GEO-A-CC-4-10-TH – SOIL AND BIOGEOGRAPHY

SOIL TEXTURE

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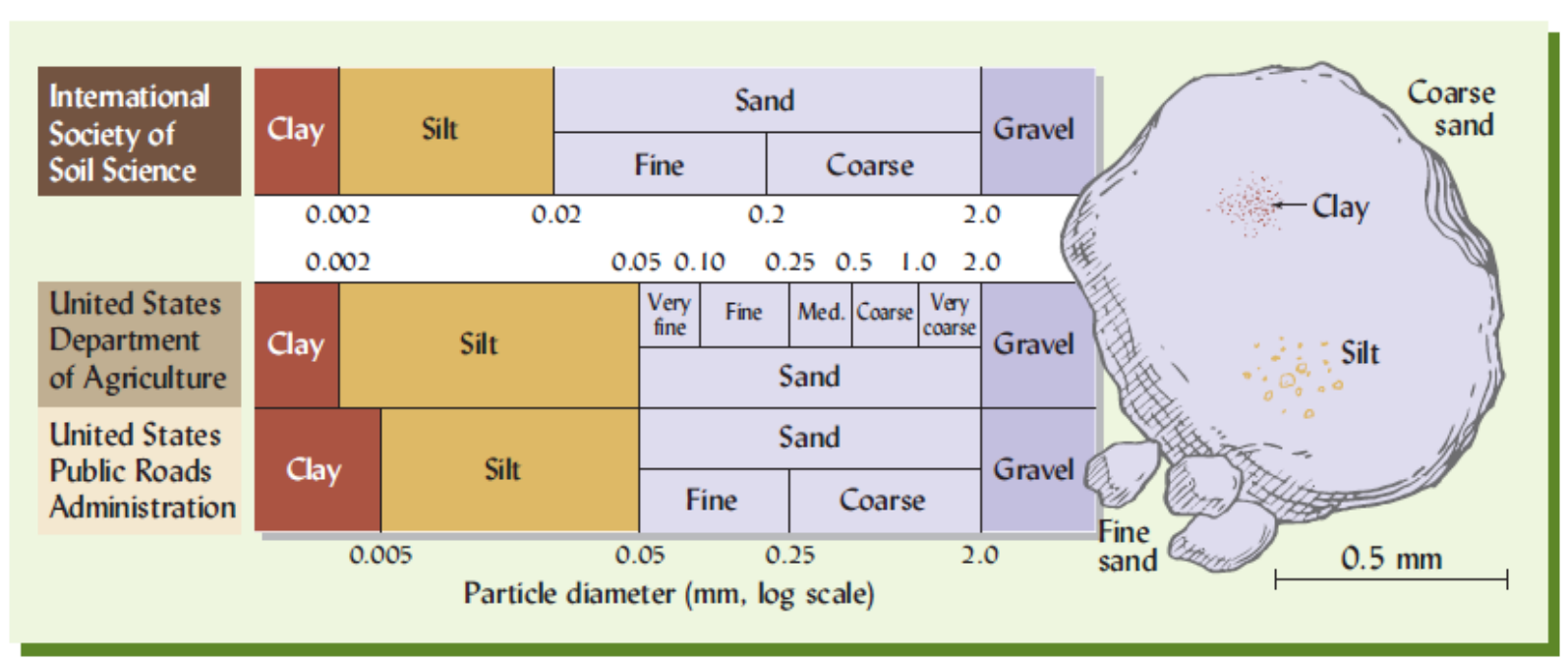
DEFINITION

- Soil texture is the relative proportions of sand, silt, and clay in a soil.
- The soil's coarseness or fineness
- Wide range in size of particles from stones, to gravel, to sand, to silt, and to very small clay particles

SOIL SEPARATES

- Diameters of individual soil particles range over six orders of magnitude, from boulders (1 m) to sub microscopic clays (<10−6 m). Scientists group these particles into soil **separates**
- Gravels, cobbles, boulders, and other coarse fragments greater than 2 mm in diameter may affect the behaviour of a soil, but they are not considered to be part of the **fine earth fraction** to which the term *soil texture* properly applies.



SOIL SEPARATES

Separate	Diameter, mm[a]	Diameter, mm[b]	Number of Particles per Gram	Surface Area in 1 Gram, cm^2
Very coarse sand	2.00-1.00		90	11
Coarse sand	1.00-0.50	2.00-0.20	720	23
Medium sand	0.50-0.25		5,700	45
Fine sand	0.25-0.10	0.20-0.02	46,000	91
Very fine sand	0.10-0.05		722,000	227
Silt	0.05-0.002	0.02-0.002	5,776,000	454
Clay	Below 0.002	Below 0.002	90,260,853,000	8,000,000

[a] United States Department of Agriculture System.

