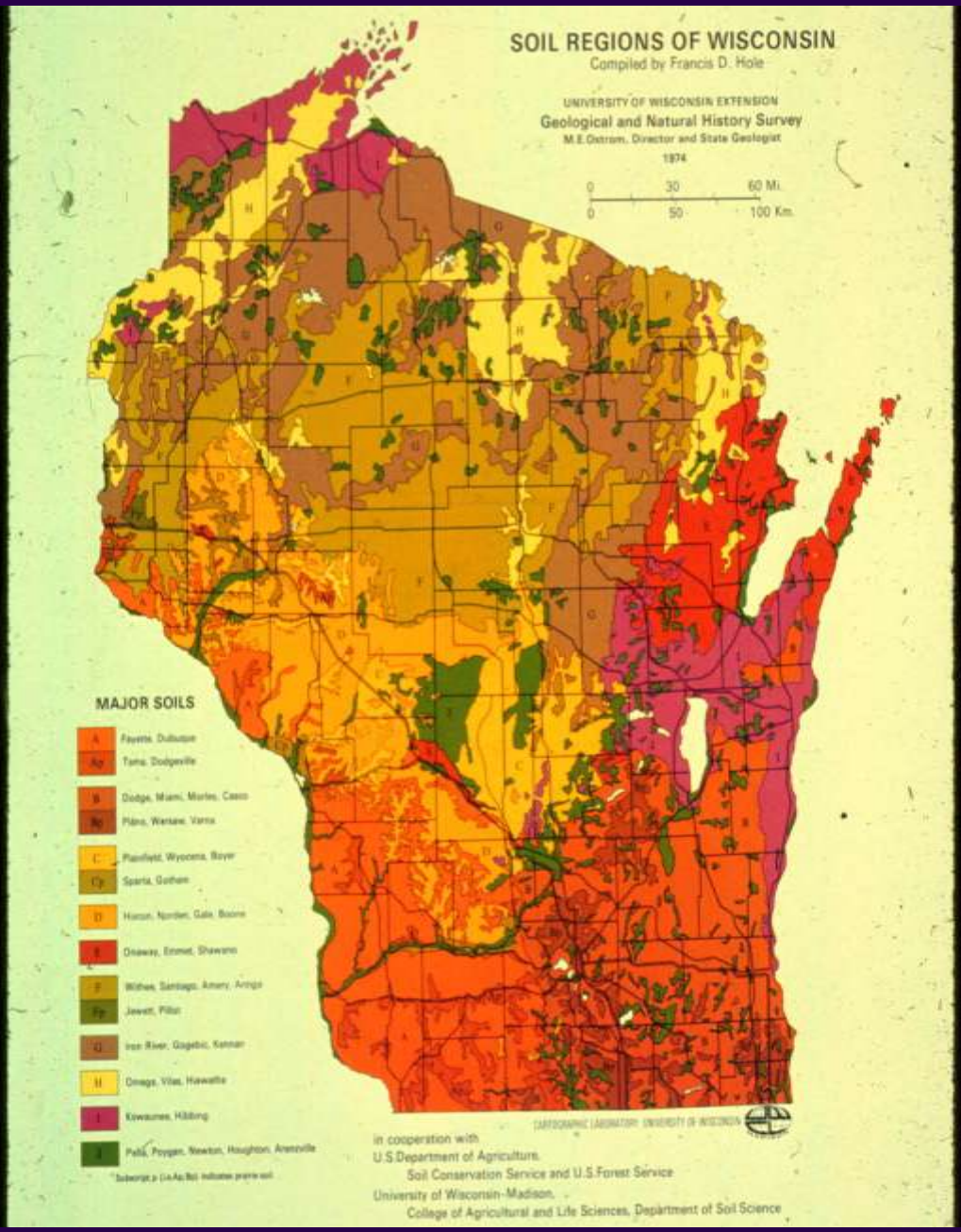
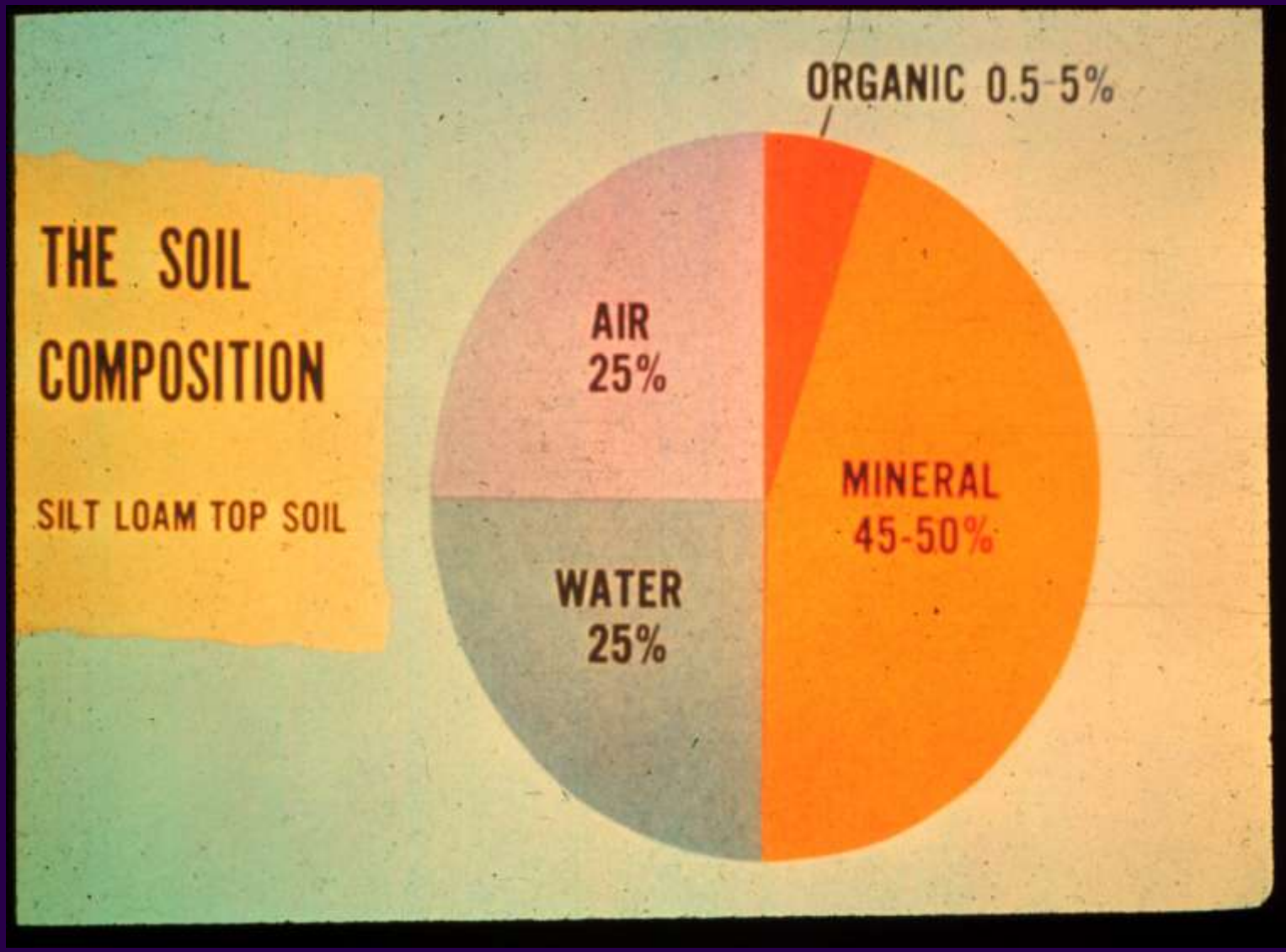

