Texas Soils and Geology for Master Naturalists

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"Daddy, which is this — soil or dirt?"

Our Challenge

Always choose your friends carefully

What is Soil?

Soil

- A natural body having properties due to the combined effects of climate and biotic activity, as modified by topography, acting on parent material over time.

- Active Factors
  - Climate
  - Biotic Activity
- Passive Factors
  - Topography
  - Parent Material
  - Time

Climate

- Three factors
- _____
- _____
- _____

Biotic Activity

- Two Major Types of Organisms
  - 1._____
  - 2._____

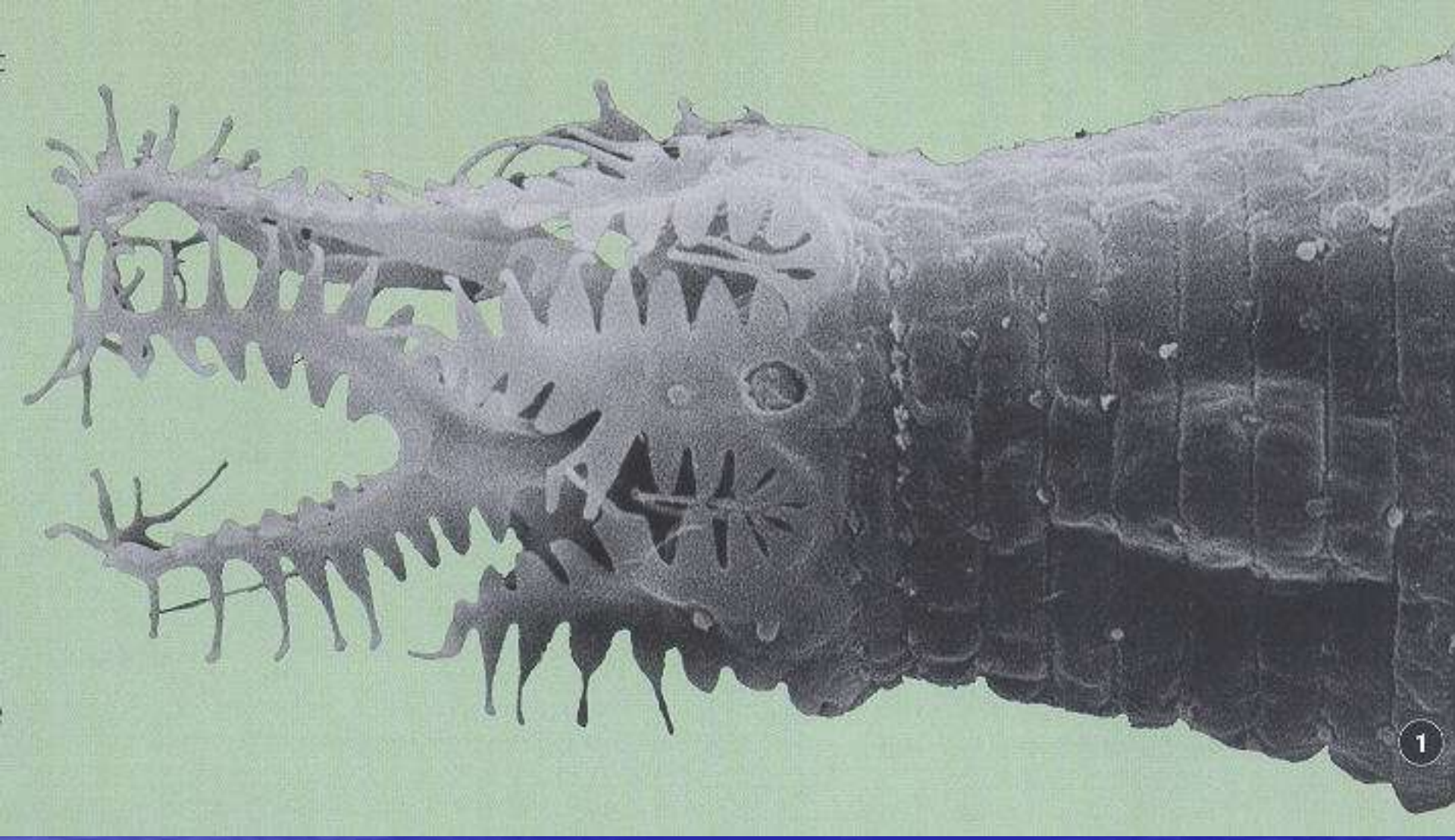
Microorganism

Decay organic materials

Biotic Activity

- Microorganisms in fertile soil (5% organic matter, a Mollisol, in millions/g soil) degradation
  - Bacteria - 1 to 100
  - Actinomycetes - 0.1 to 1
  - Fungi - 0.1 to 1
  - Algae - 0.01 to 0.1
  - Protozoa - 0.01 to 0.1

Fungal hyphae and mycorrhizae



Acrobeles mariannae,a bacterial-feeding nematode.


March
2005


March
2004


March
2003


March
2002


March
2001


2005
2001
2002
2004
2003

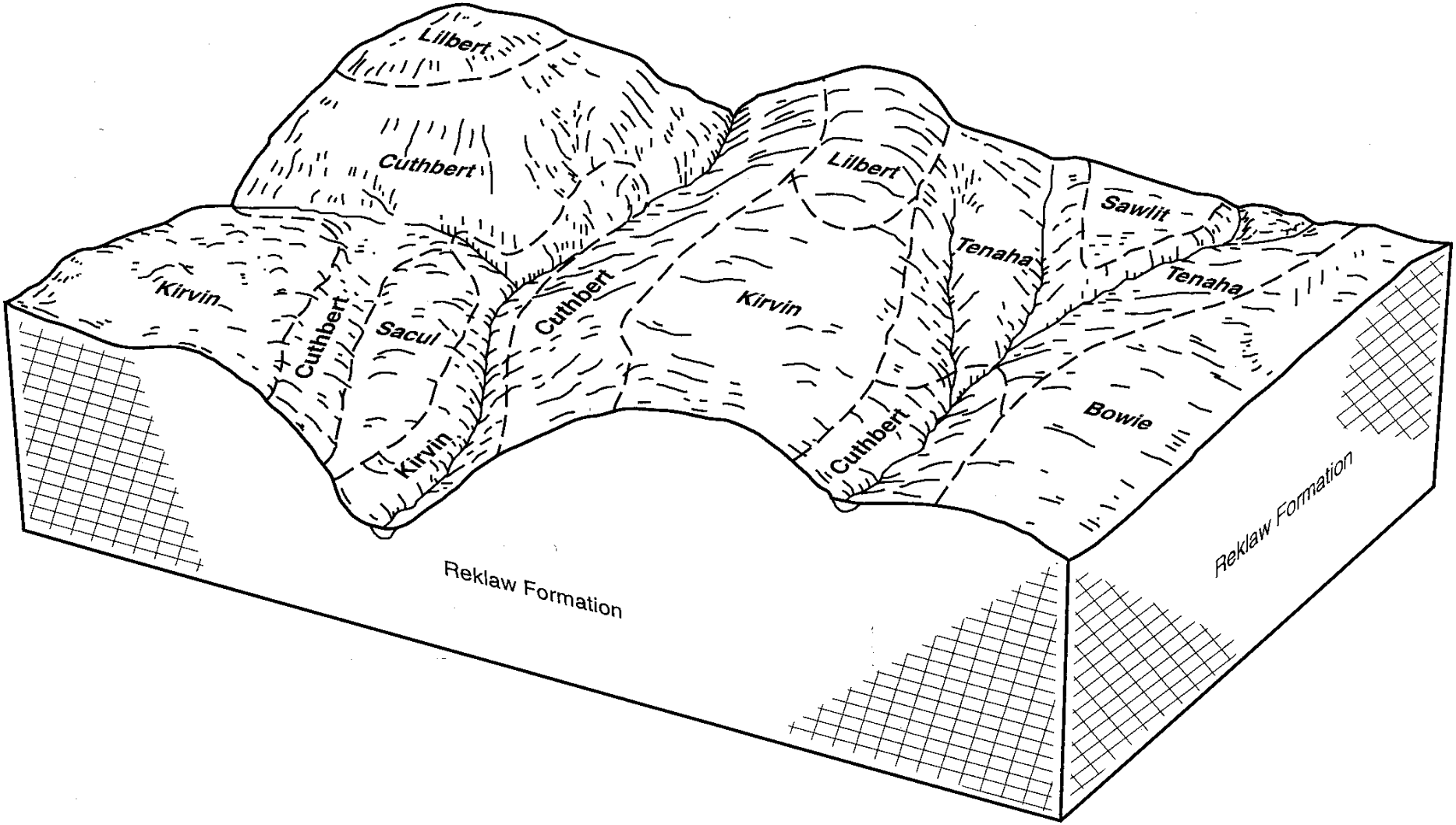
Macroorganisms

Loosen Soils

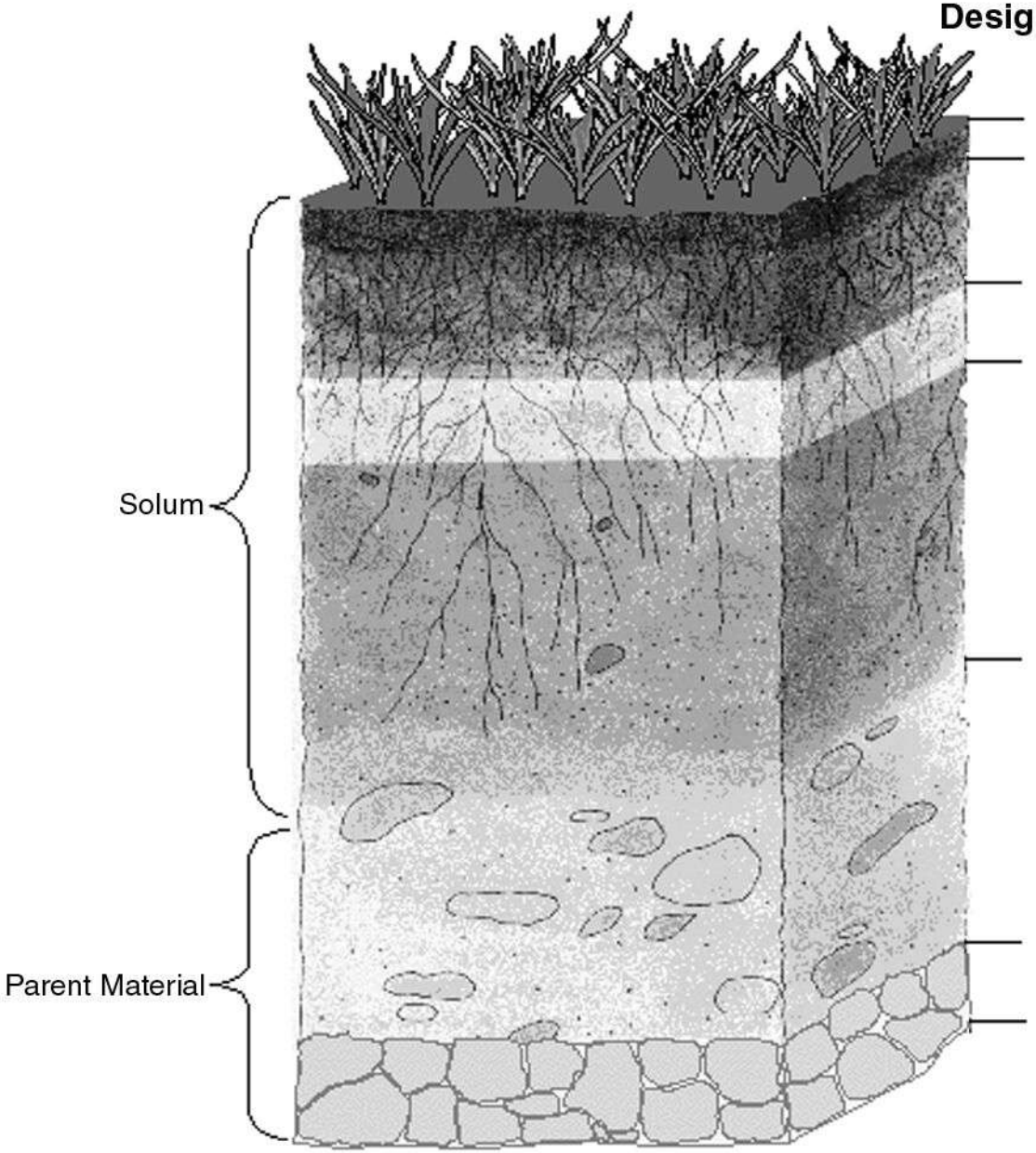

25
50
75
100
125
150
Crayfish burrows

Earthworm in burrow.

Topography


Lilbert
Cuthbert
Kirvin
Cuthbert
Sacul
Kirvin
Cuthbert
Kirvin
Lilbert
Cuthbert
Tenaha
Sawlit
Tenaha
Bowie
Reklaw Formation
Reklaw Formation

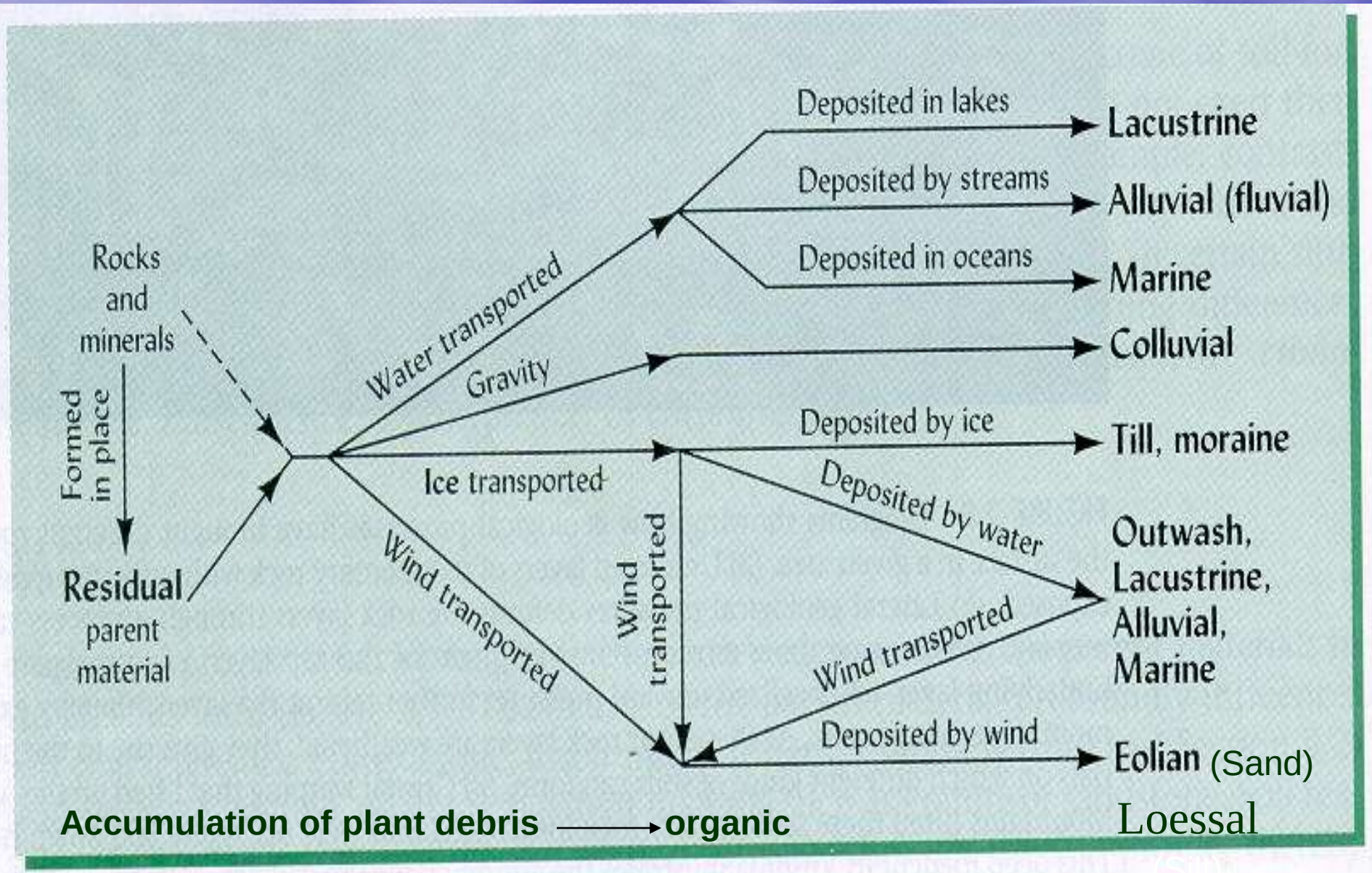
What does a soil look like?