SAND

- Particles smaller than 2 mm but larger than 0.05 mm are termed *sand*. Sand feels gritty between the fingers.
- Generally visible to the naked eye
- Rounded or angular depending on the degree of weathering and abrasion undergone.
- Coarse sand particles may be rock fragments containing several minerals, but most sand grains consist of a single mineral, usually quartz (SiO_2) or other primary silicate minerals.
- Plant nutrients: Few, the large particle size means that whatever nutrients are present will not likely be released for plant uptake. well aerated and loose, but also infertile and prone to drought
- Pores between them are relatively large, cannot hold water against the pull of gravity
- Possess little capacity to hold water or nutrients and do not stick together into a coherent mass
- Well aerated and loose, but also infertile and prone to drought

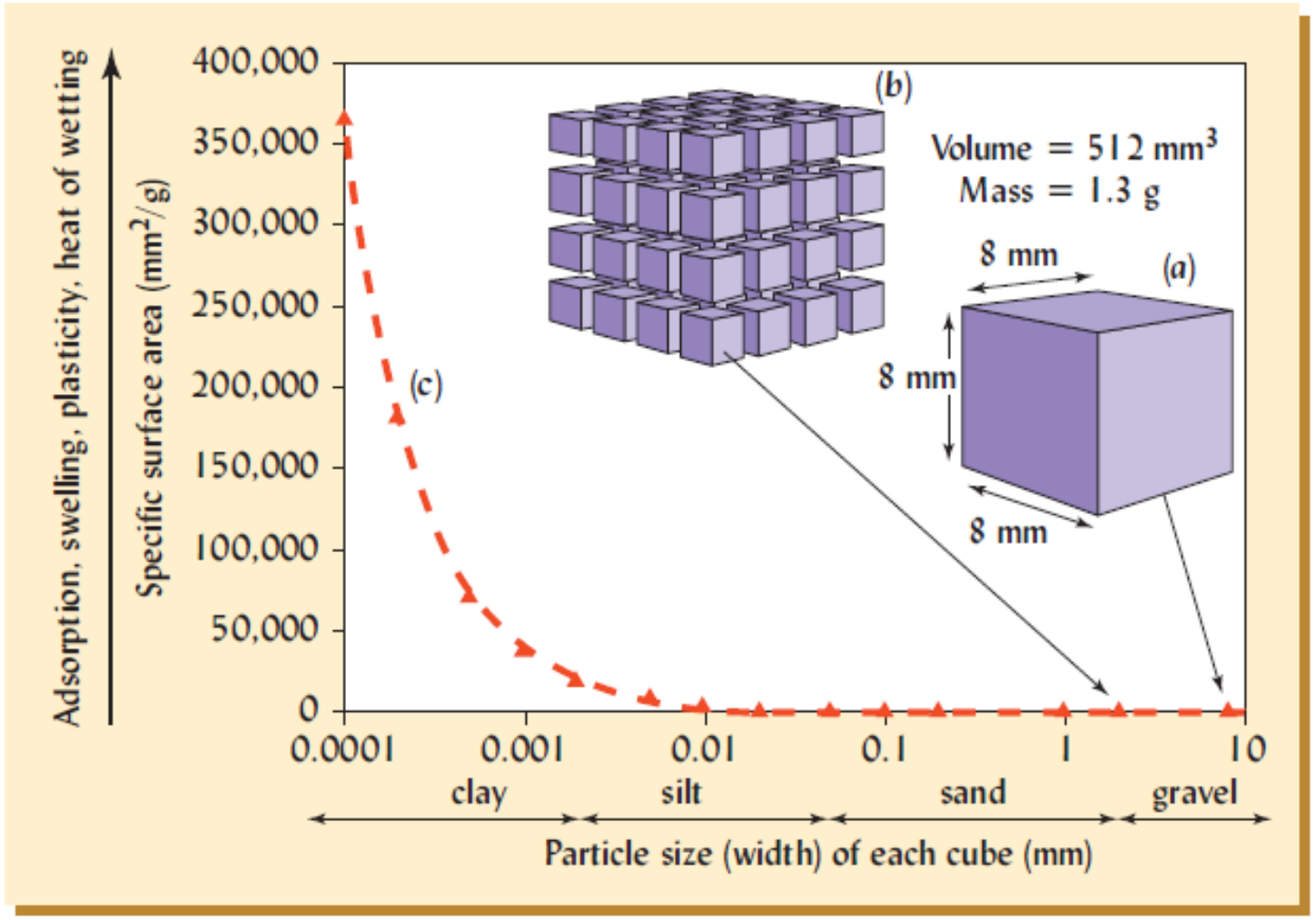
SILT

- Particles smaller than 0.05 mm but larger than 0.002 mm in diameter are classified as *silt*.
- Similar to sand in shape and mineral composition, individual silt particles are so small as to be invisible to the unaided eye
- Feeling gritty when rubbed between the fingers, silt feels smooth or silky, like flour.
- Relatively small size (and large surface area) of the particles allows weathering rapid enough to release significant amounts of plant nutrients.
- The pores are much smaller (and much more numerous) than those in sand, so silt retains less drain through.
- Does not exhibit much **stickiness** or **plasticity** (malleability).
- Easily washed away by flowing water in a process called **piping**