SOIL
BASIC RESOURCE
RESOURCE
IMPORTANT

- 700 different soils in WI



Productive soil must be fertile

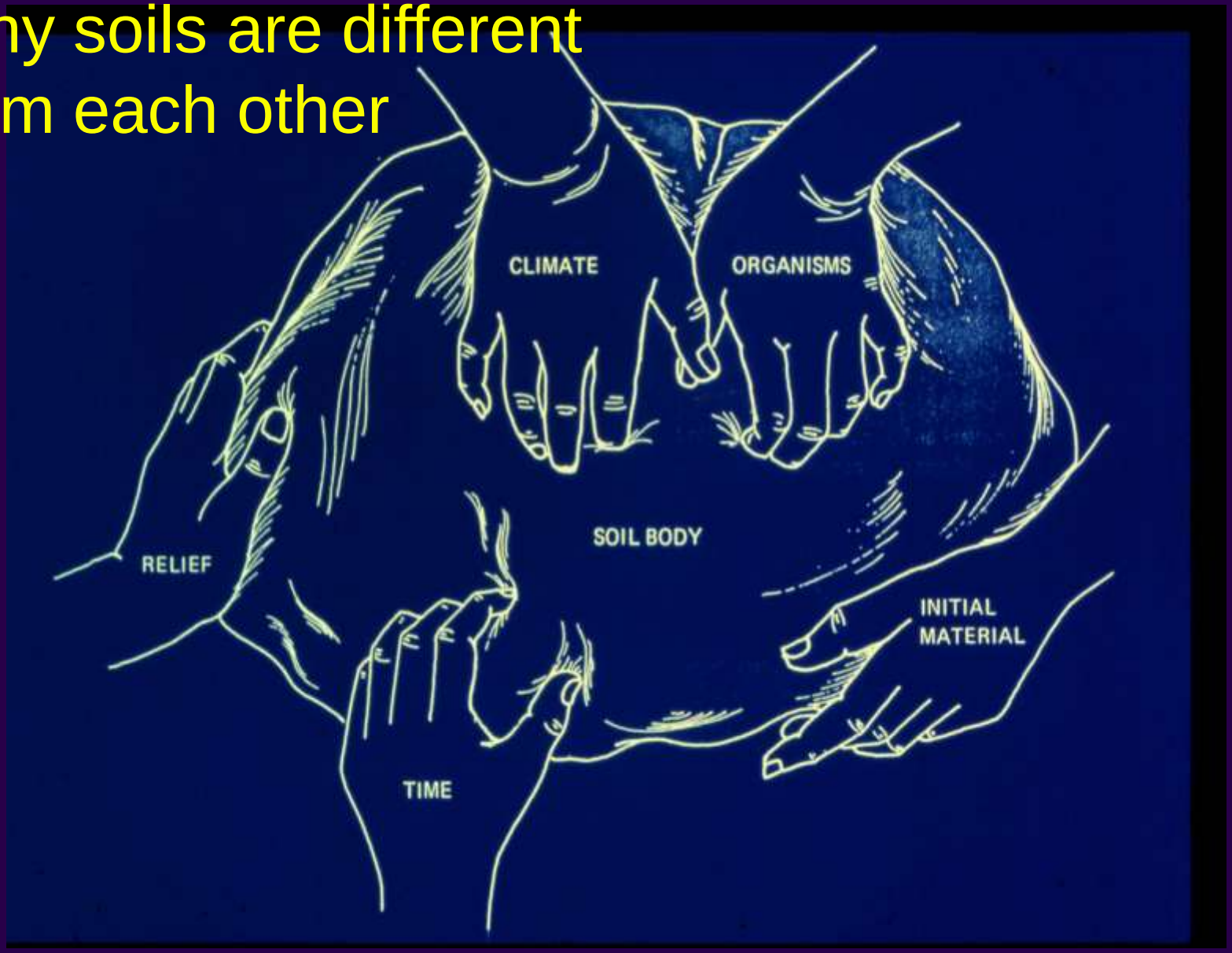
- physical fertility
  - texture, structure, drainage, tilth
- chemical fertility
  - nutrient supply
    - soil testing

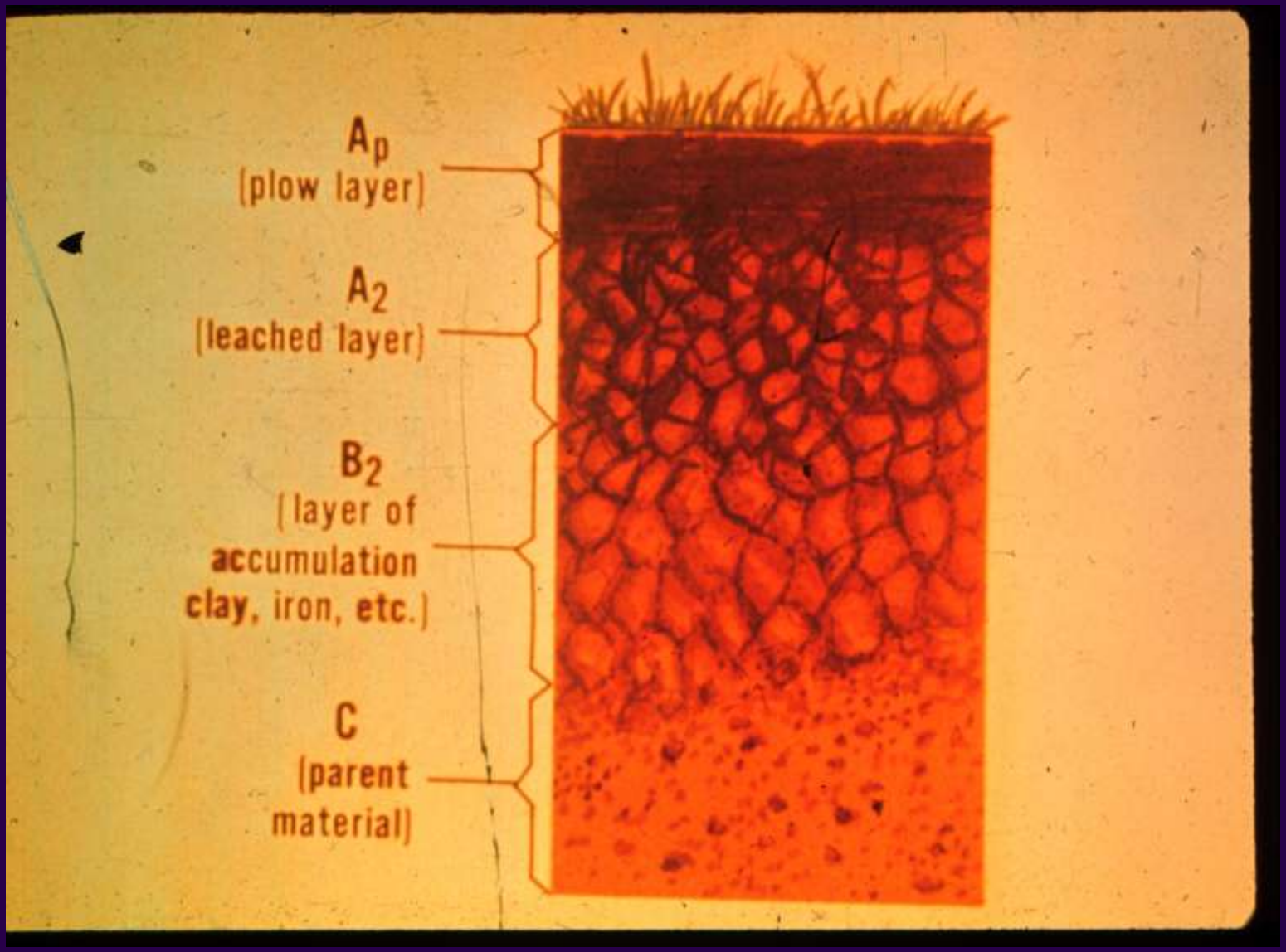

THE SOIL COMPOSITION
SILT LOAM TOP SOIL
ORGANIC 0.5-5%
AIR 25%
MINERAL 45-50%
WATER 25%

Soil formation-'weathering'