Horizon Designation	Horizon Description
O	Organic, slightly to highly decomposed
A	Mineral, mixed with humus, dark colored
E	Horizon of eluviation of silicate clays, iron and aluminum oxides, etc.
B	Horizon of alluviation of silicate clays, iron and aluminum oxide, etc.
C	Unconsolidated, unweathered, geologic material. May be dug with a shovel when moist
R	Consolidated, unweathered geologic material. Can not be dug with a shovel when moist, rock

Parent Material

Classification of Parent Materials



Accumulation of plant debris → organic

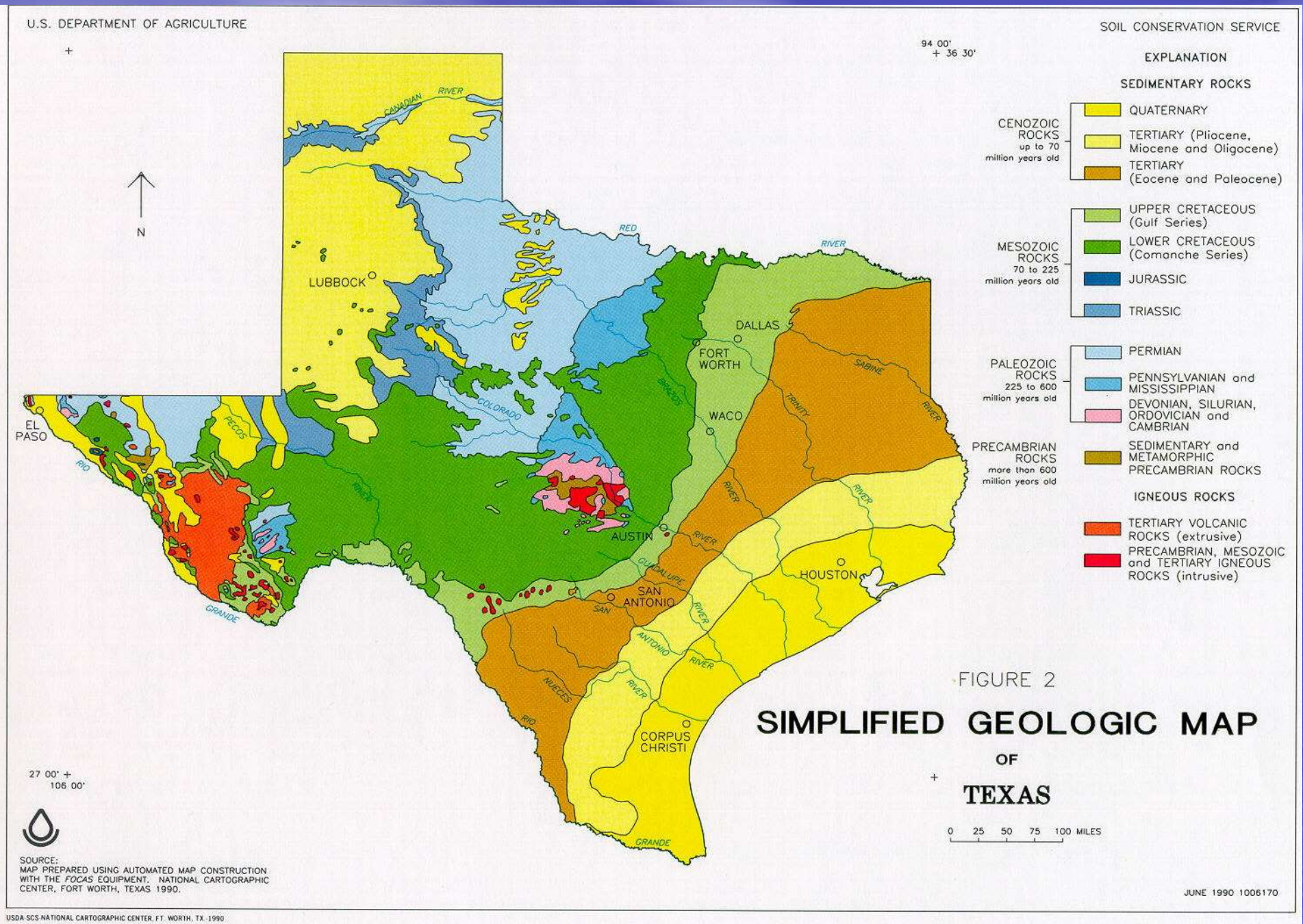


FIGURE 2

SIMPLIFIED GEOLOGIC MAP OF TEXAS

Geology of Milam County

- Cenozoic Era (present day to 65 million years ago), Paleogene Period (23 to 65 million years ago), and Eocene (34 to 56 million years ago) to Paleocene (56 to 65 million years ago) Epochs
- Coastal Plain 2/5, Timber land 3/5: Blackland prairie and clay pan areas.
- Coastal Plain: underlain with calcareous deposits of clay and marl, clayey dark colored soils.
- Timber land: underlain with mainly non-calcareous sand and clay, few areas of calcareous materials, sandy light colored soils underlain with red clayey materials.
- Drainage to the southeast.

Soil from Residuum or Residual Soil

Rumple soil, from the Edwards limestone in Central Texas

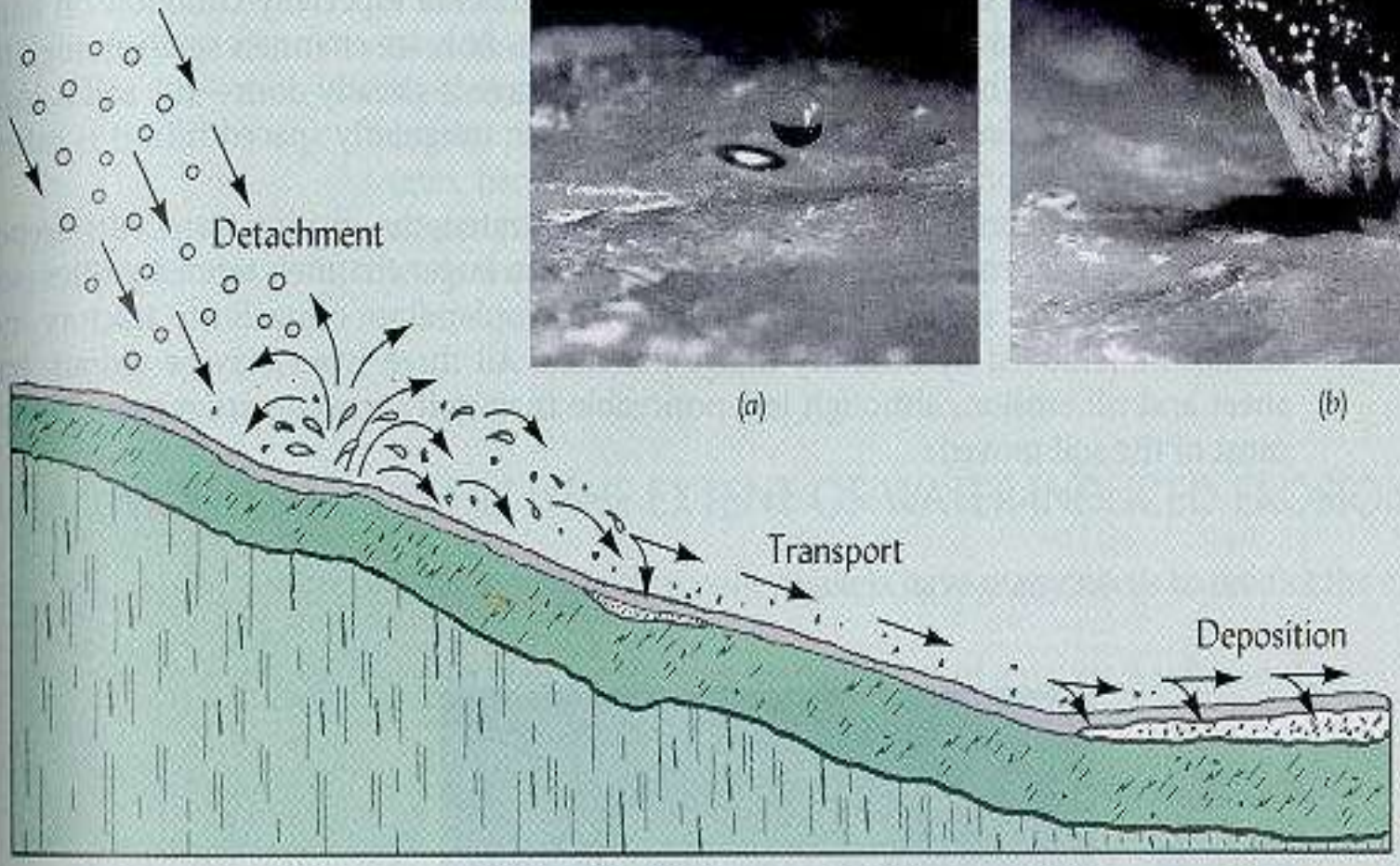
Limestone

Alluvium

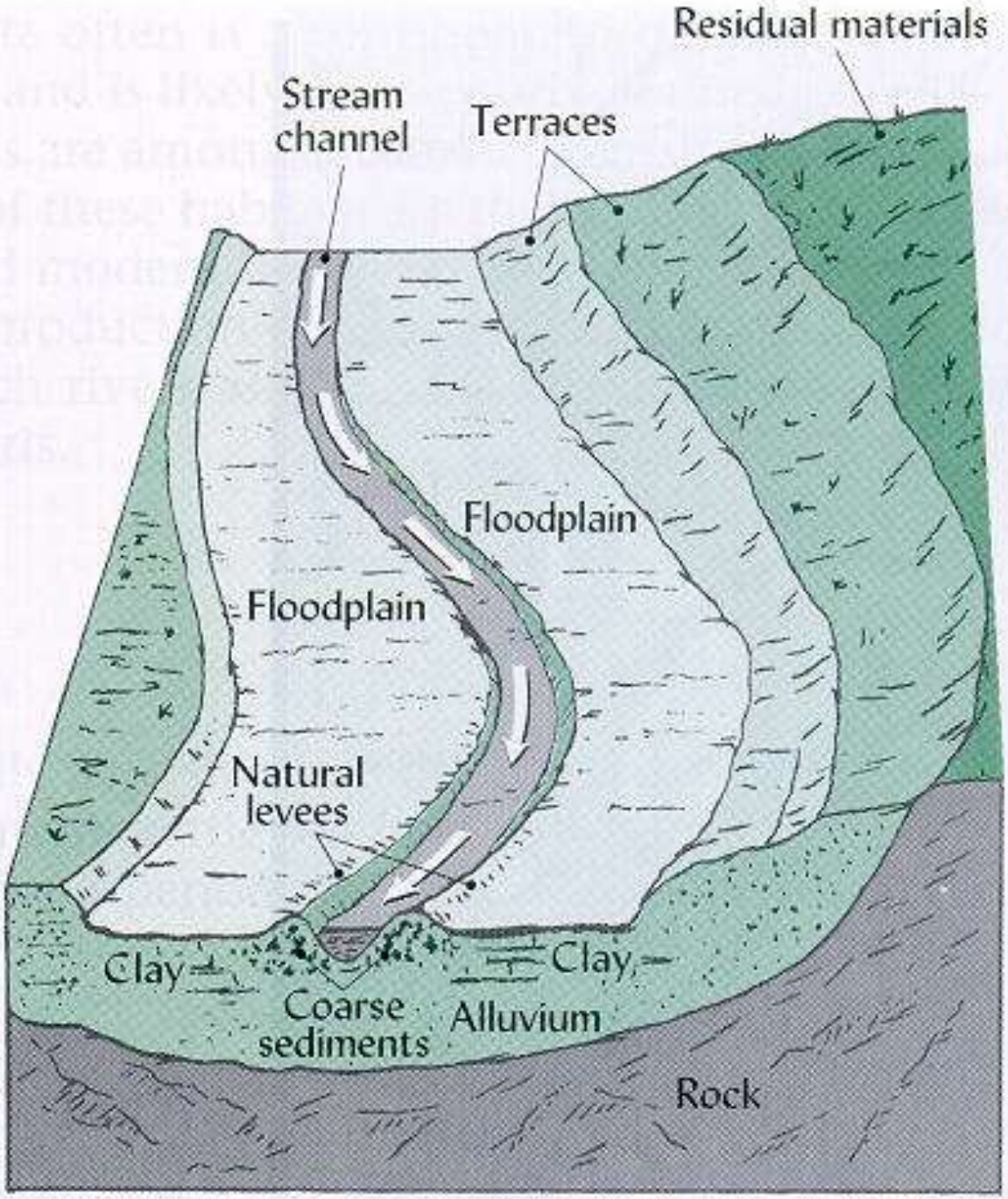
- Deposited by water associated with streams and rivers
- May have a wide range of soil textures depending upon the energy of the water that is transporting the alluvium

(a)

(b)



(c)