CLAY

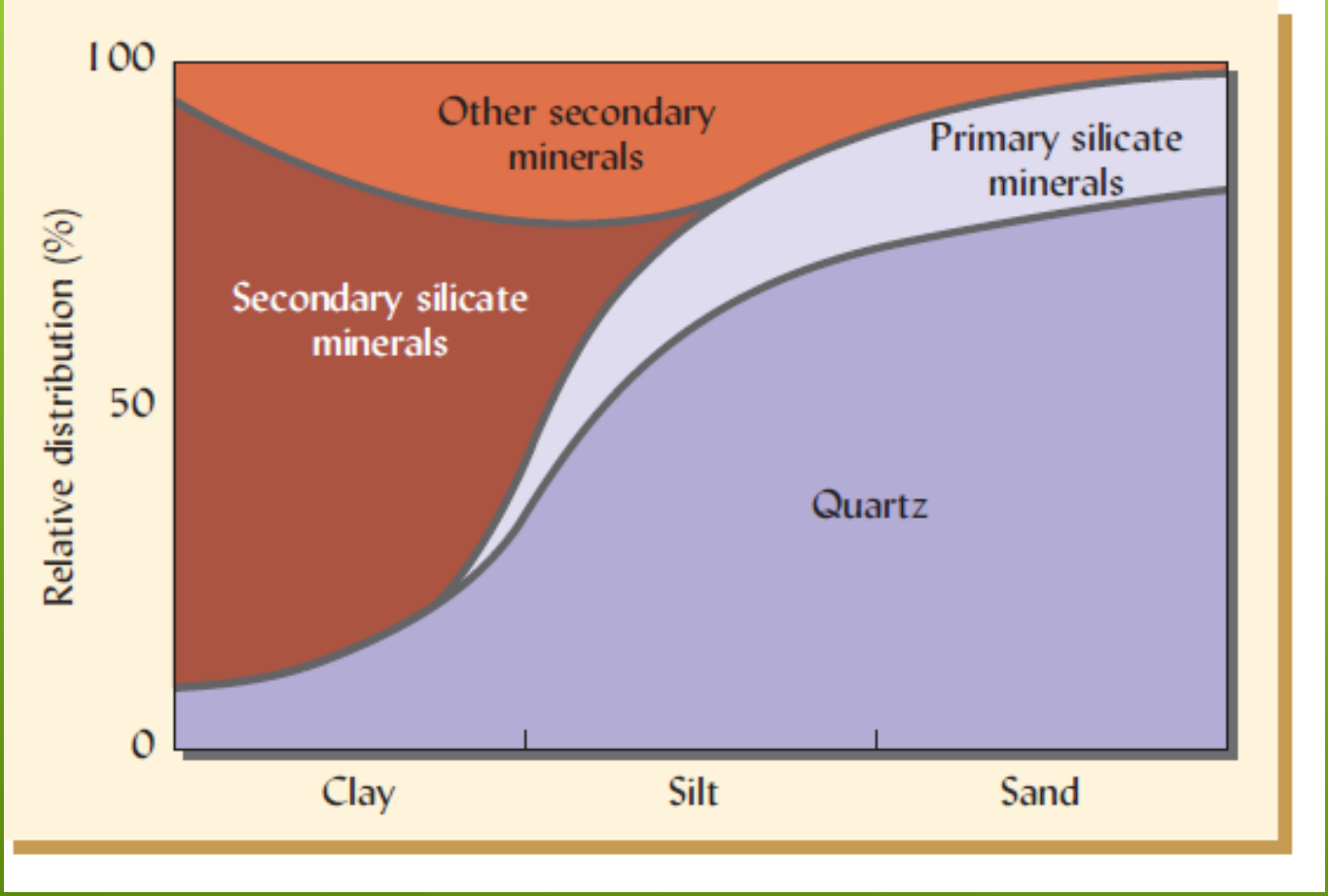
- Clay particles are smaller than 0.002 mm
- Very large specific surface areas
- Tremendous capacity to adsorb water and other substances
- A spoonful of clay may have a surface area the size of a football field
- Large adsorptive surface causes clay particles to cohere in a hard mass after drying
- When wet, clay exhibits high plasticity
- Behave as **colloids**—if suspended in water they do not readily settle out
- Clay particles tend to be shaped like tiny flakes or flat platelets
- Movement of both water and air is very slow
- Soil properties such as shrink–swell behaviour, plasticity, water-holding capacity, soil strength, and chemical adsorption depend on the *kind* of clay present as well as the *amount*