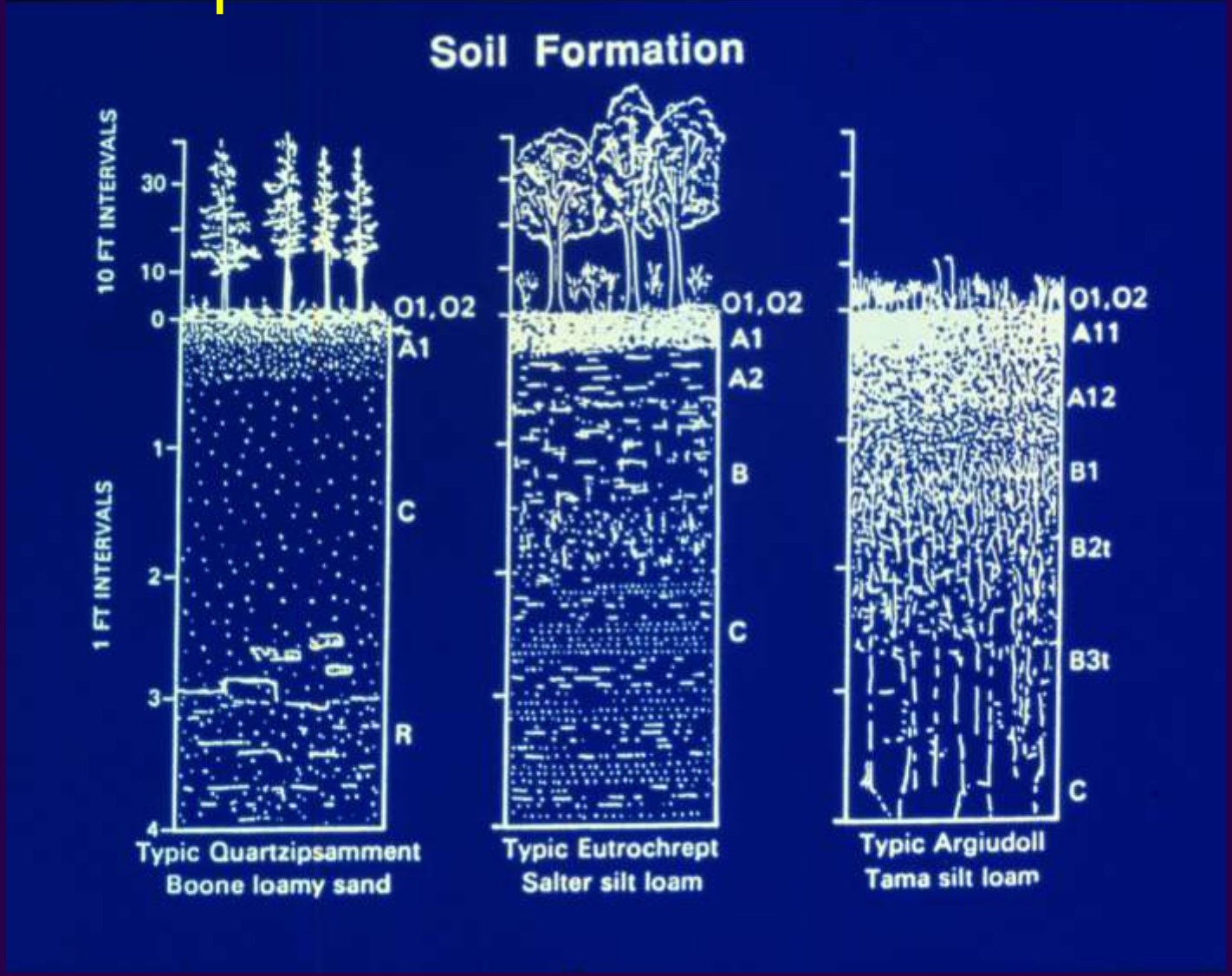
- physical
  - freezing, thawing, wetting, drying, organisms
- chemical
  - dissolved minerals moved in water
  - soil horizons formed
- 1 inch - 100 years