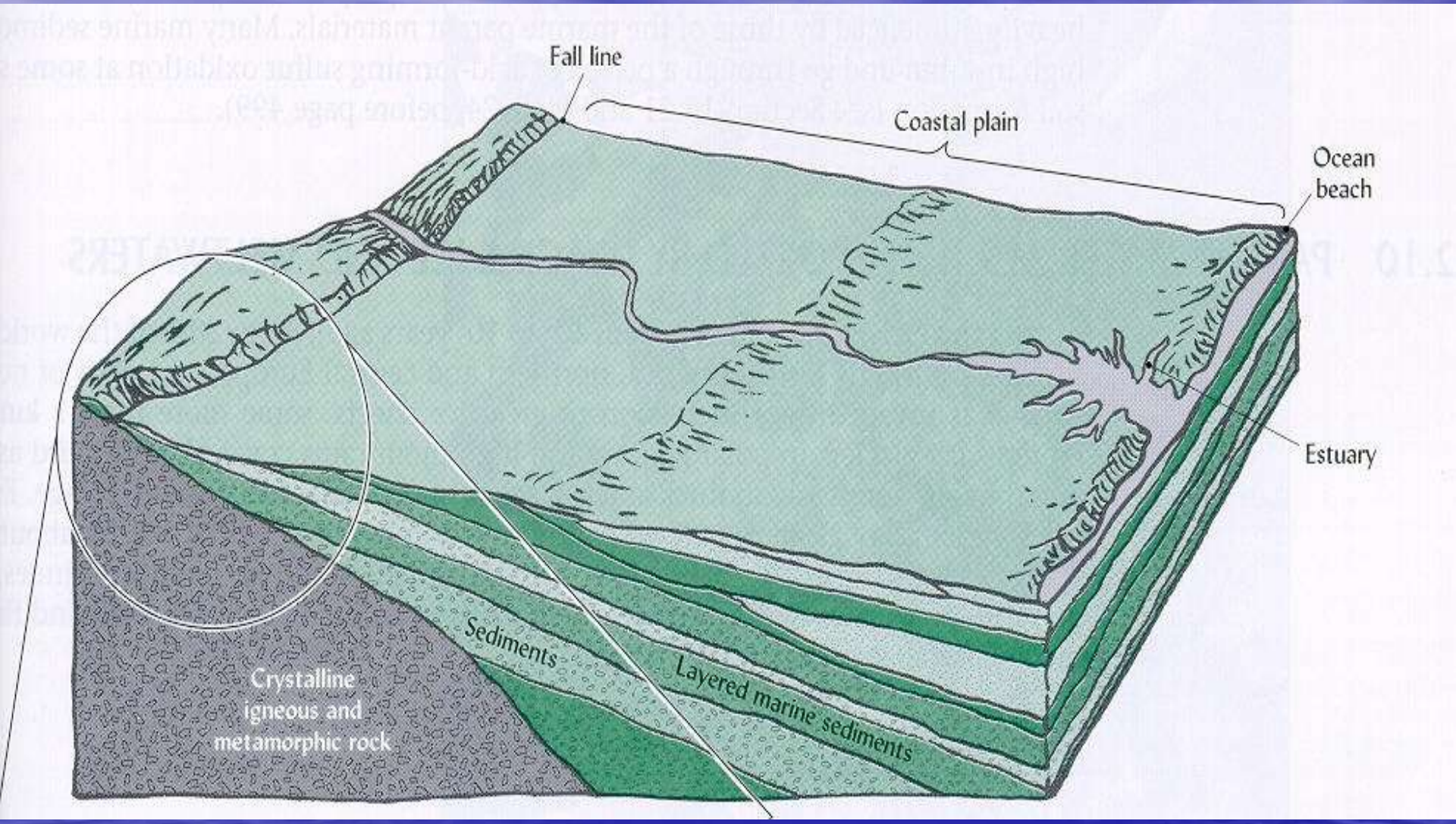

Residual materials
Stream channel
Terraces
Floodplain
Floodplain
Natural levees
Clay
Clay
Coarse sediments
Alluvium
Rock

The Shipps soil series developed in clay-rich alluvium of the Brazos River near College Station, TX

Note the buried A horizon in the lower portion of the pedon.

Coastal Plains Sediments

- A mixture of alluvium from the uplands via streams and rivers delivering sediments to the ocean, and marine sediments deposited by the ocean.



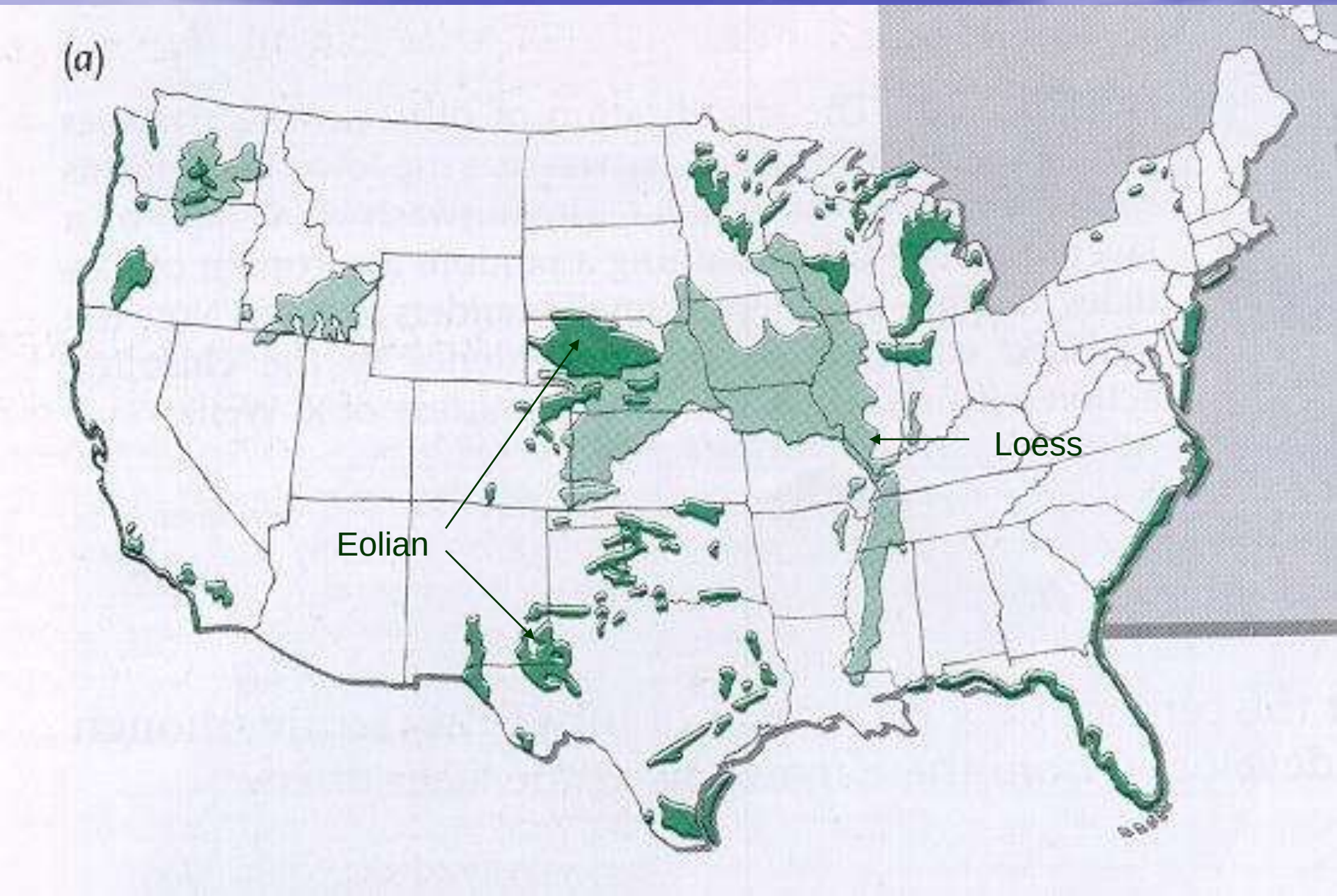
Cross-sectional diagram of coastal plains in North Carolina. From Brady and Weil.

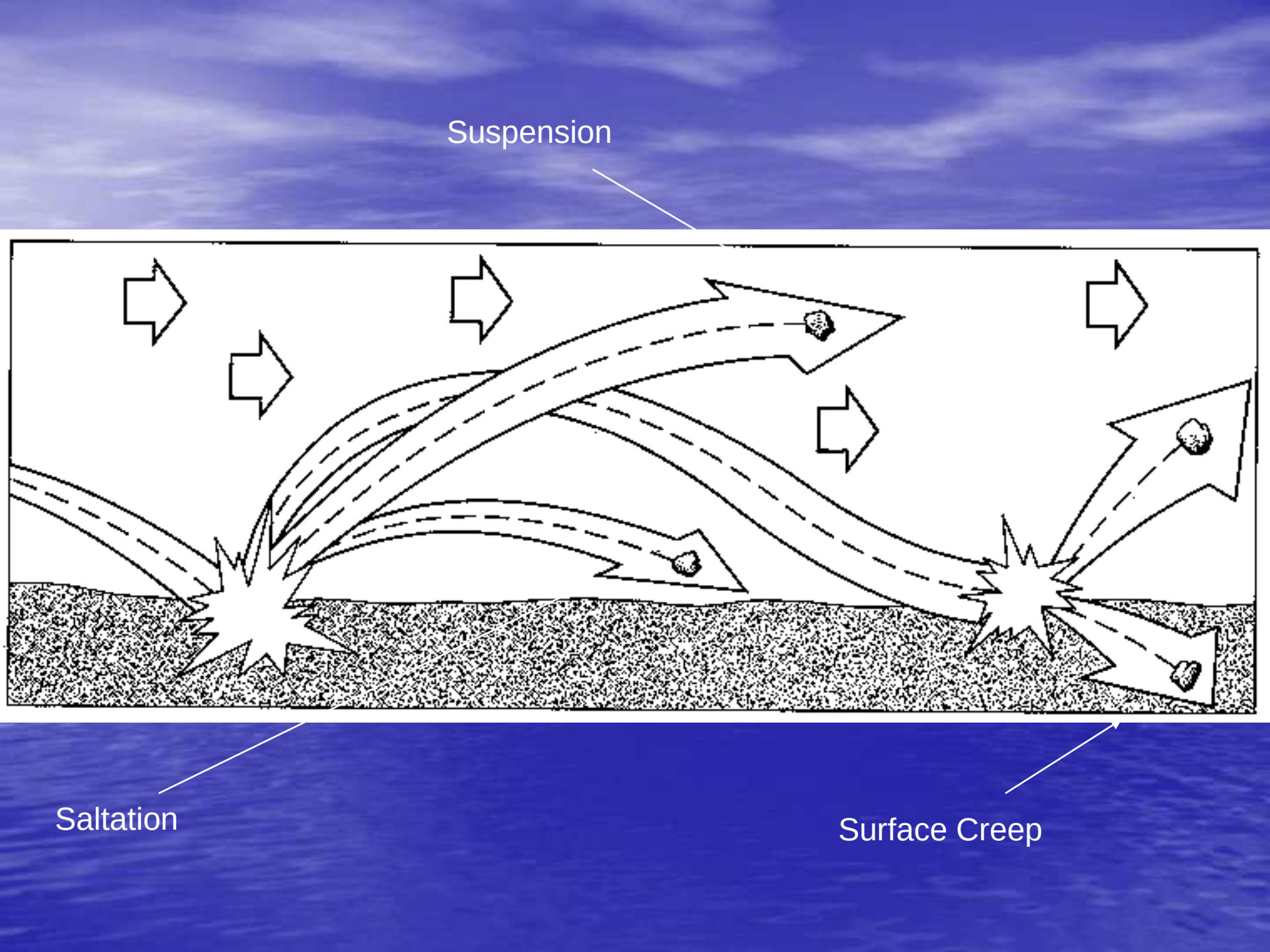
The Spiller series from Brazos County developed from Coastal Plains Sediments.

Loess and Eolian Sands

- Loess is silt to very fine sand that was deposited by wind. Most loess in the US is associated with "choked" streams and rivers carrying sediment from the melting of glaciers. Wind blew the silts from the floodplains and deposited them over existing landscapes.

Wind deposited sediments of the U.S.




Suspension
Saltation
Surface Creep

Active sand dune in Kenedy County, TX.

Roadcut into loess deposit near Vicksburg, Miss.

Soil developed in eolian sands. Note the upper 5 ft of soil is developed in a younger eolian sand deposit and covers the older soil, also developed in eolian sands.

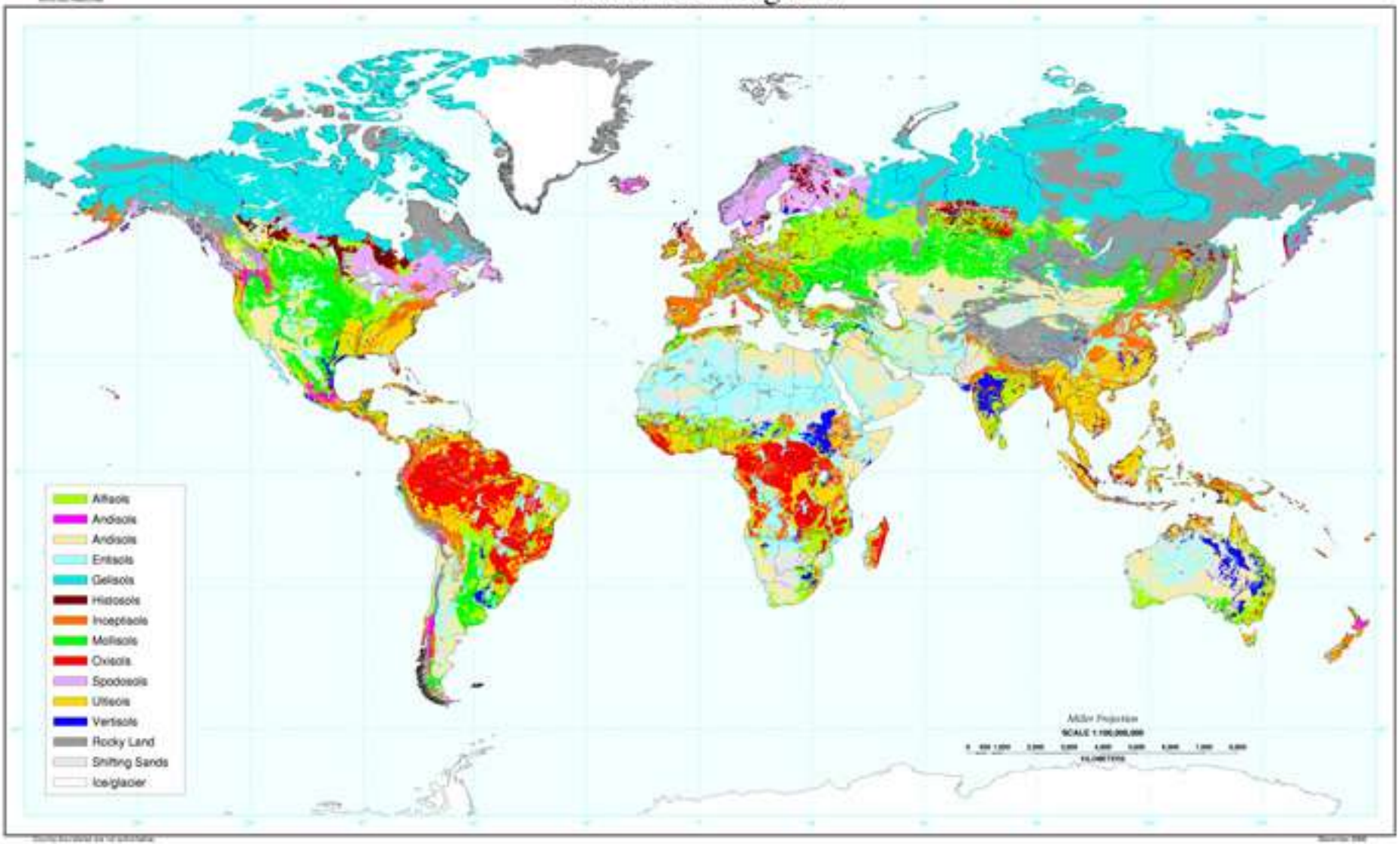
TIME

- Discuss degree of weathering, how much the parent material has changed, instead of talking about how “old” a soil is.