SOIL SEPARATES



The curve (c) *explains why nearly all of the adsorbing power, swelling, plasticity, heat of wetting, and other surface area–related properties are associated with the clay fraction in mineral soils.*

SOIL SEPARATES



General relationship between particle size and kinds of minerals present.

- *Quartz dominates the sand and coarse silt fractions. Primary silicates such as the feldspars, hornblende, and micas are present in the sands and, in decreasing amounts, in the silt fraction.*

- *Secondary silicates dominate the fine clay. Other secondary minerals, such as the oxides of iron and aluminum, are prominent in the fine silt and coarse clay fractions.*

INFLUENCE OF SURFACE AREA ON OTHER SOIL PROPERTIES

- When particle size decreases, specific surface area and related properties increase greatly
- Fine colloidal clay has about 10,000 times as much surface area as the same weight of medium-sized sand

1. capacity for holding water
2. capacity to retain nutrients
3. release of plant nutrients
4. particles to stick together
5. microbial reactions

EXPLAINED

1.Water is also retained in soils as thin films on the surfaces of soil particles. The greater the surface area, the greater the soil's capacity for holding water films.

2. Both gases and dissolved chemicals are attracted to and adsorbed by mineral particle surfaces. The greater the surface area, the greater the soil's capacity to retain nutrients and other chemicals.

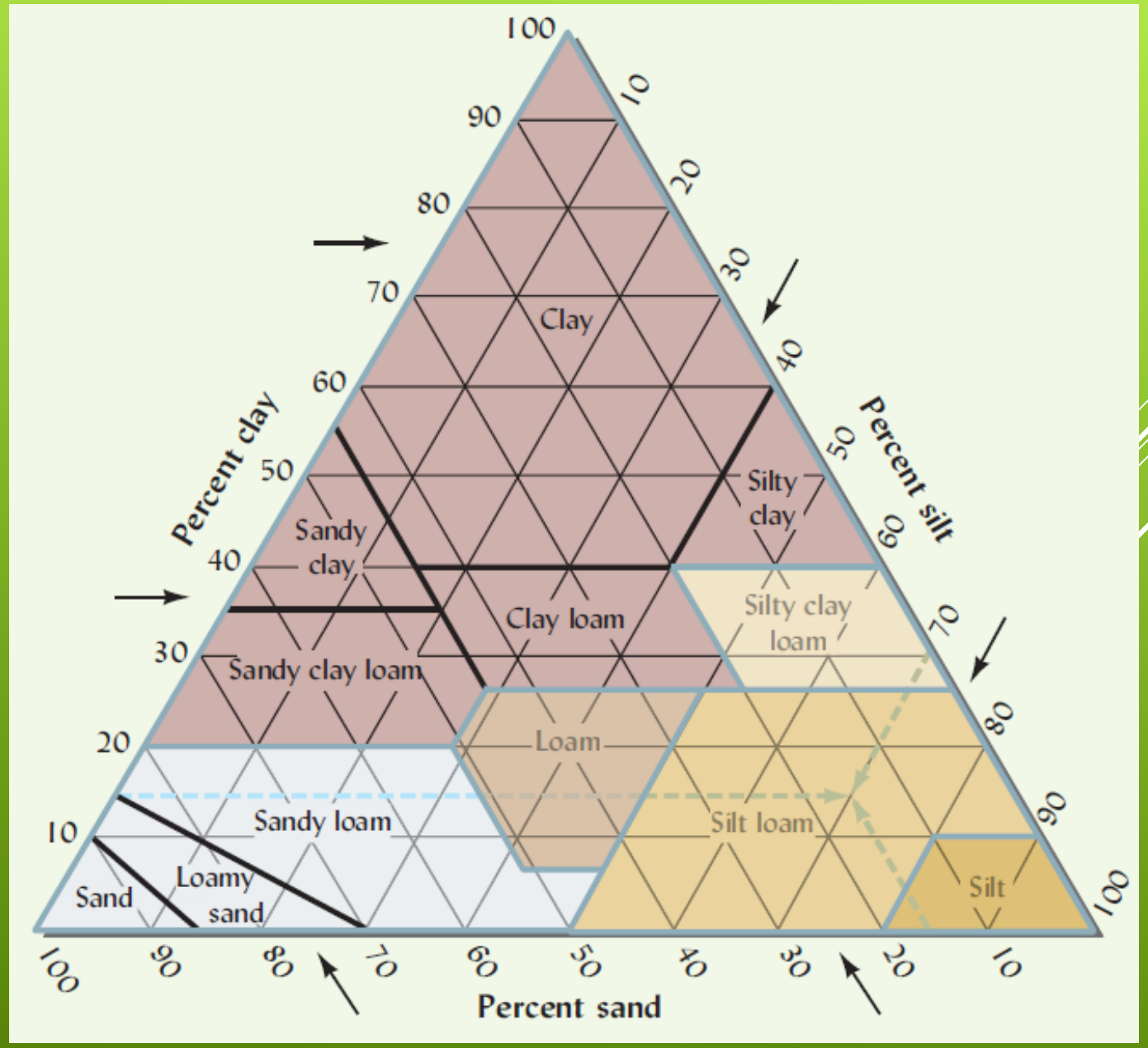
3. Weathering takes place at the surface of mineral particles, releasing constituent elements into the soil solution. The greater the surface area, the greater the rate of release of plant nutrients from weatherable minerals.