Why soils are different from each other



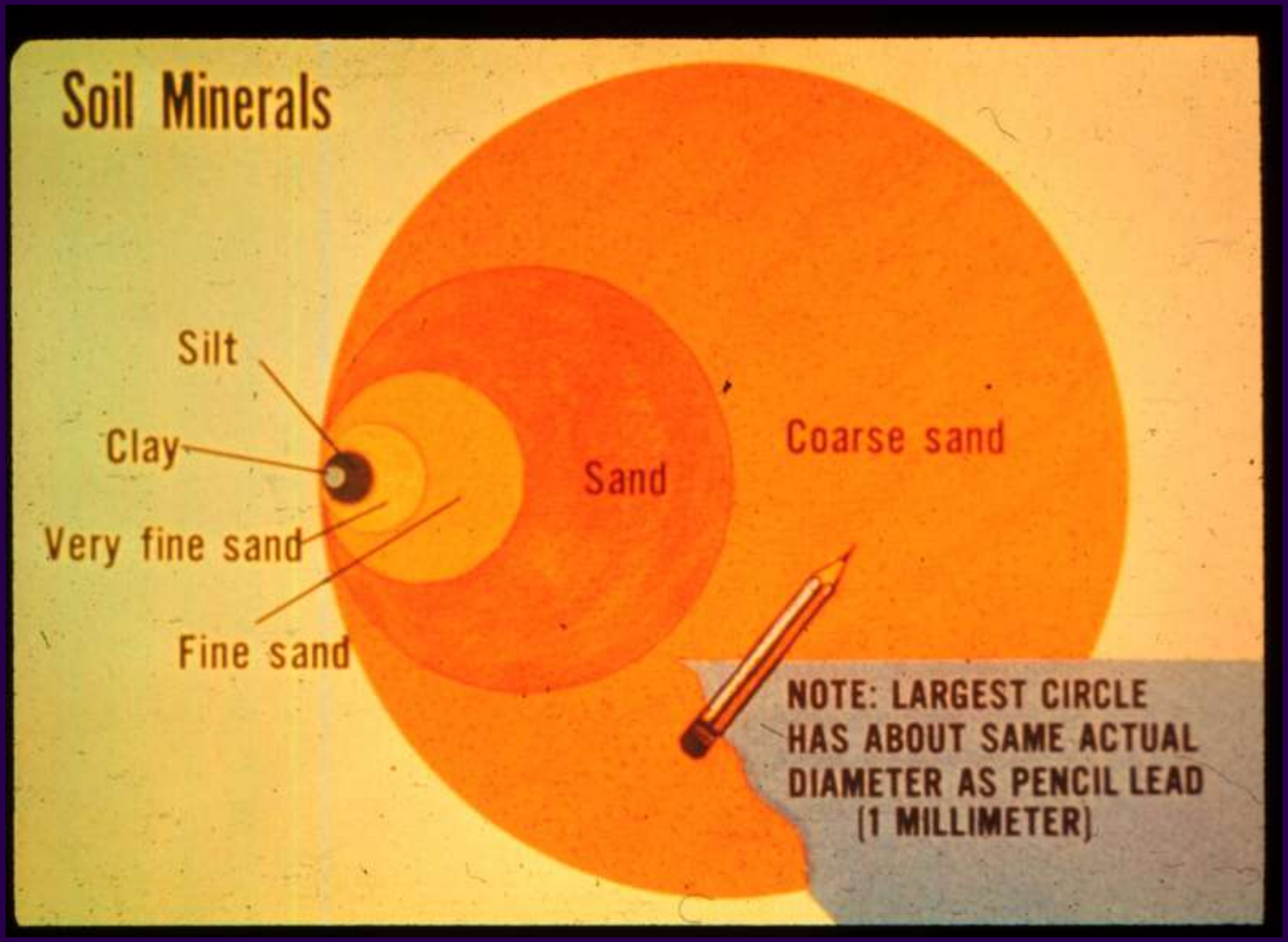

A_p
(plow layer)
A_2
(leached layer)
B_2
(layer of
accumulation
clay, iron, etc.)
C
(parent
material)

Plants and parent material affect how soils form



Soil texture

- classes - sand, silt, clay
  - names based on proportions
    - –loam, silty clay, loamy sand
    - –changing proportions not recommended
- clay also group of minerals
  - montmorillinite, kaolinite….
- nutrient storehouse


Soil Minerals
Silt
Clay
Very fine sand
Fine sand
Sand
Coarse sand
NOTE: LARGEST CIRCLE HAS ABOUT SAME ACTUAL DIAMETER AS PENCIL LEAD (1 MILLIMETER)

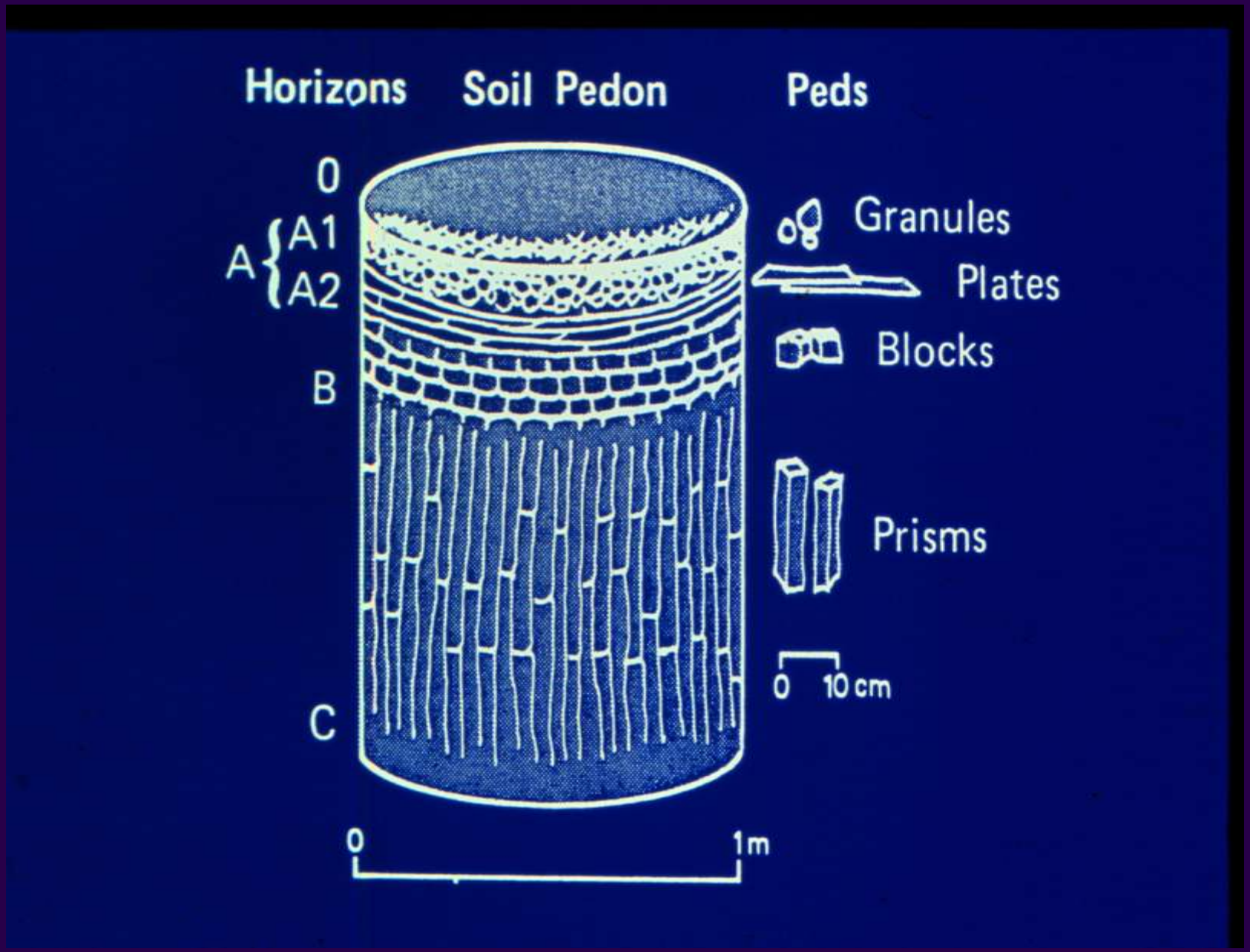
Soil organic matter

- plants, animals, microorganisms
  - living, dead, decay products
  - humus
    - complex, dark-colored, reactive
- soil acidity reservoir
- nutrient storehouse

Soil structure

- particles ‘glued’ into aggregates
  - organic matter, clay, bacterial secretions, Fe/Al oxide coatings
    - granular, platy, blocky
  - finer aggregates in ‘topsoil’, massive in subsoil
- improve by adding organic residues
  - decay: 90% CO_2 + H_2O

PLATELIKE	 PLATY Leafy and flaky also found	May occur in any part of profile. At times inherited from the soil material.
PRISMLIKE	 PRISMATIC (Level tops)	Both usually subsoil manifestations. Common in soils of arid and semiarid regions.
	 COLUMNAR (Rounded tops)	
BLOCKLIKE	 BLOCKY (Cubelike)	Common in heavy subsoils, particularly those of humid regions.
	 BLOCKY (Subangular)	
SPHEROIDAL	 GRANULAR (Porous)	Characteristic of the furrow slice. Subject to wide and rapid changes.
	 CRUMB (Very porous)	


Horizons
Soil Pedon
Peds
0
A
A1
A2
B
C
Granules
Plates
Blocks
Prisms
0 10 cm
0
1m

Problem: 'heavy' soil

- aggregates tightly packed
  - small pores
    - poor drainage, roots suffocate
  - 'cloddy' if tilled wet
    - compacts easily
- improve with organic residues
  - better crumb stability, larger pores
  - larger pores
    - sand + clay = cement