Soil Orders

- Inceptisol
- Entisol
- Mollisol
- Alfisol
- Aridisol
- Andisol
- Vertisol
- Gelisol
- Histosol
- Spodosol
- Ultisol
- Oxisol

Global Soil Regions



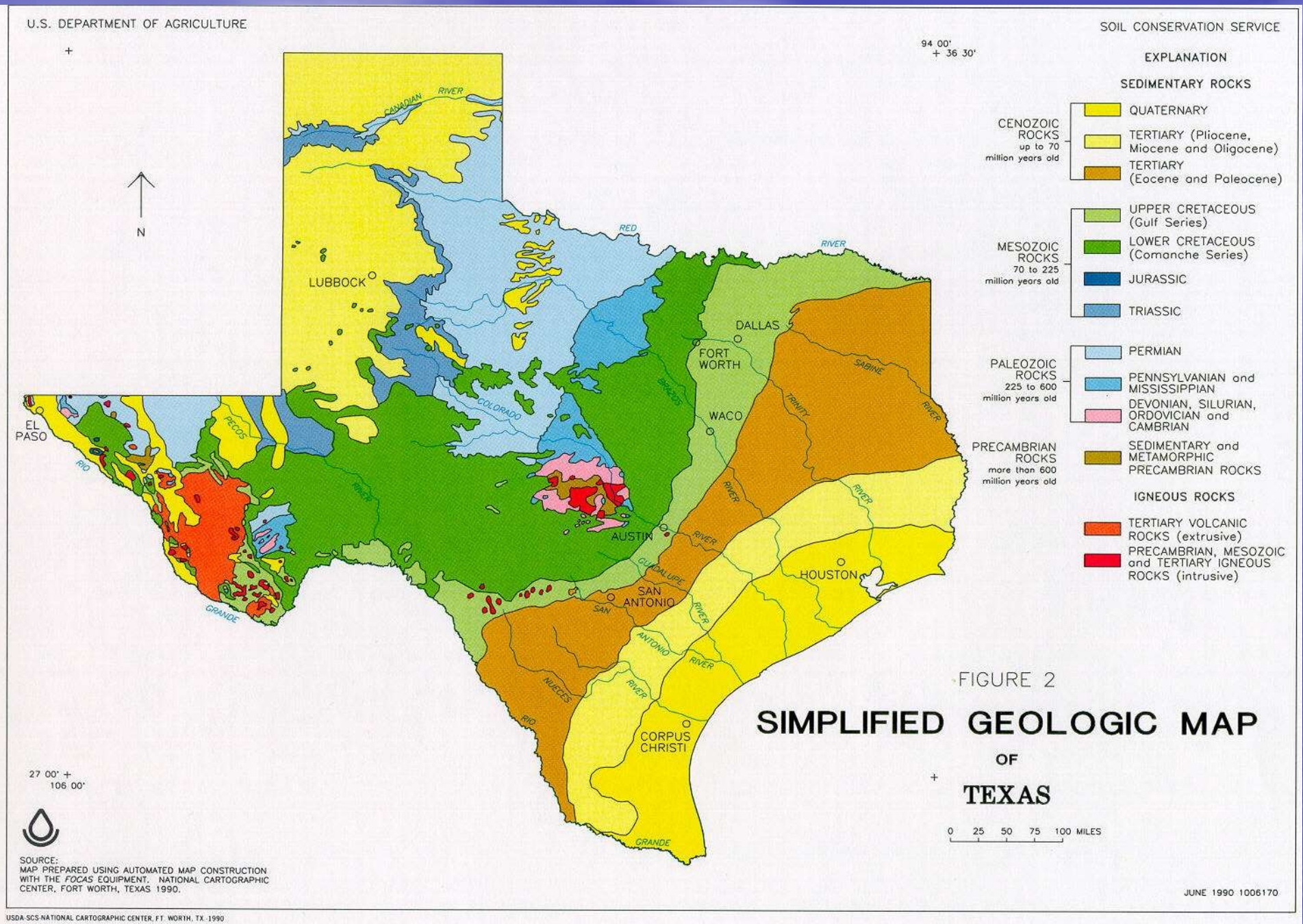
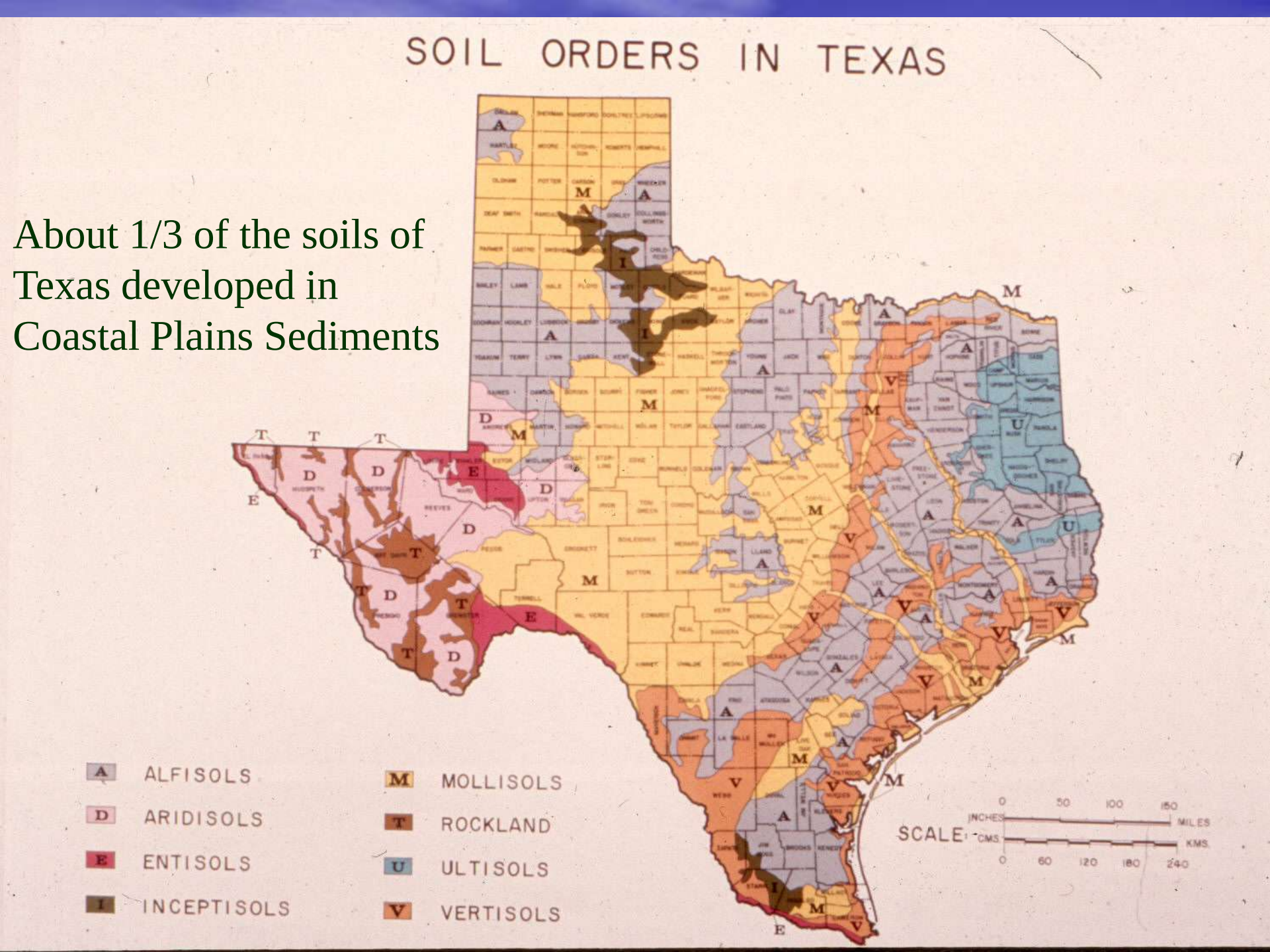


FIGURE 2

SIMPLIFIED GEOLOGIC MAP OF TEXAS

About 1/3 of the soils of Texas developed in Coastal Plains Sediments

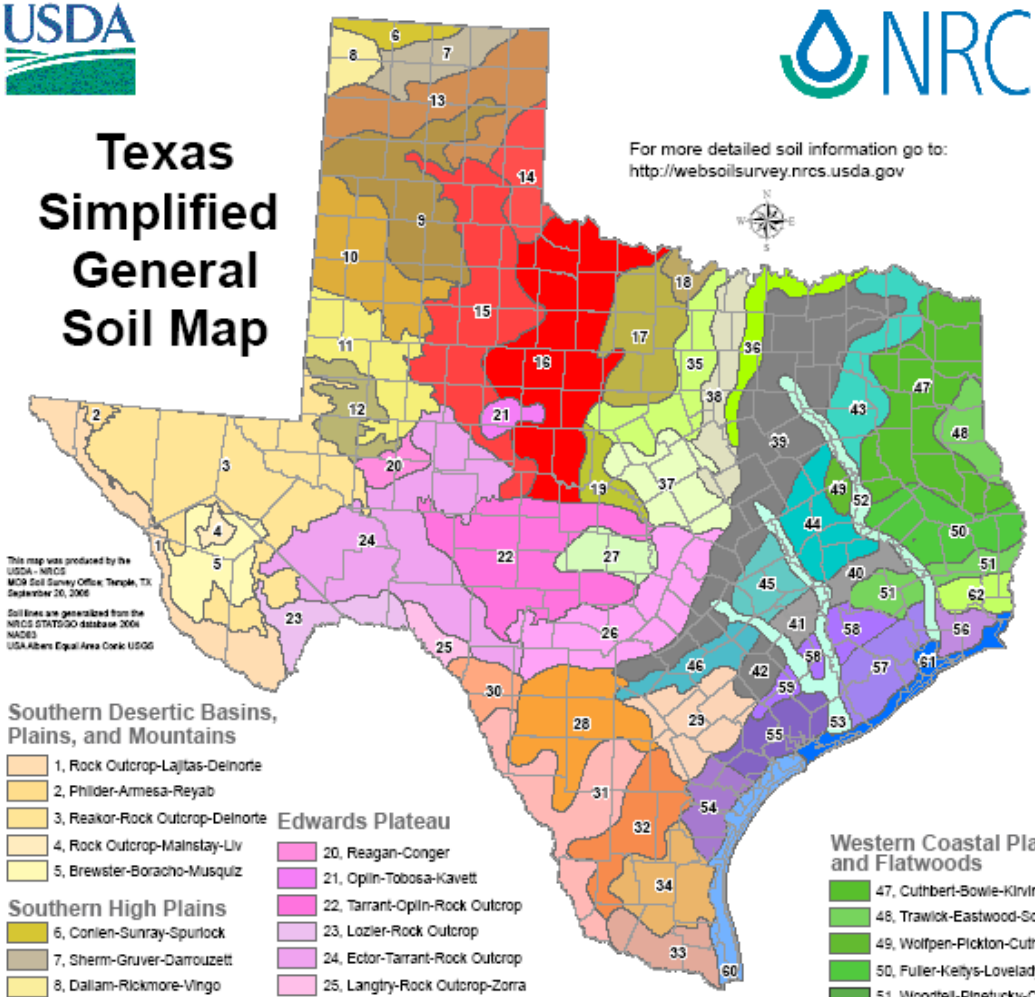


USDA

NRCS

Texas Simplified General Soil Map

For more detailed soil information go to:
http://websoilsurvey.nrcs.usda.gov



This map was produced by the USDA - NRCS MCR Soil Survey Office, Temple, TX September 20, 2006

Soil lines are generalized from the NRCS STATSGO database 2004
NAD83
USA Albers Equal Area Conic USGS

Southern Desertic Basins, Plains, and Mountains

- 1, Rock Outcrop-Lajitas-Delnorte
- 2, Philder-Armesa-Reyab
- 3, Reakor-Rock Outcrop-Delnorte
- 4, Rock Outcrop-Mainstay-Liv
- 5, Brewster-Boracho-Musquiz

Southern High Plains

- 6, Conlen-Sunray-Spurlock
- 7, Sherm-Gruver-Darrouzett
- 8, Dallam-Rickmore-Vingo
- 9, Pullman-Randall-Lofton
- 10, Amarillo-Acuff-Olton
- 11, Patricia-Brownfield-Nutivoll
- 12, Jalmar-Penwell-Triomas
- 13, Mobeetie-Berda-Veal

Central Rolling Red Plains

- 14, Miles-Springer-Delwin
- 15, Miles-Delwin-Woodward
- 16, Tillman-Vernon-Hollister

Texas North Central Prairies

- 17, Bluegrove-Bonti-Truce
- 18, Stoneburg-Anocon-Kirkland
- 19, Bonti-Throck-Callahan

Edwards Plateau

- 20, Reagan-Conger
- 21, Oplin-Tobosa-Kavett
- 22, Tarrant-Oplin-Rock Outcrop
- 23, Lozier-Rock Outcrop
- 24, Ector-Tarrant-Rock Outcrop
- 25, Langtry-Rock Outcrop-Zorra
- 26, Brackett-Eckrant-Real

Texas Central Basin

- 27, Keese-Ligon-Rock Outcrop

Rio Grande Plain

- 28, Duval-Uvalde-Pryor
- 29, Olmos-Weesatche-Samosa
- 30, Olmos-Langtry-Elindio
- 31, Montell-Catarina-Maverick
- 32, Delmita-Pernitas-Randado
- 33, McAllen-Hidalgo-Brennan
- 34, Nueces-Sarita-Falfurrias

Cross Timbers

- 35, Windthorst-Cheney-Duffau
- 36, Gasil-Crosstell-Callisburg

Grand Prairie

- 37, Brackett-Purves-Real
- 38, Aledo-Sanger-Bolar

Texas Blackland Prairie

- 39, Houston Black-Helden-Wilson
- 40, Freisburg-Latium-Crockett
- 41, Freisburg-Bleiblerville-Carbengle
- 42, Freisburg-Hallettsville

Texas Claypan Area

- 43, Woodtell-Crockett
- 44, Edge-Tabor-Silstid
- 45, Edge-Padina
- 46, Straber-Padina-Crockett

Western Coastal Plain and Flatwoods

- 47, Cuthbert-Bowie-Kirvin
- 48, Trawick-Eastwood-Scottsville
- 49, Wolfpen-Pickton-Cuthbert
- 50, Fuller-Keltys-Lovelady
- 51, Woodtell-Pinetucky-Conroe
- 62, Otanya-Kirbyville-Evadale

Flood Plains

- 52, Tinn-Trinity-Kaufman
- 53, Pledger-Brazoria-Norwood

Gulf Coast Prairie

- 54, Victoria-Orella-Edroy
- 55, Laewest-Dacosta-Edna
- 56, Beaumont-League-Labelle
- 57, Lake Charles-Bernard-Edna
- 58, Katy-Wockley-Gessner
- 59, Telferner-Cleno-Nada

Gulf Coast Saline Prairie

- 60, Mustang-Daggerhill-Barrada
- 61, Harris-Surfside-Francitas

Categories in U.S. Soil Taxonomy

- Order (12)
- Suborder (63)
- Great Group (~250)
- Subgroup (~1400)
- Family (~8000)
- Series (~20,000 in U.S.)