4. The surfaces of mineral particles often carry both negative and some positive electromagnetic charges so that particle surfaces and the water films between them tend to attract each other. The greater the surface area, the greater the propensity for soil particles to stick together in a coherent mass, or as discrete aggregates.

5. Microorganisms tend to grow on and colonize particle surfaces. For this and other reasons, microbial reactions in soils are greatly affected by the specific surface area.

SOIL TEXTURAL CLASSES

- Within the three broad groups of *sandy soils*, *clayey soils*, and *loamy soils*, specific **textural class** names convey a more precise idea of the size distribution of particles and the general nature of soil physical properties. The relationship between textural class names and proportions of sand, silt, and clay is commonly shown diagrammatically as a triangular graph'



SOIL TEXTURAL CLASSES

General Terms Used to Describe Soil Texture in Relation to the Basic Soil Textural Class Names in the U.S. Department of Agriculture Classification System

Basic soil textural class names													
Sands	Loamy sands	Sandy loam	Fine sandy loam[a]	Very fine sandy loam[a]	Loam	Silt loam	Silt	Sandy clay loam	Silty clay loam	Clay loam	Sandy clay	Silty clay	Clay
General texture terms													
----- Coarse -----		-- Moderately -- coarse		---------- Medium ----------				--- Moderately fine ---			---------- Fine ----------		
Sandy soils		---------- Loamy soils ----------									----- Clayey soils -----		

[a]Although not included as class names in Figure 4.13, these soils are usually treated separately because of their fine sand content.