Problem: 'light' soil

- aggregates too big to pack tightly
  - large pore spaces
  - droughty
- improve with organic residues
  - 'sponge'

Organic residues

- compost, grass clippings, crop residues
  - annual gardens - 1 bu / 20 sq ft
  - perennial gardens - 1 bu / 10 ft
    - do not add to tree/shrub planting hole
- green manure, fall cover crops
  - green topgrowth tilled under
- extra N needed if high C residue
  - microorganisms ‘tie-up’ N
    - wood chips, sawdust, oat straw

Organic residues

- provides ‘food’ for microorganisms
  - for every 100 lb. added, 90 lb. converted to water, carbon dioxide
    - 10 lb. stable 1st year
    - 1 lb. stable 2nd year
- microbial decay process
  - more ‘cement’ for better crumb stability
  - nutrients released
  - fresh surfaces for nutrient holding

Nutrient supply

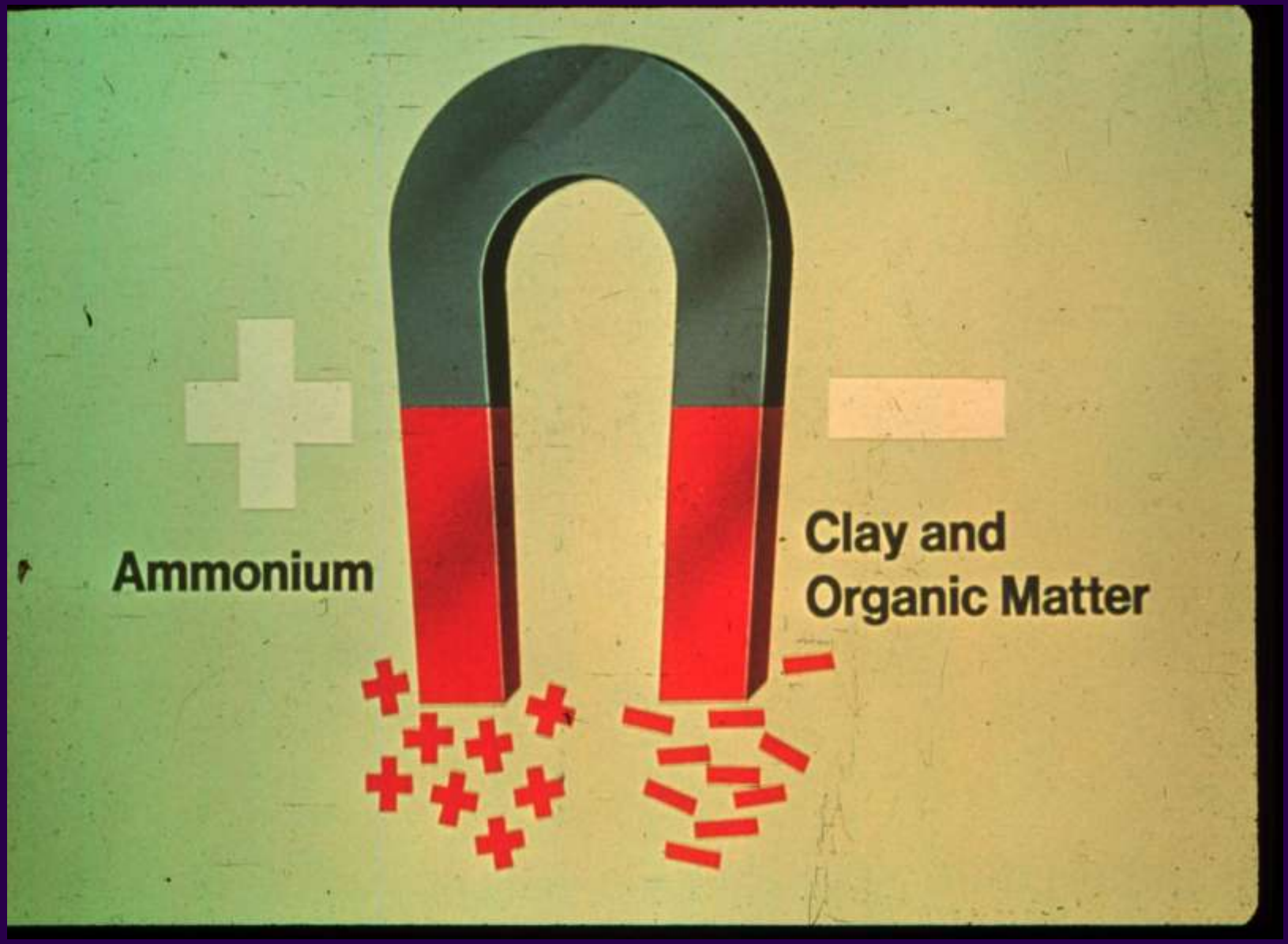
- clay main ‘nutrient storehouse’
  - negative charge
  - attracts, holds positive ions
    - Ca^{++}, Mg^{++}, K^{+}, NH_4^{+}
- easily displaced, exchanged
  - plant uptake

CEC, Whether Large or Small

AFFECTS:

1 Capacity to hold nutrients such as Ca, Mg, and NH_4-nitrogen

2 Quantity of a nutrient needed to change its relative level in soils


Ammonium
Clay and
Organic Matter

Nutrient supply: other sources

- Al, Fe and/or Ca compounds
  - –phosphate fixed
  - –recovery of fertilizer P < 30%
- organic matter
  - –N, S, trace elements
- soil solution
  - –NO_3^-, Cl^-, SO_4^{--}

Essential Elements for PLANTS

AIR, WATER

- **C** carbon
- **H** hydrogen
- **O** oxygen

SOIL

- **N** nitrogen
- **P** phosphorus
- **K** potassium
- **Ca** calcium
- **Mg** magnesium
- **S** sulphur
- **B** boron
- **Cu** copper
- **Fe** iron
- **Mn** manganese
- **Mo** molybdenum
- **Zn** zinc
- **Cl** chlorine

Food for plants?

- plant, animal nutrition very different
  - plants manufacture basics
    - protein, carbohydrate, sugar….
    - 13 essential soil elements
      - N, P, K - primary
      - Ca, Mg, S - secondary
      - B, Cl, Cu, Fe, Mn, Mo, Zn – trace
  - animals eat basics