Heiden clay, 1 to 3% slope; fine, smectitic, thermic Udic Haplustert

- Order - Vertisol (look for formative element at the end)
- Suborder - Ustert
- Great Group - Haplustert
- Subgroup - Udic Haplustert
- Family - fine, smectitic, thermic Udic Haplustert
- Series - Heiden

- Phase - 1-3% slope *Clay is texture of surface horizon*

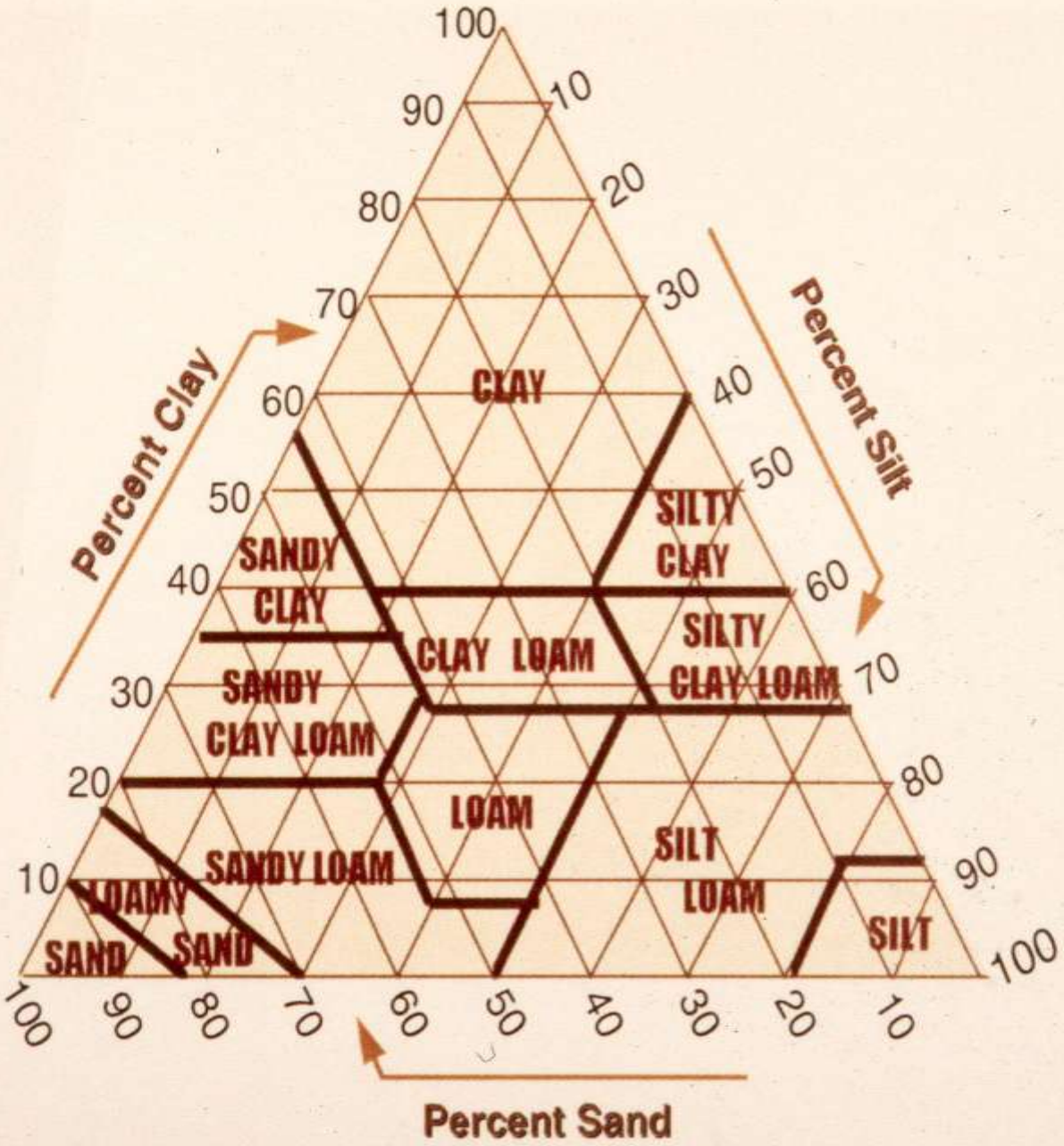
Soil Components

• Mineral	45% vol	99% wt
• Organic	5% vol	1% wt
• Water	25% vol	>1% wt
• Air	25% vol	>1% wt

Soil Mineral Components

- Sand (0.05-2.00 mm): Quartz and feldspars
- Silt (0.002-0.05 mm): Quartz, feldspars, carbonates, oxides, sulfates
- Clay (>0.002 mm): Aluminosilicates, such as smectite, kaolinite, illite, etc.

SOIL TEXTURE TRIANGLE



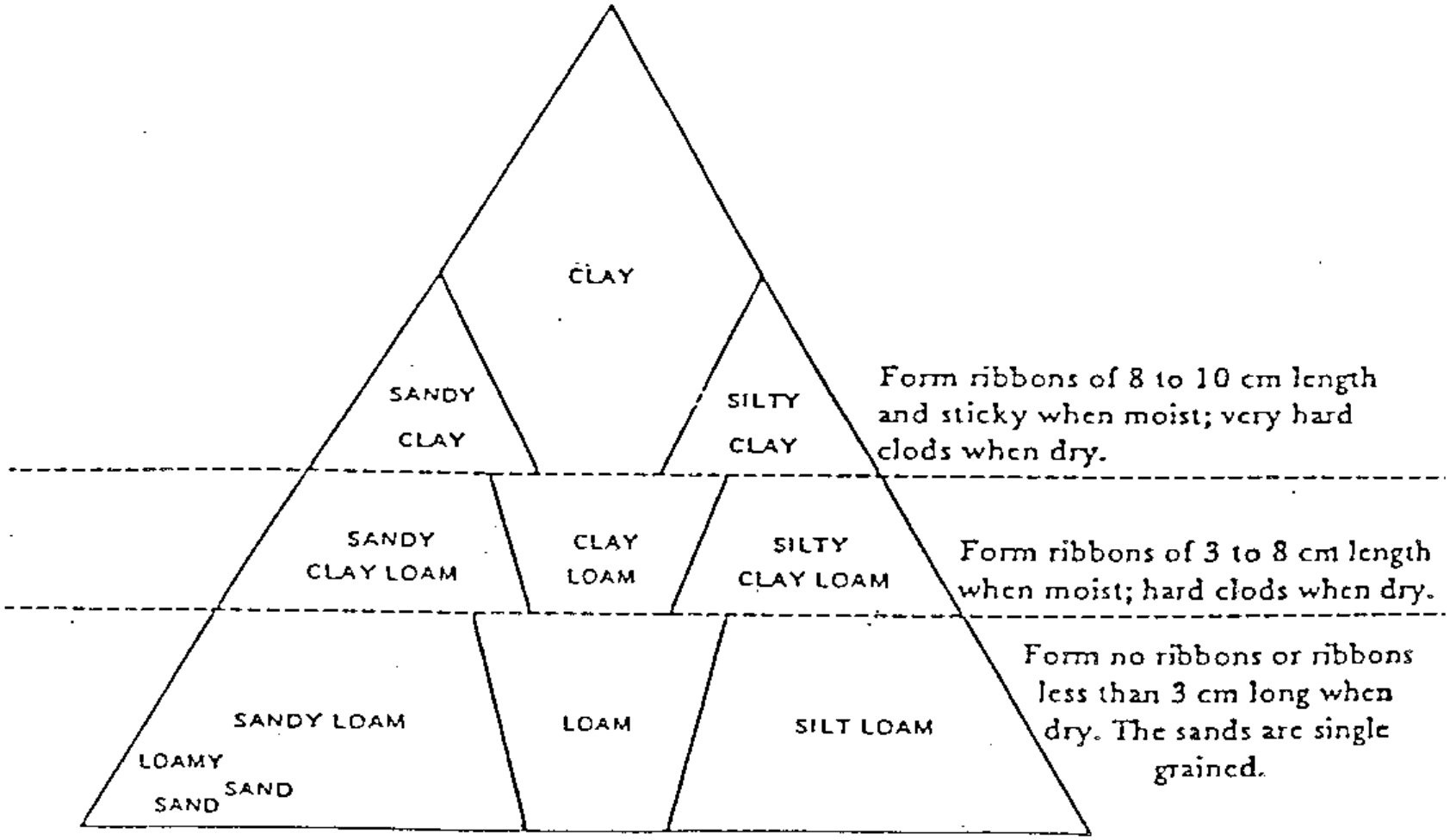
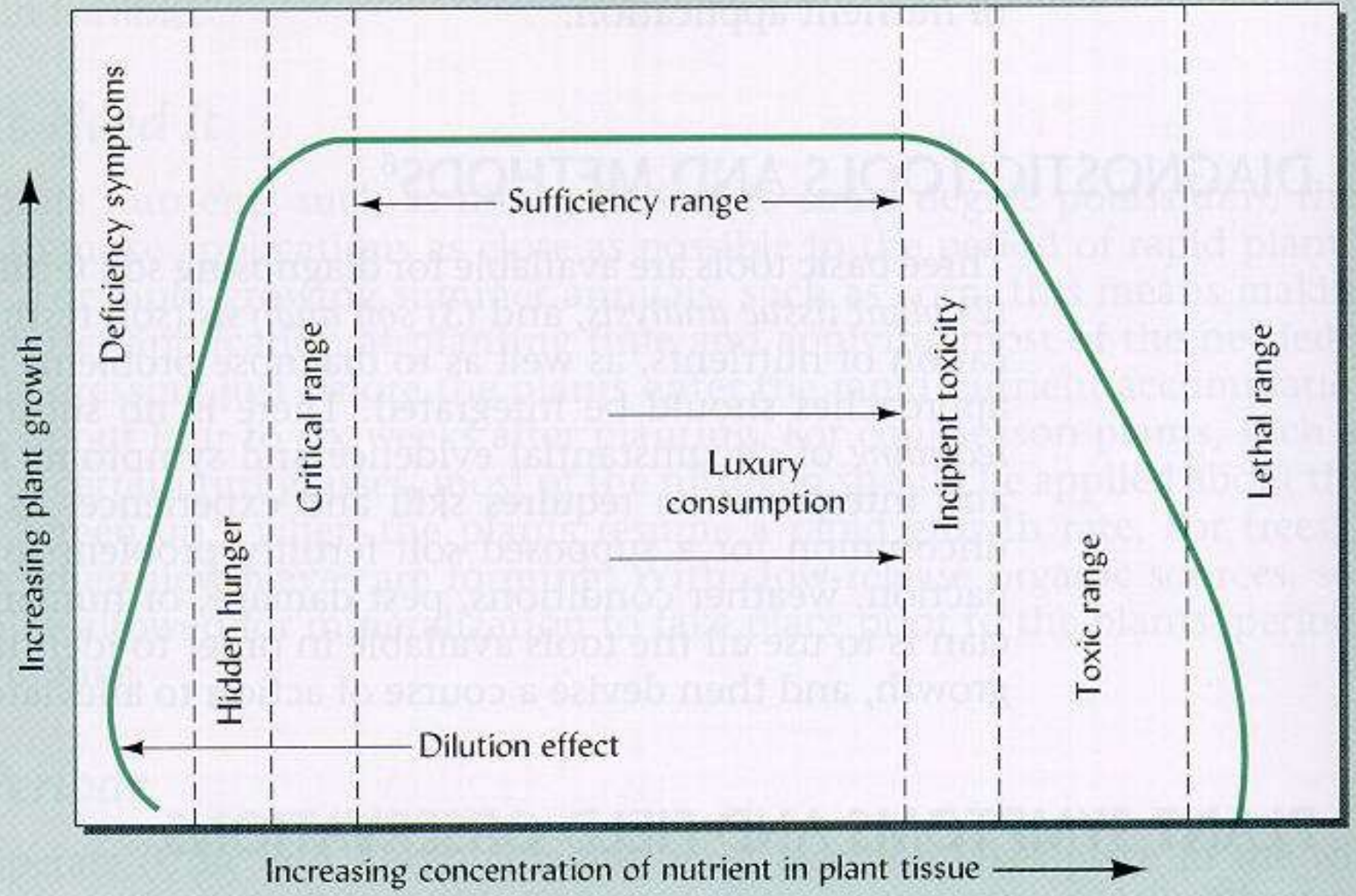


Figure 3. Modified textural triangle for determining soil texture by the feel method.


TEXAS AGGIES

Essential Nutrients

- Any element required by plants or animals for normal growth and reproduction.