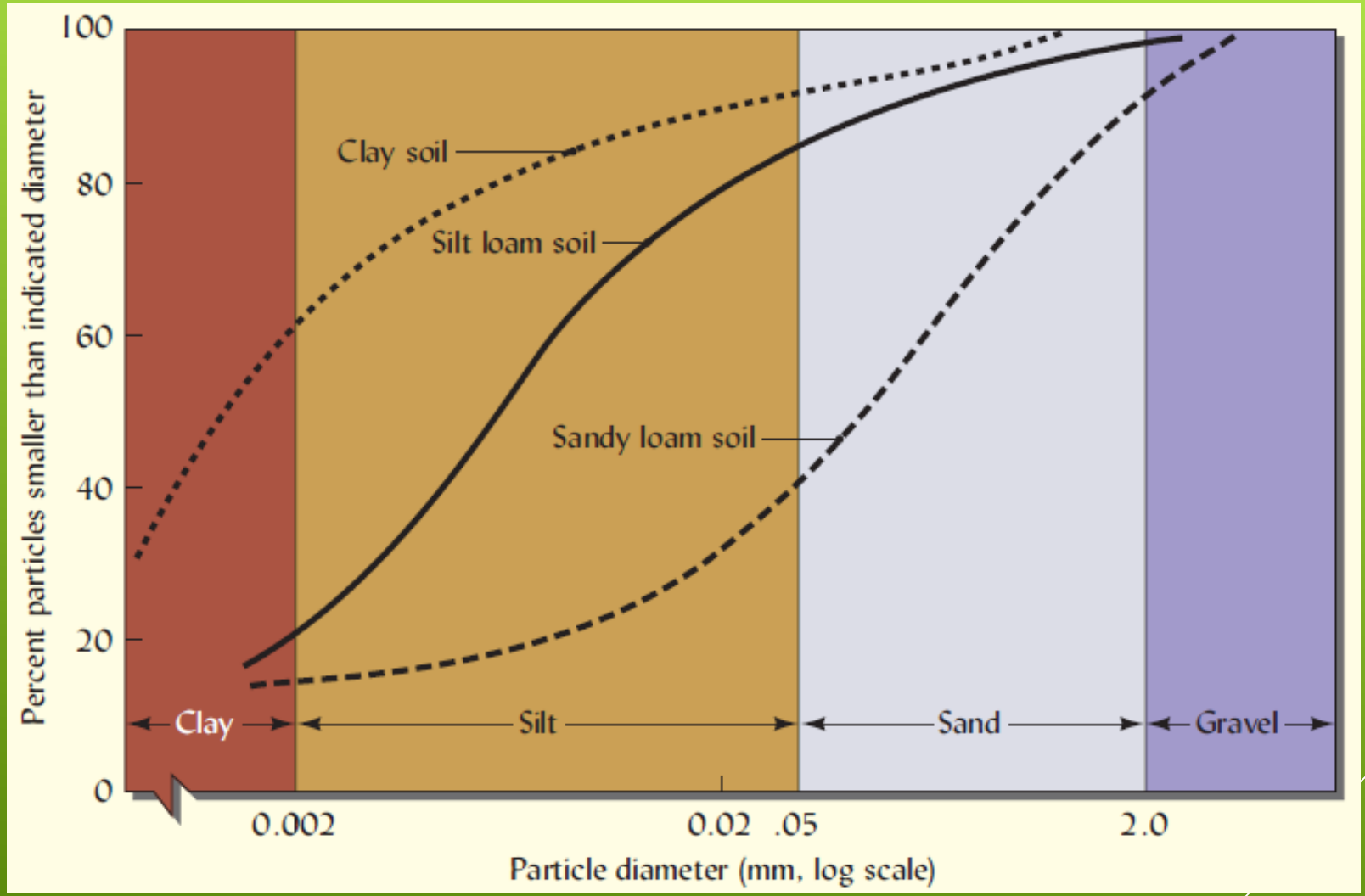
- The 14 textural classes named in form a graduated sequence from the sands, which are coarse in texture to the clays, which are fine.
- Sands and loamy sands are dominated by the properties of sand, for the sand separate comprises at least 70% of the material by weight and less than 15% of the material is clay
- Clays, sandy clays, and silty clays are dominated by characteristics of clay
- Silts are dominated by the properties of silt. However, most soils are some type of **loam**.

SOIL TEXTURAL CLASSES

TABLE 9.3 *PRINCIPAL TEXTURAL GROUPS*

Textural group	Sand	Silt	Clay
	per cent		
1. Sand	85-100	0-15	0-10
2. Loamy sand	70-90	0-30	0-15
3. Sandy loam	45-85	0-50	0-20
4. Sandy clay loam	45-80	0-28	20-35
5. Sandy clay	45-65	0-20	35-55
6. Clay	0-47	0-40	40-100
7. Silt clay	0-20	40-60	40-60
8. Clay loam	20-45	15-53	27-40
9. Silty clay loam	0-20	40-73	27-40
10. Loam	23-52	28-50	7-27
11. Silt loam	0-50	50-87	0-27
12. Silt	0-20	80-100	0-13

SOIL SEPARATES



Particle-size distribution in three soils varying widely in their textures. Note that there is a gradual transition in the particle-size distribution in each of these soils.

LOAM

- A **loam** is a mixture of sand, silt, and clay particles that exhibits the *properties* of those separates in about equal proportions
- does not mean that the three separates are present in equal *amounts*
- Relatively small percentage of clay is required to engender clayey properties in a soil
- Small amounts of sand and silt have a lesser influence on how a soil behaves
- A loam in which sand is dominant is classified as a *sandy loam*
- In the same way, some soils are classed as *silt loams*, *silty clay loams*, *sandy clay loams*, and *clay loams*
- A *clay loam* may have as little as 26% clay, but to qualify as *sandy loam* or *silt loam*, a soil must have at least 45% sand or 50% silt, respectively.

COARSE FRAGMENT MODIFIERS.

- If a soil contains a significant proportion of particles larger than sand (termed **coarse fragments**)
- Coarse fragments that range from 2 to 75 mm along their greatest diameter are termed *gravel* or *pebbles*
- those ranging from 75 to 250 mm are called **cobbles** (if round) or ***channers* (if flat)**
- those more than 250 mm across are called ***stones* or *boulders***
- A *gravelly, fine sandy loam* is an example of such a modified textural class.