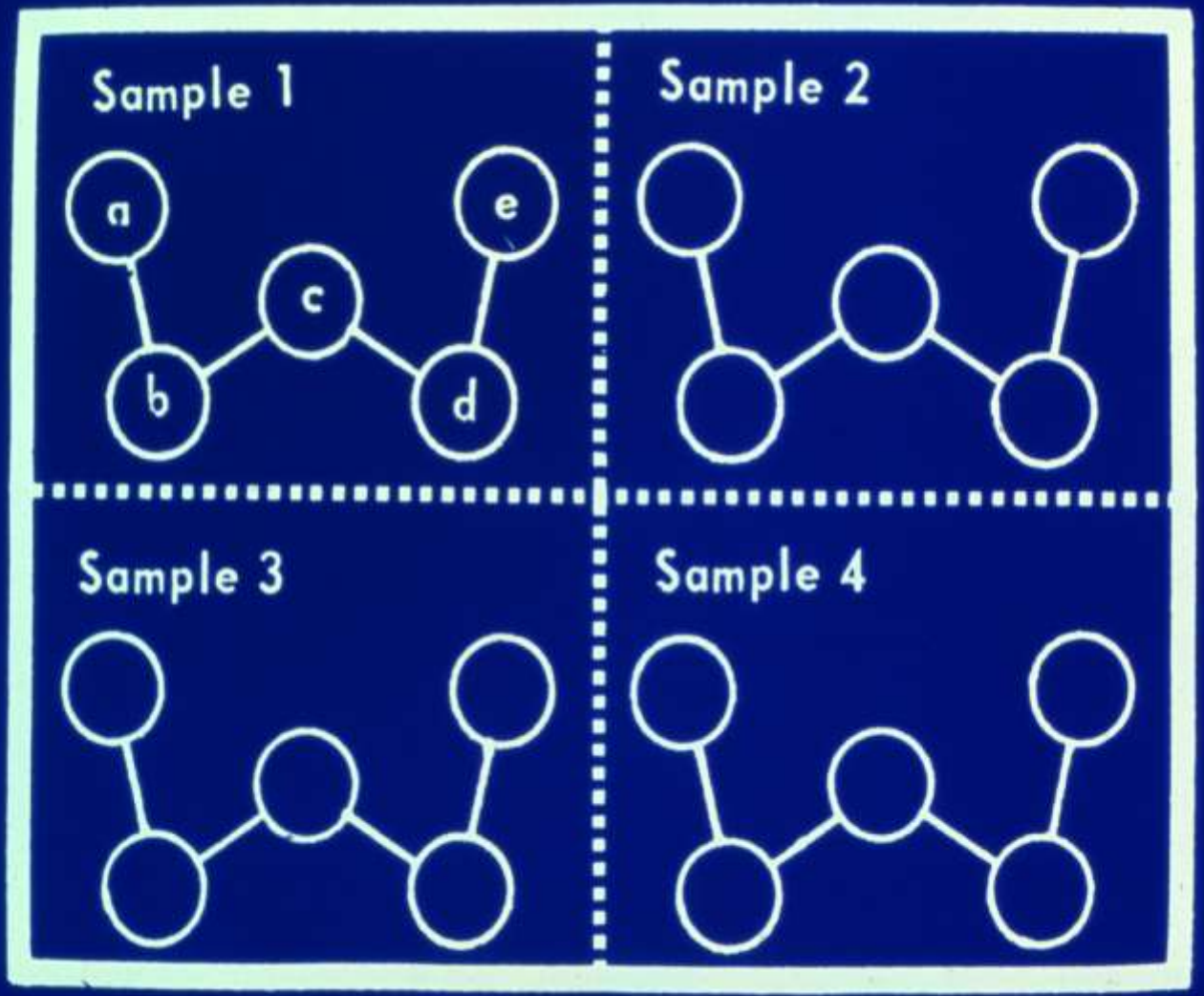

Soil Testing:
•sampling
•laboratory testing
•interpretations/recommendations

Soil test

- rapid chemical analysis
- index of potential nutrient supply
  - deficiency
  - excess
- sample to show ‘true’ variation
  - composiate

Sampling soils

- sample depth
  - established turf - 4 inches
  - new turf, gardens - 6 inches or tillage depth
  - raised beds - depth of bed
  - probe best, spade OK
- combine 5 subsamples – composiate



Avoid unusual areas: backfill, wet spots, etc.


Combine 5 subsamples for composiate

Sampling soils

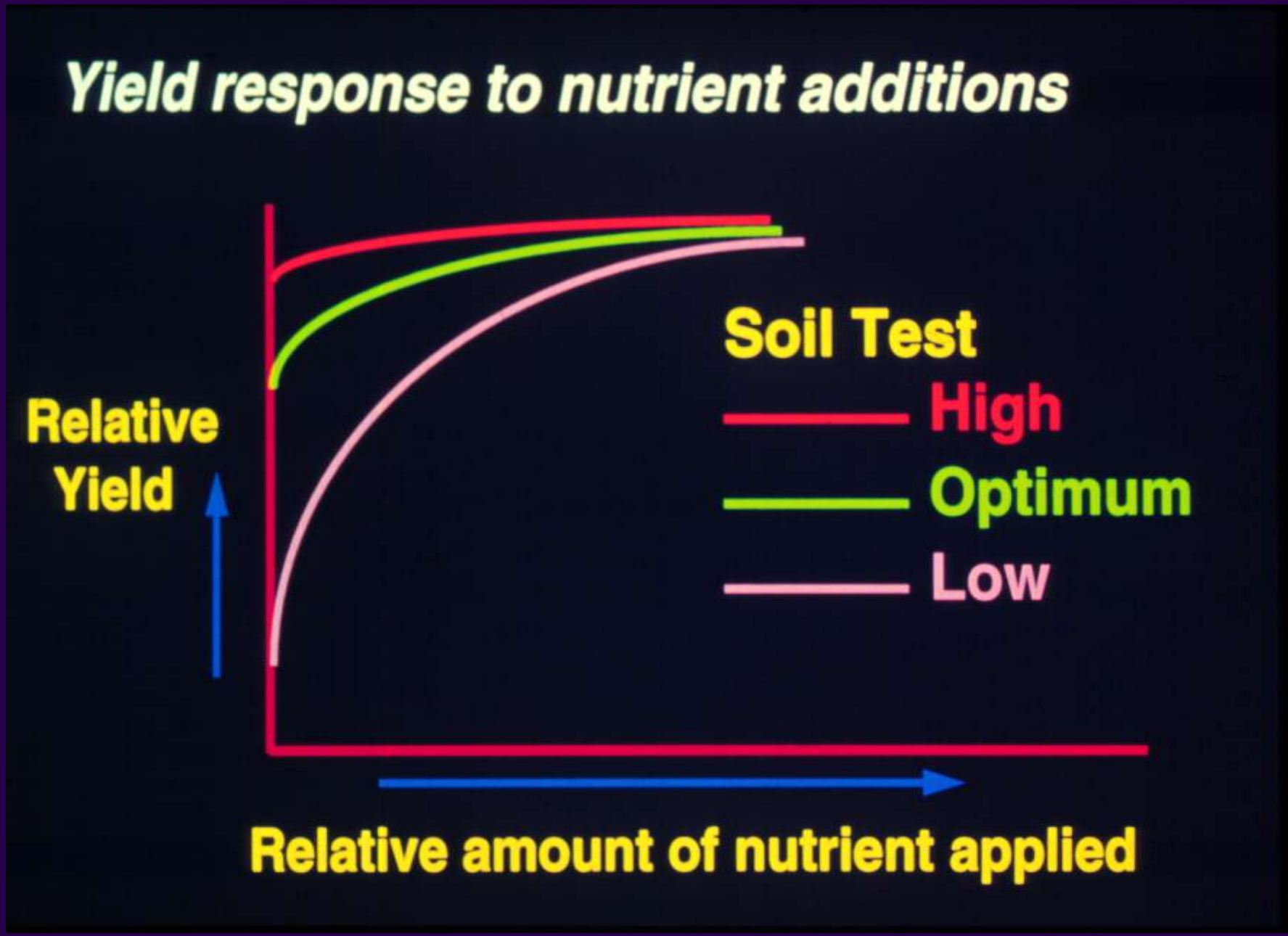
- when
  - annual gardens, new turf
    - fall, spring before tillage
  - perennials, problems, established turf
    - anytime
  - suspected salt damage
    - very early spring
- sample each area separately
  - repeat every 2-3 yrs

Useful laboratory tests

- routine
  - soil pH, ‘buffer’ pH
  - organic matter %
  - available P and K
    - no good test/need for N, Ca, Mg, S, B, Zn, Mn, Fe, Cu, Mo
- ‘problem solving’
  - texture, soluble salts, Cl, Pb, As,...