Increasing plant growth
Deficiency symptoms
Hidden hunger
Critical range
Sufficiency range
Luxury consumption
Incipient toxicity
Toxic range
Lethal range
Dilution effect
Increasing concentration of nutrient in plant tissue

Primary Macronutrients

- Carbon-C
- Hydrogen-H
- Oxygen-O
- Nitrogen-N
- Phosphorus-P, P_2O_5
- Potassium-K, K_2O

Primary Macronutrients

- Carbon-C
- Hydrogen-H
- Oxygen-O
- Nitrogen-N
- Phosphorus-P, P_2O_5
- Potassium-K, K_2O

Derived from air and water

Derived from soil

Secondary Macronutrients

- Calcium-Ca
- Magnesium-Mg
- Sulfur-S

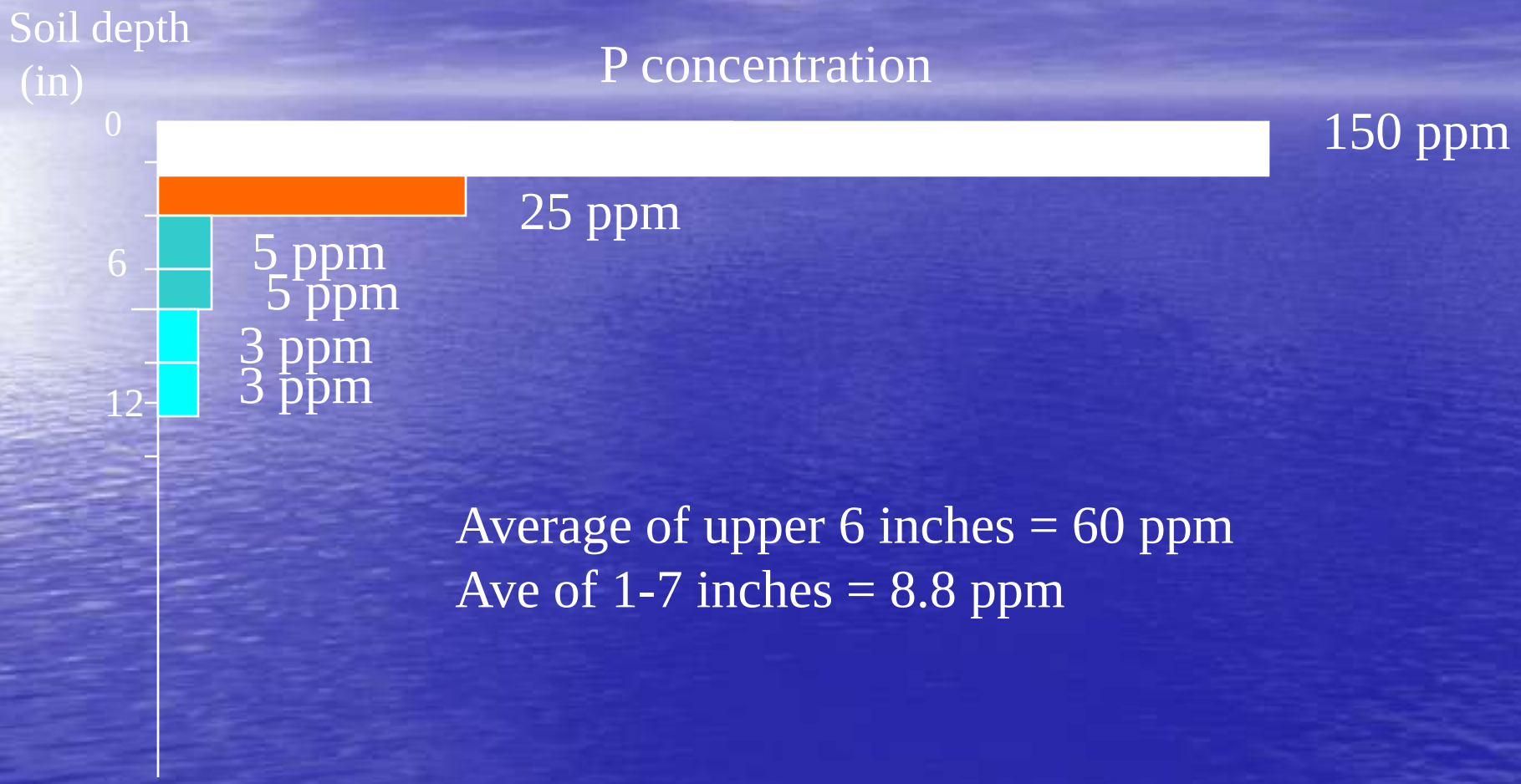
Derived from soil

Micronutrients

- Iron-Fe
- Copper-Cu
- Boron-B
- Chloride-Cl
- Cobalt-Co
- Silica-Si
- Manganese-Mn
- Zinc-Zn
- Molybdenum-Mo
- Sodium-Na
- Vanadium-V
- Nickel-Ni

All derived from soil

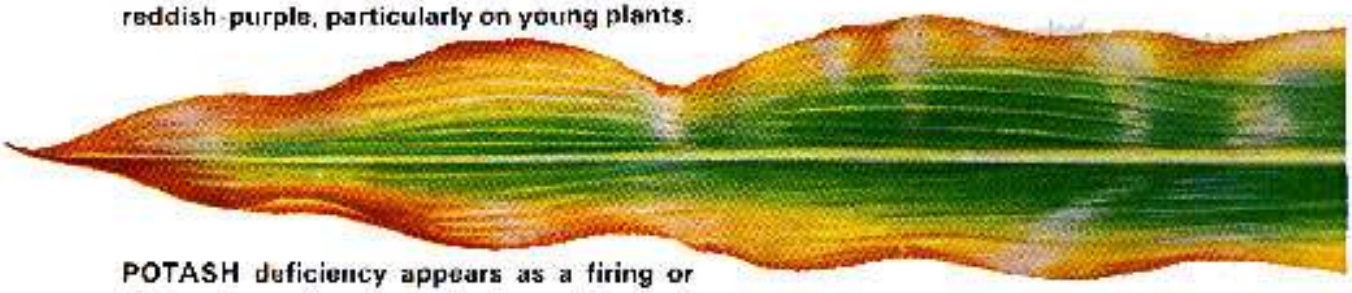
Stratification of P



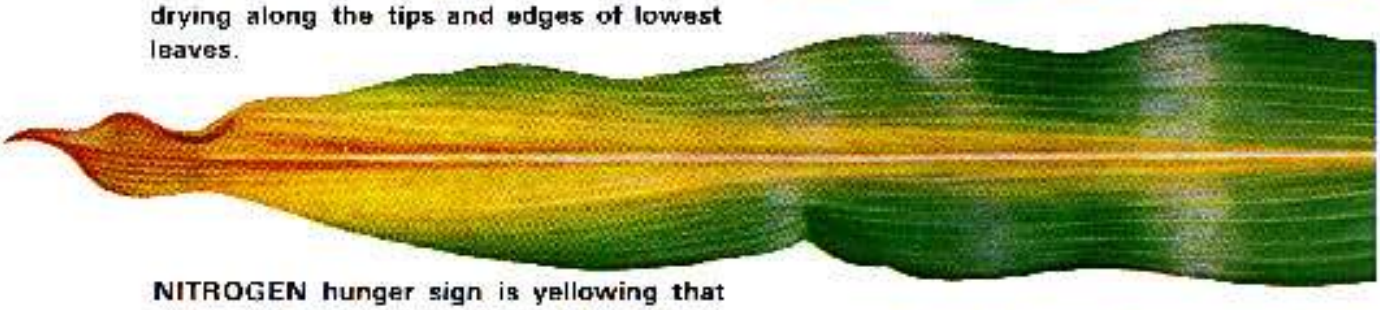
Average of upper 6 inches = 60 ppm
Ave of 1-7 inches = 8.8 ppm

HEALTHY leaves shine with a rich dark green color when adequately fed

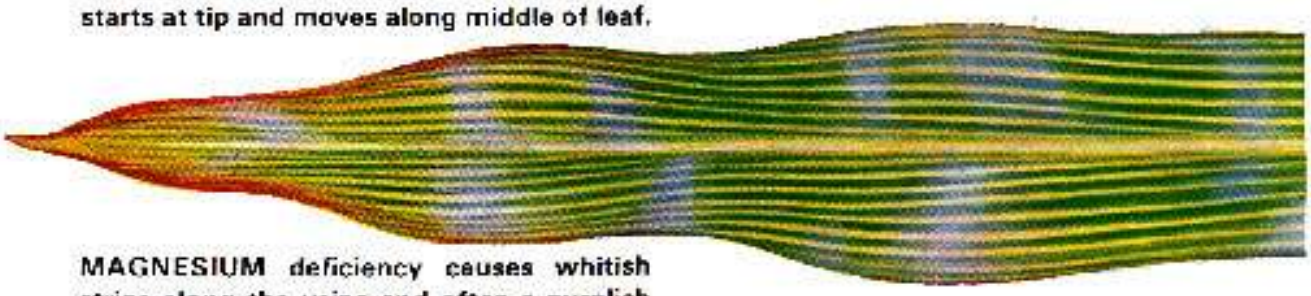
PHOSPHATE shortage marks leaves with reddish-purple, particularly on young plants.



POTASH deficiency appears as a firing or drying along the tips and edges of lowest leaves.



NITROGEN hunger sign is yellowing that starts at tip and moves along middle of leaf.



MAGNESIUM deficiency causes whitish strips along the veins and often a purplish color on the underside of the lower leaves.

Soil Reactivity, Soil pH

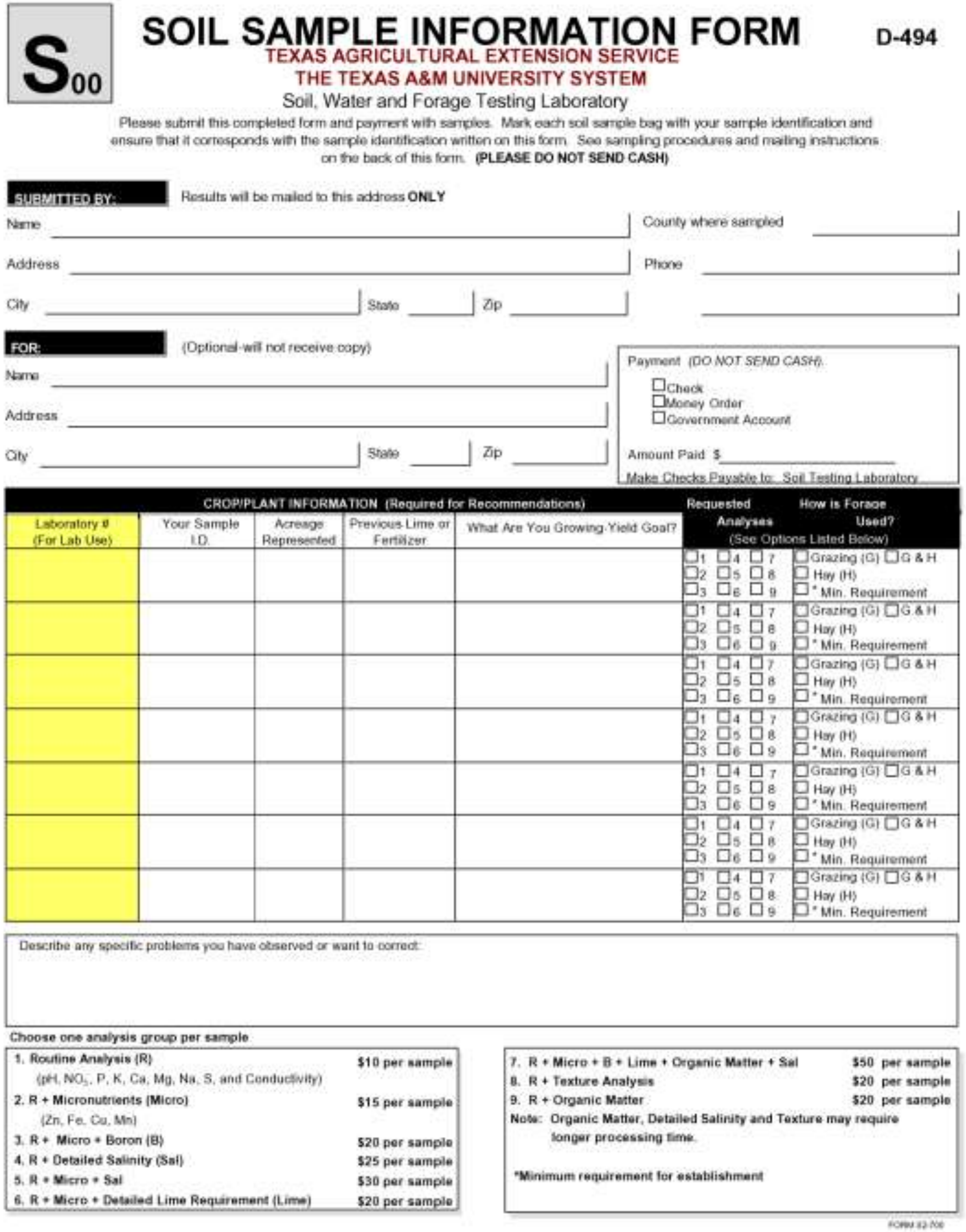
- pH = _____
- Neutral pH = ____
- Alkaline or basic pH = _____
- Acid pH =_____
- Tremendous effect on availability of nutrients to plants.

Soil Reactivity, Soil pH

- All nutrients most available to plants between pH values of 6 to 7 for mineral soils and 5.5 to 6.5 for organic soils
- Availability of most nutrients increases as the pH decreases
- Availability of Mo increases as pH increases
- Fe and Zn are often deficient in calcareous soils (pH > 7.5)

Soil Sampling and Soil Testing

Soil Sample Information Form



S00

SOIL SAMPLE INFORMATION FORM

D-494

TEXAS AGRICULTURAL EXTENSION SERVICE
THE TEXAS A&M UNIVERSITY SYSTEM
Soil, Water and Forage Testing Laboratory

Please submit this completed form and payment with samples. Mark each soil sample bag with your sample identification and ensure that it corresponds with the sample identification written on this form. See sampling procedures and mailing instructions on the back of this form. **(PLEASE DO NOT SEND CASH)**

SUBMITTED BY: Results will be mailed to this address **ONLY**

Name ______ County where sampled ______
Address ______ Phone ______
City ______ State ______ Zip ______

FOR: (Optional-will not receive copy)

Name ______
Address ______
City ______ State ______ Zip ______

Payment *(DO NOT SEND CASH)*
☐Check
☐Money Order
☐Government Account
Amount Paid $ ______
Make Checks Payable to: Soil Testing Laboratory

CROP/PLANT INFORMATION (Required for Recommendations)

Laboratory # (For Lab Use)	Your Sample I.D.	Acreage Represented	Previous Lime or Fertilizer	What Are You Growing-Yield Goal?	Requested Analyses (See Options Listed Below)	How is Forage Used?
					☐1 ☐4 ☐7 ☐2 ☐5 ☐8 ☐3 ☐6 ☐9	☐Grazing (G) ☐G & H ☐ Hay (H) ☐* Min. Requirement
					☐1 ☐4 ☐7 ☐2 ☐5 ☐8 ☐3 ☐6 ☐9	☐Grazing (G) ☐G & H ☐ Hay (H) ☐* Min. Requirement
					☐1 ☐4 ☐7 ☐2 ☐5 ☐8 ☐3 ☐6 ☐9	☐Grazing (G) ☐G & H ☐ Hay (H) ☐* Min. Requirement
					☐1 ☐4 ☐7 ☐2 ☐5 ☐8 ☐3 ☐6 ☐9	☐Grazing (G) ☐G & H ☐ Hay (H) ☐* Min. Requirement
					☐1 ☐4 ☐7 ☐2 ☐5 ☐8 ☐3 ☐6 ☐9	☐Grazing (G) ☐G & H ☐ Hay (H) ☐* Min. Requirement
					☐1 ☐4 ☐7 ☐2 ☐5 ☐8 ☐3 ☐6 ☐9	☐Grazing (G) ☐G & H ☐ Hay (H) ☐* Min. Requirement
					☐1 ☐4 ☐7 ☐2 ☐5 ☐8 ☐3 ☐6 ☐9	☐Grazing (G) ☐G & H ☐ Hay (H) ☐* Min. Requirement

Describe any specific problems you have observed or want to correct:

Choose one analysis group per sample

1. Routine Analysis (R) (pH, NO_3, P, K, Ca, Mg, Na, S, and Conductivity)	**$10 per sample**
2. R + Micronutrients (Micro) (Zn, Fe, Cu, Mn)	**$15 per sample**
3. R + Micro + Boron (B)	**$20 per sample**
4. R + Detailed Salinity (Sal)	**$25 per sample**
5. R + Micro + Sal	**$30 per sample**
6. R + Micro + Detailed Lime Requirement (Lime)	**$20 per sample**
7. R + Micro + B + Lime + Organic Matter + Sal	**$50 per sample**
8. R + Texture Analysis	**$20 per sample**
9. R + Organic Matter	**$20 per sample**

Note: Organic Matter, Detailed Salinity and Texture may require longer processing time.