TEXTURAL CLASS BY THE "FEEL" METHOD

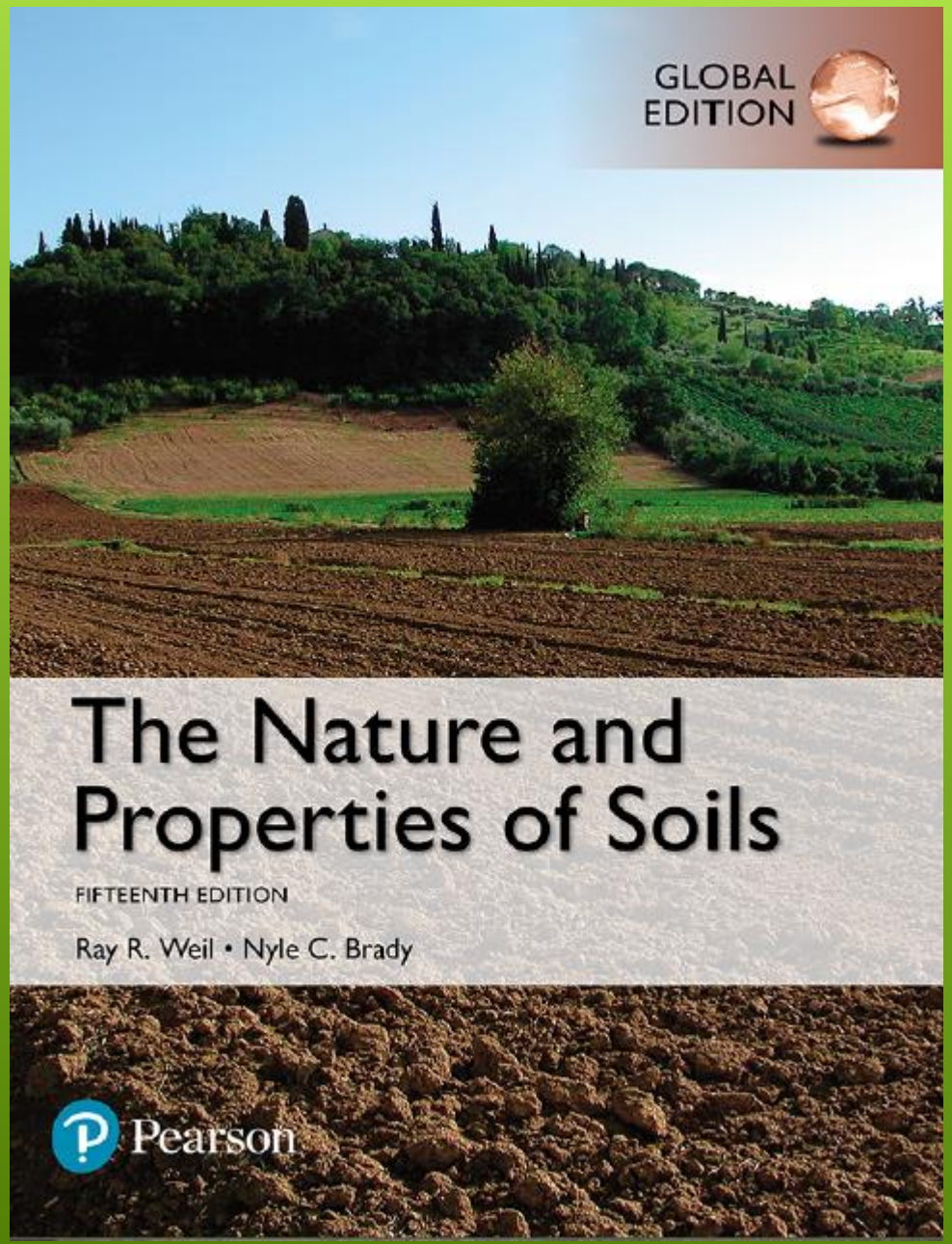
- A small quantity of soil is moistened with water and kneaded to the consistency of putty to determine how well the soil forms casts or ribbons (plasticity). The kind of cast or ribbon formed is related to the clay content and is used to categorize soils as loams, clay loams, and clays.
- If a soil is a loam, and feels very gritty or sandy, it is a sandy loam.
- Smooth-feeling loams are high in silt content and are called silt loams. If the sample is intermediate, it is called a loam. The same applies to the clay loams and clays.
- Sands are loose and incoherent and do not form ribbons.

Determination of texture by the field method. Loam soil on left forms a good cast when moist. Clay loam in center forms a ribbon that breaks somewhat easily. Clay on the right forms a long fexible ribbon.