Soil test report

- potential for deficiency
- which nutrient needed
- how much to apply
  - fertilizer for nutrient need
  - lime, sulfur amendments for pH change
- when to apply
- when to STOP!


Yield response to nutrient additions
Relative Yield
Soil Test
High
Optimum
Low
Relative amount of nutrient applied

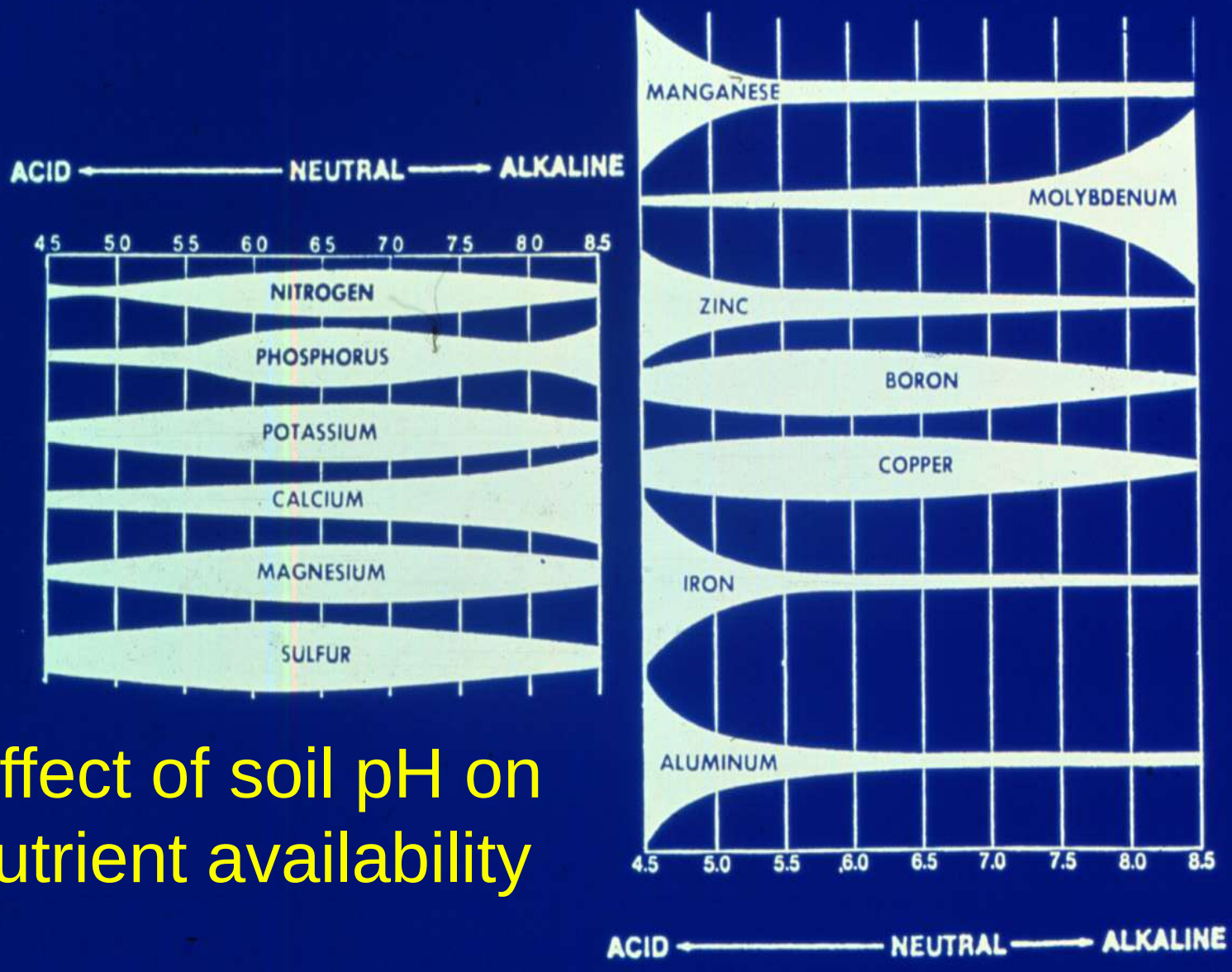

HIGH SOIL TEST
Less Nutrients Needed From Fertilizer
LOW SOIL TEST
More Nutrients Needed From Fertilizer

Soil test results

- excessively high
  - common for residential areas
  - not detrimental
  - adding more not beneficial
  - avoid balanced blends, most organics
- low
  - build to optimum
    - turf fertilizer blends

Soil test results - pH

- measure of acidity, alkalinity
  - scale 1 - 14, optimum 6 - 7+
- add lime only if recommended
  - incorporate 6 - 8 inches
- add aluminum sulfate to acidify
  - new turf
    - if strongly alkaline
  - blueberry, rhododendron



Effect of soil pH on nutrient availability

Optimum pH for turf

- depends on species**

	pH range
– kentucky bluegrass	6.0 - 7.6
– annual bluegrass	5.1 - 7.5
– creeping red fescue	5.3 - 7.5
– bentgrass	5.3 - 7.5
– ryegrass	5.4 - 8.1

***Musser, 1982*

Soil test results - organic matter

- 2 - 4% most soils
  - impractical, difficult to change
- nutrient reservoir
- basis for N rec

Soil test results - N

- promotes leaf growth
- no direct measures on report
  - N rec from crop need, organic matter
- excess N
  - delays maturity
  - moves below root zone

Soil test results - P

- stimulates root growth and flowering
  - shallow rooted greater need
- optimum soil test P for turf

at planting	
–seed	31 - 45 ppm
–sod	21 - 30 ppm
established	11 - 15 ppm

Soil test results - K

- promotes disease resistance, winter hardiness
  - root crops require most
  - optimum soil test K for turf

    at planting

    –seed all levels OK

    –sod all levels OK

    established 41 - 60 ppm

Inorganic fertilizer

- chemically simple
  - N in air plus water/fossil fuel
  - rock phosphate, potash mined, sized and cleaned
    - handling improved
      - clay, diatomaceous earth added
    - TSP from added acid
- very soluble, easily blended

Inorganic fertilizer

Type	Nutrient		
	N	P_2O_5	K_2O
	----------%----------		
urea	46	0	0
ammonium nitrate	33	0	0
triple super P	0	46	0
ordinary super P	0	20	0
muriate of potash	0	0	60
potassium sulfate	0	0	50

Recommended fertilizer - turf blends

- regular or maintenance - ‘high N’
  - soil test P, K optimum, above
- starter - ‘high P_2O_5’
  - soil test P below optimum
- winterizer - ‘high K_2O’
  - soil test K below optimum

Organic fertilizer

- chemically complex, contains C
  - naturally occurring
  - byproducts
- microorganisms must degrade
  - slow release, rate ???
- improve structure with long-term use