***Minimum requirement for establishment**

FORM 82-700

Procedure for Taking Soil Samples

Taking the Soil Sample (Refer to Figure 1)

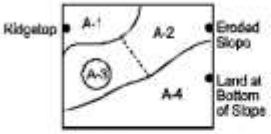


Fig. 1

- Take one composite sample for every 10 to 40 acres. A separate sample should be taken for:
  - ⇒ Areas with different soil types
  - ⇒ Areas with different land uses or fertilizer uses
  - ⇒ Areas with different terrain
- Approximately 1 pint of the composite soil sample is required for routine analyses.
- Additional sample is required for texture or detailed salinity (submit 2 sample bags marked identically).
- Avoid sampling areas such as small gullies, slight field depressions, terrace waterways, or unusual areas.
- When sampling fertilized fields, avoid sampling directly in fertilized band.

Taking a Composite Sample (Refer to Figures 2 and 3)

Fig. 2

- Take a sample from 10 to 15 different areas.
- Use a spade, soil auger or soil sampling tube.
- Clear litter from the surface (do not remove decomposed black material).
- When using a soil auger or sampling tool, make the core or boring 6 inches deep into the soil (3 to 4 inches deep for permanent sod).
- When using a spade:
  - ⇒ Dig a V-shaped hole and take a 1-inch slice from the smooth side of the hole.
  - ⇒ Take a 1 x 1 inch core from the center of the shovel slice.
- Repeat in 10 to 15 different places. Put in a clean plastic bucket or other non-metallic container, thoroughly mix and remove a pint (or more if additional tests are desired) as a composite sample representing the whole field or area.
- To improve the nitrate-nitrogen analysis, samples may be **air-dried** before sending to the laboratory. **Do not use heat** to dry samples. Completely fill soil sample bag or other suitable pint container. Do not use old vegetable cans, tobacco cans, match boxes, glass containers, etc. to submit samples. If more than one sample bag is used, label bags as 1 of 2, 2 of 2,

Fig. 3

Shipping the Sample and Payment (Refer to Figure 4)

Fig. 4

- Complete the information form on the front page (information required for recommendations).
- Please include payment with the sample. Send check or money order made out to Soil Testing Laboratory. **DO NOT SEND CASH**. Please note that the ***price is per sample***.
- Be sure to keep a record for yourself of the area represented by each sample.
- Be sure that sample numbers on sample bags correspond with sample numbers on the front page.
- Send samples and payment to:

Soil, Water and Forage Testing Laboratory
2474 TAMU
College Station, TX 77843-2474

For further information please contact:
Your local County Extension Service Office
or
Soil, Water and Forage Testing Laboratory
2474 TAMU
345 Heep Center
College Station, TX 77843-2474
Phone: (979) 845-4816

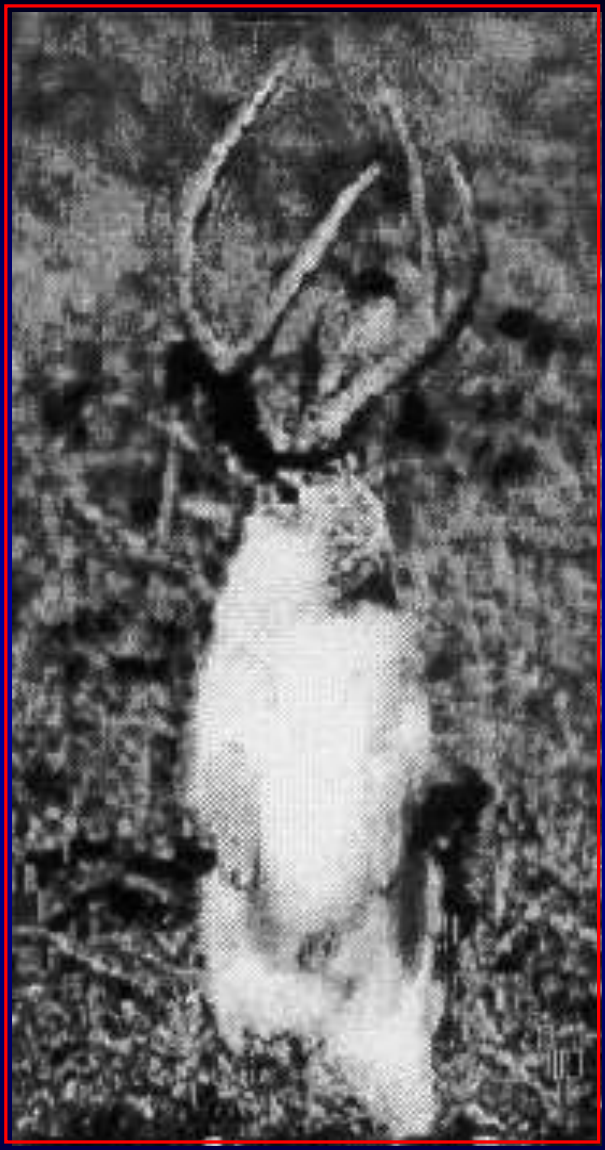
Routine Soil Testing:

* 3 year interval
* Micro's every other time

Sampling Methods:

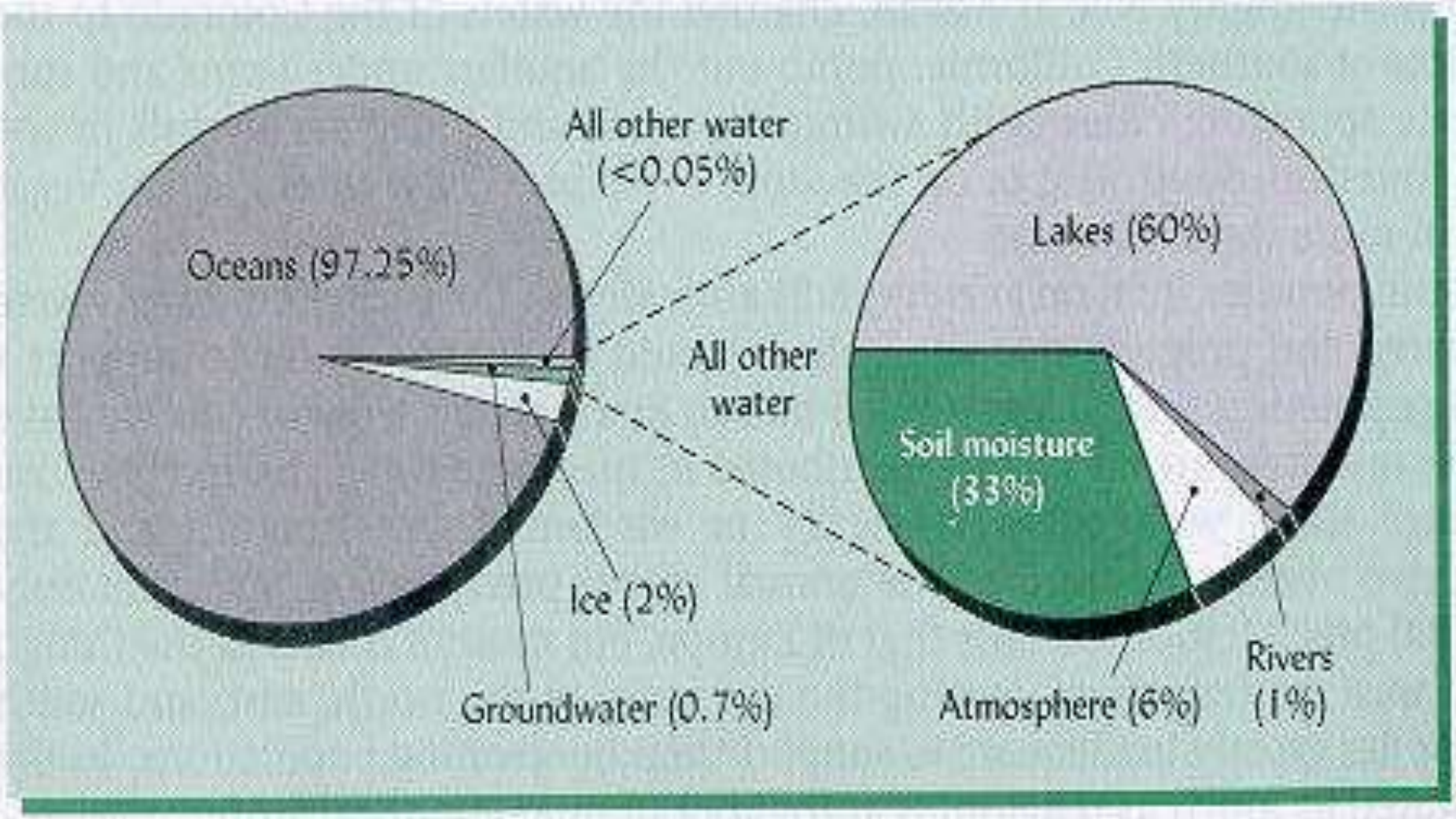
*Composite samples
*3-10 cores around home
* 10-15 cores per field
* Mix and ship immediately

Soil Sample Report Form



Don’t let yourself be tricked by people

Managing Water and Nutrients


All other water
(<0.05%)
Oceans (97.25%)
Lakes (60%)
All other
water
Soil moisture
(33%)
Ice (2%)
Rivers
(1%)
Groundwater (0.7%)
Atmosphere (6%)

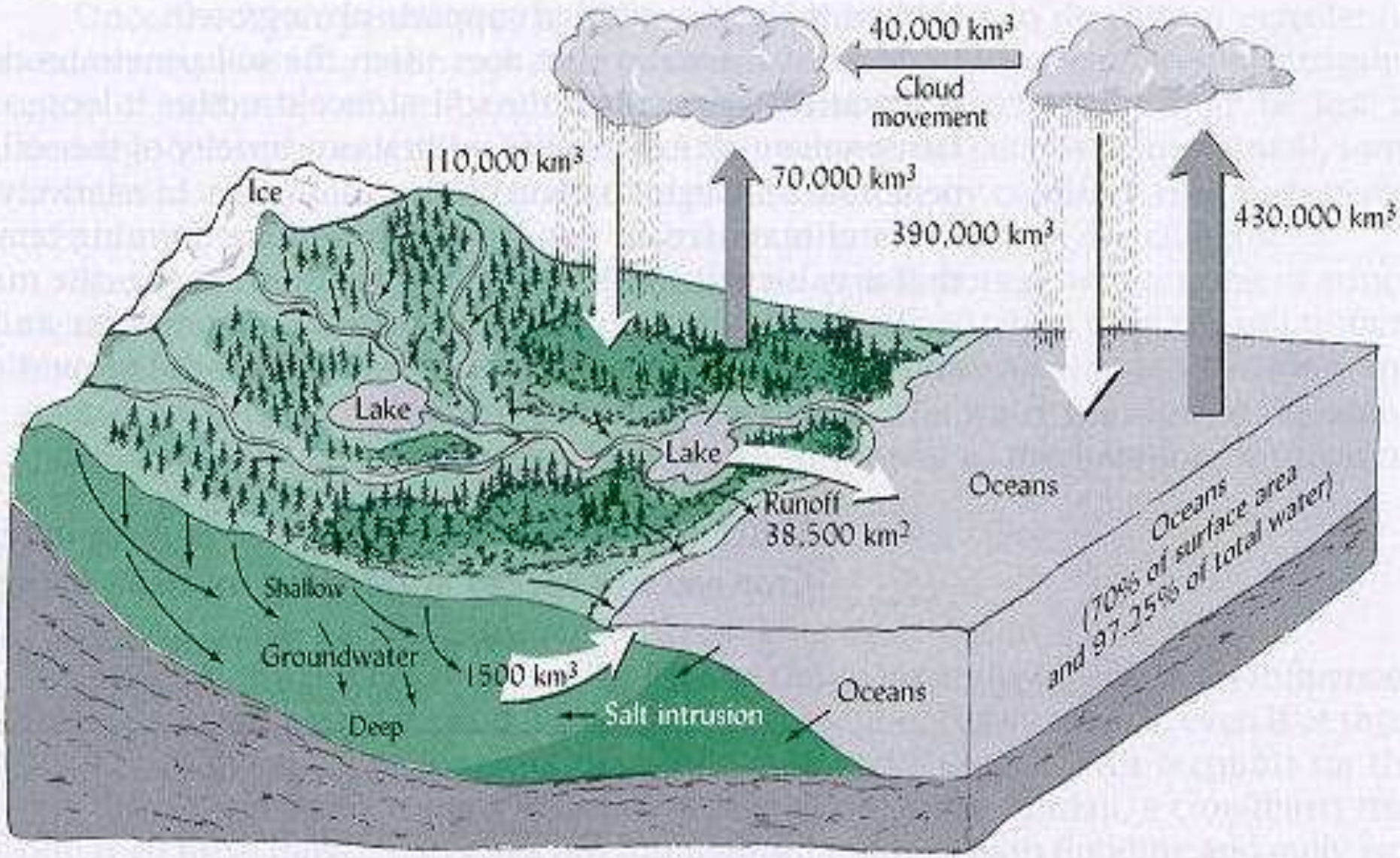


Fig. 6.2 Hydrologic Cycle

Conserve Water

- Watering flowerbeds, gardens
- Watering lawn

What's In a Bag of Fertilizer

- Three numbers, 15-5-10
- First number, % nitrogen as N
- Second number, % phosphorus as P_2O_5
- Third number, % potassium as K_2O

How Do I Know How Much to Add?

- Assume recommendation was 1-0-0 per 1000 square feet
- Recommendation means to add 1 lb of N, 0 lbs of P_2O_5, and 0 lbs of K_2O per 1000 square feet of lawn

How Do I Know How Much to Add?

- My bag of fertilizer is 13-13-13
- Need 1 lb of N per 1000 square feet
- 1lb N ÷ 13% (0.13) = 8 lbs of 13-13-13 to get 1 lb of N
- Also when apply the 8 lbs of 13-13-13, you get 1 lb of phosphorus and potassium, that you did not need
- Ratio of nutrients most plants need is 3 to 4-1-2 to 3

How Do I Know How Much to Add?

- New fertilizer bag is 15-5-10 (What is the nutrient ratio?)
- Need 1 lb of N
- OR, 1 ÷ 15% (0.15) = 7, thus to get 1 lb of N, I need 7 lbs of 15-5-10.

How Do I Know How Much to Add?

- How much phosphorus and potassium does this 7 lbs have in it?
- For P_2O_5: 7 lbs x 5% (0.05) = 0.4 lbs
- For K_2O: 7 lbs x 10% (0.1) = 0.7 lbs
- Thus, we added phosphorus and potassium that was not recommended, but less that what we would if we used 13-13-13 (1lb-1lb-1lb).

What is Really in the Bag?

- N – ammonium nitrate, NH_4NO_3, 34-0-0
  ammonium sulfate, $(NH_4)_2SO_4$, 21-0-0
  urea, $CO(NH_2)_2$, 46-0-0
- P – diammonium phosphate, 18-46-0
  monoammonium phosphate, 11-48-0
  calcium phosphates, 0-20-0 to 0-45-0
- K – potassium chloride, KCl, 0-0-60

Nutrients with Other Amendments

- Fertilizer with herbicides
- Fertilizer with insecticides

Is There a Problem Adding Too Much Nutrient?