TEXTURE AND THE USE OF SOILS

TABLE 9.1 *RECOMMENDED CROPS ACCORDING TO SOIL TEXTURE*

General soil textural groups	Basic soil textural classes	Recommended crops
Fine textured soils	Clay,silty-clay sandy-clay, clay-loam, Sandy clay, loam	rice,wheat, sorghum, gram, tobacco, arhar, cotton, sugar-beet, linseed, ragi, black gram, banana.
Medium text-ured soils	Loam, silt loam, silt	wheat, sorghum, barely, maize, cotton, soybean, lucern, sugarcane, potato, millets, safflower, peas lentil, arhar, green gram, black gram, cowpea, jute, sunhemp, oat, berseem, citrus, grape, guava, pomegranate, sapota, papaya etc.
Coarse text-ured soil	Sandy loam, Loamy sand, sand	maize, bajra, groundnut, sesamum, sugarbeet, potato, grape , pomegranate, coconut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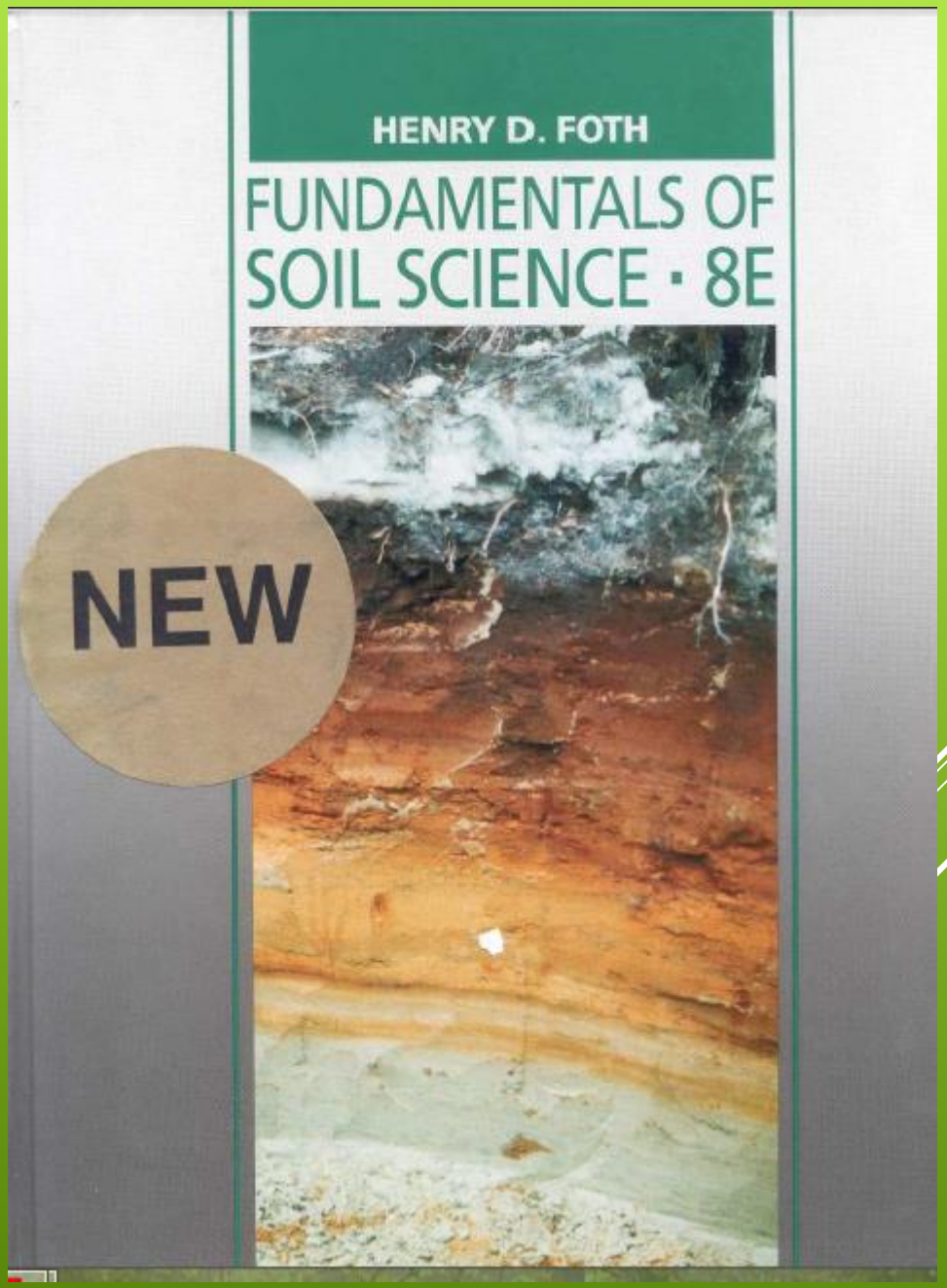
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