Organic fertilizer

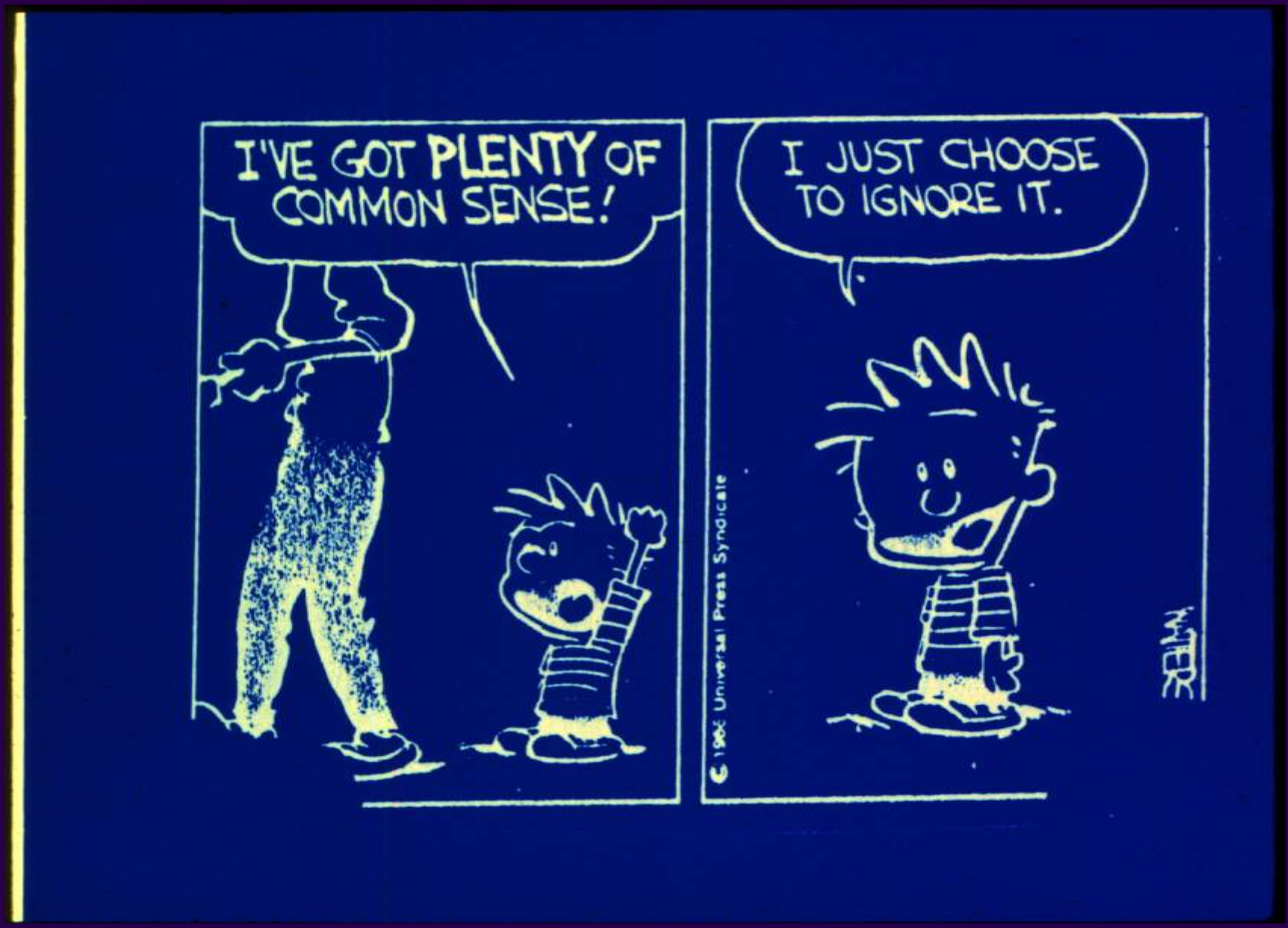
Type	Nutrient		
	N	P_2O_5	K_2O
	----------%----------		
blood meal	13.0	1.5	0.6
bone meal, steam	2.2	27.0	0
seaweed	1.5	1.0	4.9
tree leaves	0.7	0.1	0.8
greensand	0	1.4	6.3
activated sewage s.	6.0	3.0	0.2

Organic fertilizer

- may contain
  - unnecessary nutrients, compounds
  - nonessential elements
- does not add nutrition nor improve flavor

Foliar sprays: fruits, sensitive ornamentals

- trace, secondary elements
  - soil Fe, Mn ‘fixed’ at high soil pH
  - supply by spraying leaves
  - temporary ‘fix’, requires repeating
- emergenies
  - no substitute for soil applied nutrients
    - leaf burn, expensive, extra work
    - most spray falls on soil


I'VE GOT PLENTY OF COMMON SENSE!
I JUST CHOOSE TO IGNORE IT.
© 1986 Universal Press Syndicate

Product claims

- Peters Fertilizer 20 - 20 - 20
  - all purpose
  - dissolves completely in water and will not settle out
  - free of excess soluble salts
  - very safe, nonburning
  - contains proper trace elements

Product claims

- Neptune's Harvest 2 - 4 - 0.5
  - 100% liquid fish food
  - made from N. Atlantic fish, cold process
  - all nutrients intact, chelated
  - contains vitamins, minerals, macro- and micronutrients, amino acids, trace elements, growth hormones
  - builds healthier soils by aiding bacteria and other organisms which support healthier plants

Product claims

- Alaska Fish Fertilizer 5 - 1 - 1
  - made from ocean fish
  - no chemical amendments to increase nutritional content
  - over 19 different trace elements
  - 11 different vitamins, especially B
  - amino acids naturally occurring are more readily available to plants than other N forms

Product claims

- Eleanor's VR 0.15 - 0.85 - 0.55
  - ‘seems like magic’
  - use VR-11 safely on any plant and expect immediate improvement
  - aids blossoming, promotes lush fern growth, vigorous growth in creeping plants
  - only Eleanor knows the ‘magic’ ingredients

Product claims

- Granite Meal 0 - 0 - 3
  - pulverized granite rock
  - some growers criticize it as too slow releasing, others praise its gentle breakdown rate
  - contains 67% silica, trace elements
  - silica plays important role in soil fertility

Product claims

- Greensand 0 - 1 - 6
  - mined sea deposit has a pleasant odor and is hefty enough not to get blown away
  - the greener it is, the more potassium it has
  - contains 50% silica, 18 - 20% iron oxide and 22 trace elements
  - loosens clay soil and prolongs flower bloom

Product claims

- Lonfosco Soft Rock Phosphate 0 -16 -0
  - soft, natural colloidal clay - a form most usable by crops
  - has 27% calcium plus 18 essential trace elements
  - unlike chemically treated phosphates, its insoluble in water and lasts in soil without leaching for years

Product claims

- Harvest Alive!
  - highly concentrated complete liquid organic foliar plant food
  - made with a unique digestive process from plant and animal manures
  - ‘super manure tea’ made from concentrated essential minerals, cytokinius, vitamins and amino acids
  - does not replace regular fertilizer, but provides benefits beyond scope of conventional plant food

Product claims

- Mother Natures Worm Castings
  - odorless excrement of earthworms
  - unique in versatility as fertilizer, soil amendment, plant food, propagating medium
  - chemical evaluation shows high to very high phosphorus, potassium, calcium, magnesium, and nitrates

Product claims

- ERTH-RITE
  - introduces friendly bacteria essential for soil improvement
  - careful combination of animal, mineral, plant and marine products
  - major and trace elements for proper plant growth
  - helps fix N, loosen soils, release tied-up elements and much more

Product claims

- SUPERthrive
  - formula contains 50 vitamins, hormones
  - indoor plants helped to survive low light, great equalizer for over/under watering
  - nontoxic solution containing crystalline compounds of C, H, O
  - given enough time, your plant will produce all of these by itself--but can get all they need now!

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