Water Quality and Nutrient Issues

Second Challenge

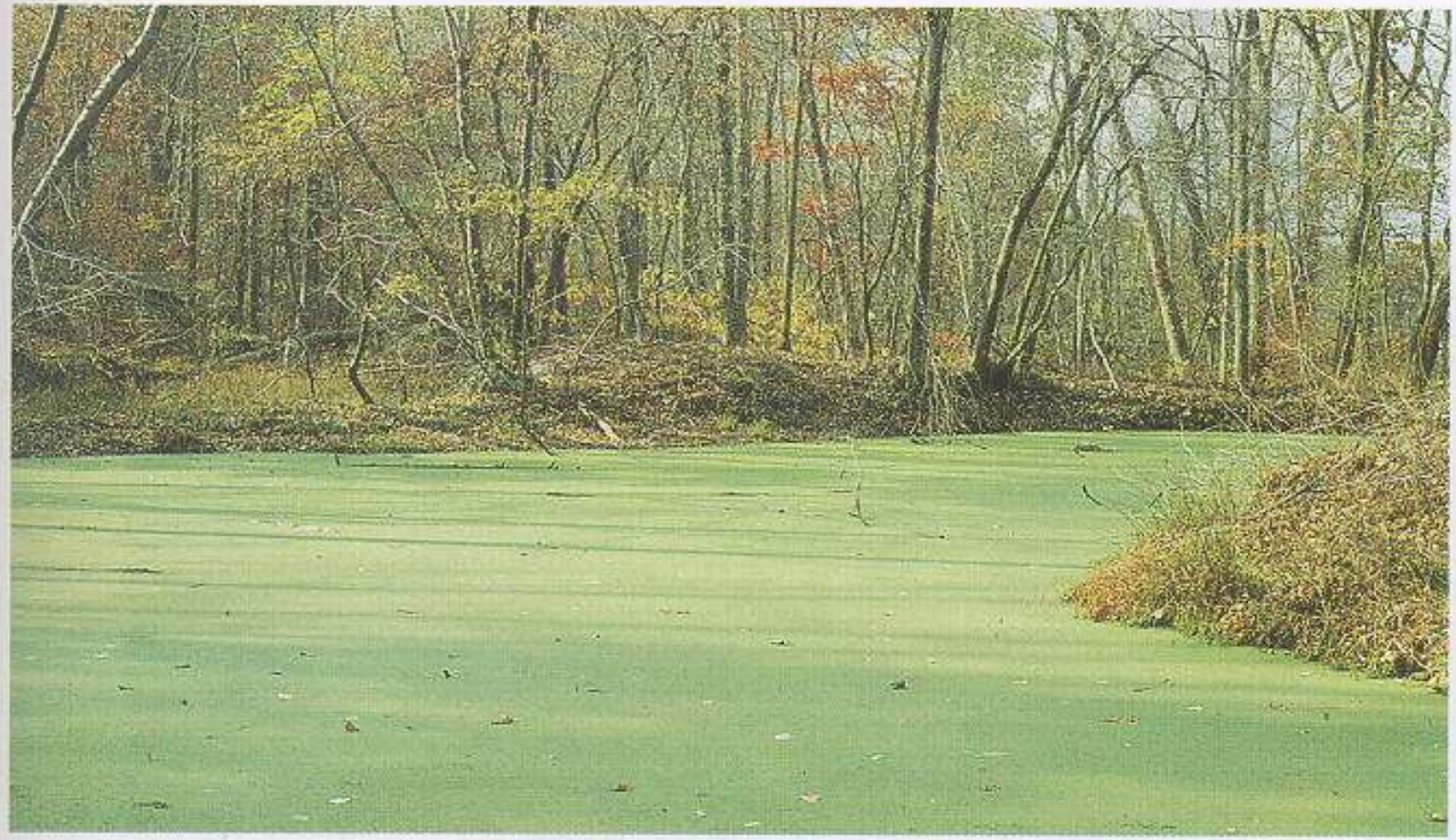
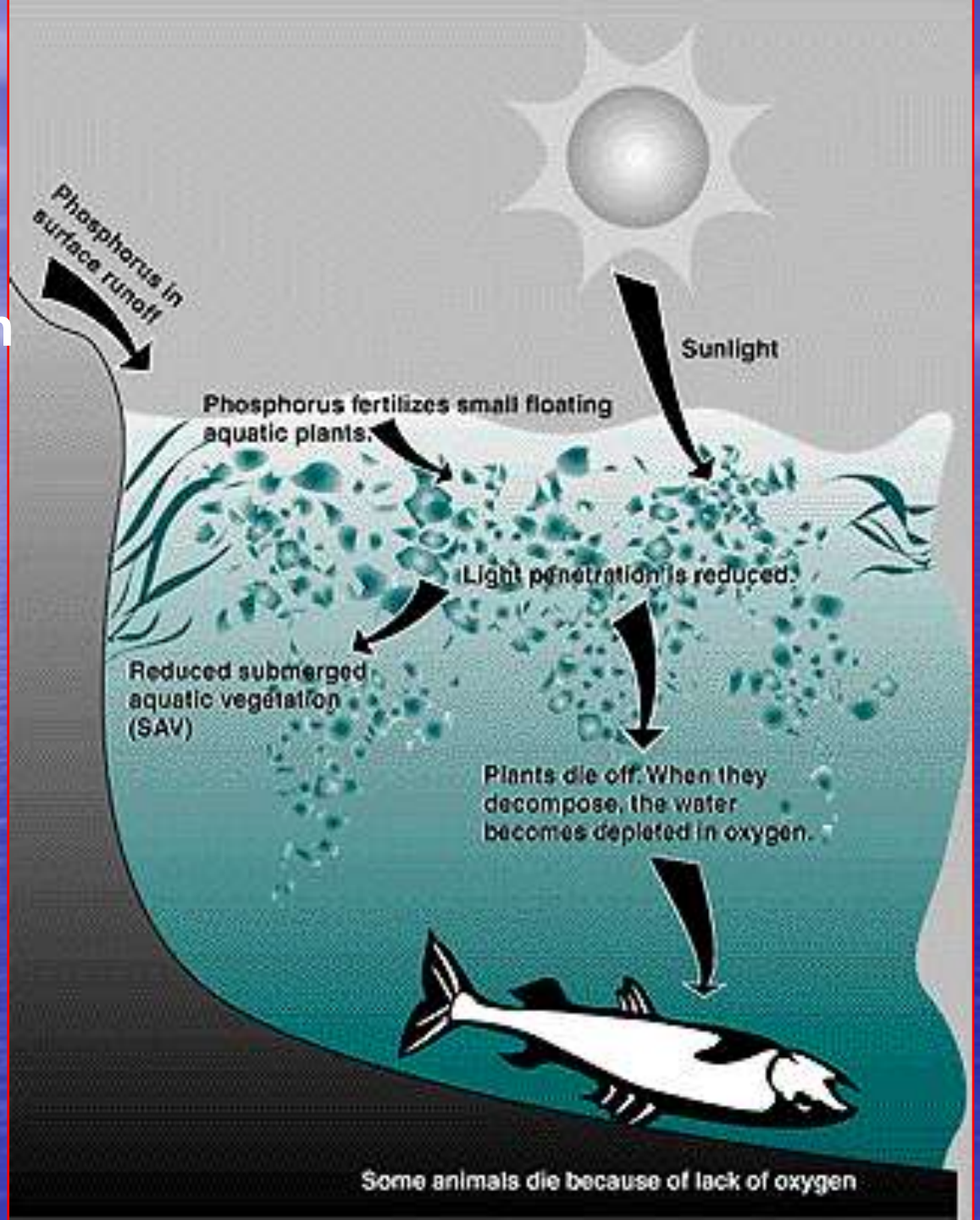


PLATE 27 Excessive inputs of nitrogen and phosphorus from upstream farmland resulted in the algal bloom that caused this slow-moving coastal plain stream to become choked with a green scum.

Eutrophication



- Too much inorganic P can induce Fe and Zn deficiencies

Organic vs inorganic sources of nutrients

- Plants can only take up nutrients in the inorganic form
- Example: organic N forms are amino acids, inorganic N forms are nitrate (NO_3) and ammonium (NH_4)
- Nitrate is water soluble and moves where ever the water goes
- Ammonium adheres to the cation exchange sites or is converted to nitrate by microorganisms

Organic vs inorganic sources of nutrients

- Soil amendments
  - Not regulated in Texas
  - List of organic sources from Master Gardener Handbook page 2-16
  - If it has nutrient analyses on label, can make recommendations

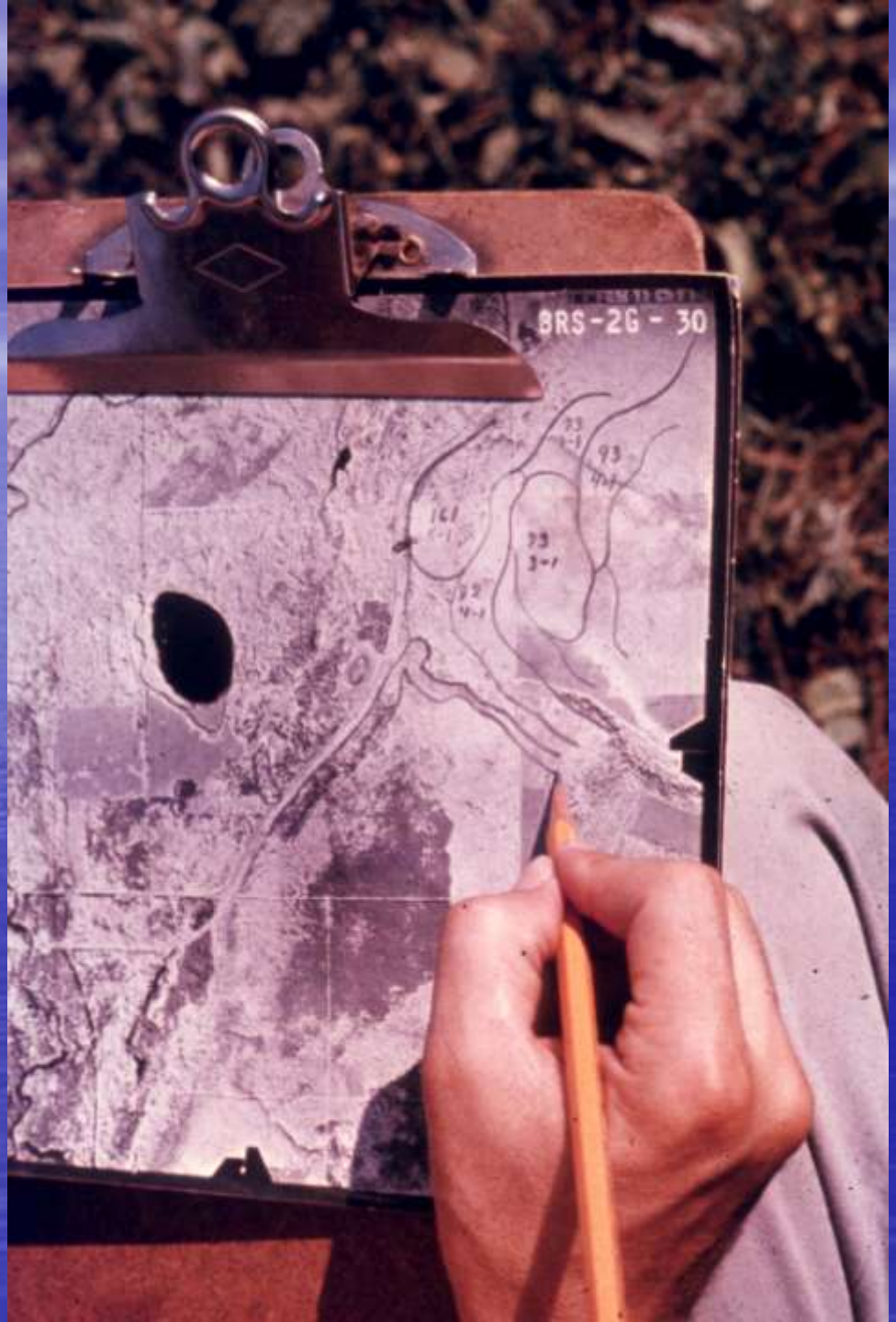
County Soil Survey Report

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

In cooperation with
Texas Agricultural
Experiment Station

Soil Survey of Grimes County, Texas


BRS-2G - 30


Na
KrD
Ha
ToD
BuC
BuE
EmC
KrD
BxE
BuE
ShC
BuE
SnC
Sulphur
BuE
BuC
EmC
ShC
ToD
Ha
FaC
BuE
BuC
w
w
w
BuC
w
BuC
KrD
LxB
BuC
BxE
FaC
FaC2
FaC
BuE
w
EmC
BxE
ShC
SnC
EmC
Gp
Gp
BuC
RoC
Piedmont
BuE
SnC
BuC
FaC2
PaD
w
w
(Joins sheet 24)
5000

Navasan Series

The Navasan series consists of very deep, moderately well drained, sandy soils on low stream terraces. These soils formed in sandy sediments. Slopes range from 1 to 5 percent.

Typical pedon of Navasan loamy sand, 1 to 5 percent slopes; from the intersection of Texas Highway 39 and Farm Road 1696 north of Iola, 0.4 mile north on Texas Highway 39, about 4.5 miles west on Democrat Road, and 500 feet north of the road in a pasture:

Ap—0 to 6 inches; light brown (7.5YR 6/4) loamy sand, pink (7.5YR 7/4) dry; structureless; single grained; loose, nonsticky, nonplastic; many fine roots; slightly acid; clear smooth boundary.

E1—6 to 30 inches; pink (7.5YR 8/4) loamy sand, pink (7.5YR 8/4) dry; structureless; single grained; loose, nonsticky, nonplastic; common fine roots; slightly acid; gradual wavy boundary.

E2—30 to 65 inches; pink (7.5YR 8/4) loamy sand, pink (7.5 YR 8/4) dry; single grained; loose, nonsticky, nonplastic; slightly acid; few fine roots; gradual wavy boundary.

B/E—65 to 75 inches; reddish yellow (7.5YR 6/6) sandy clay loam, reddish yellow (7.5YR 7/6) dry; moderate medium subangular blocky structure; about 40 percent, by volume, pink loamy sand in pockets and tongues; structureless; single grained; loose, nonsticky, nonplastic; few fine roots; slightly acid; clear wavy boundary.

Bt—75 to 85 inches; light brown (7.5YR 6/4) sandy clay loam; common medium distinct red (2.5YR 5/6) and light yellowish brown (10YR 6/4) mottles; moderate medium subangular blocky structure; hard, firm, nonsticky, nonplastic; few fine roots; few patchy clay films on faces of peds; moderately acid; clear smooth boundary.

Other Soil Amendments

Raised Flowerbeds/Gardens

- Use a mixture of topsoil and compost
- Compensate for the nutrients in the compost and topsoil and reduce the amount of nutrients added through other organic sources or inorganic sources
- Evaluate your topsoil before purchasing

He makes grass grow for cattle, and plants for man to cultivate bringing forth food from the earth…Psalm 104:14

- Remember that it is God who pushes tiny shoots of wheat up through the soil, and provides pasture for the livestock to graze. Our own efforts are powerless without the impulse of our creator's hand.
- Pam Painter, Poseyville, IN
- The Fellowship of Christian Farmers International


Designated Driver
Texas Style