

**A GUIDE FOR PREPARING
SOIL PROFILE DESCRIPTIONS**

Soils Properties and Processes

2003

NRE 430/EEB 489

Master Horizons and Layers

The capital letters O, A, E, B, C, and R represent the master horizons and layers of soils. The capital letters are the base symbols to which other characters are added to complete the designation.

<u>Old</u>	<u>New</u>	
O	O	<u>O horizons or layers</u> : Layers dominated by organic material, except limnic layers ¹ that are organic.
O1	Oi, Oe	
O2	Oa, Oe	
A	A	<u>A horizons</u> : Mineral horizons that formed at the surface or below an O horizon and (1) are characterized by an accumulation of humified organic matter intimately mixed with the mineral fraction and not dominated by properties characteristic of E or B horizons (defined below) or (2) have properties resulting from cultivation, pasturing, or similar kinds of disturbance.
A1	A	
A2	E	
A3	AB or EB	
AB	AB or EB	
A&B	E/B	
AC	AC	
A2	E	<u>E horizons</u> : Mineral horizons in which the main feature is loss of silicate clay, iron aluminum, or some combination of these, leaving a concentration of sand and silt particles of quartz or other resistant minerals.
B	B	<u>B horizons</u> : Horizons that formed below an A, E, or O horizon and are dominated by obliteration of all or much of the original rock structure ² and by (1) illuvial concentration of silicate clay, iron, aluminum, humus, carbonates, gypsum, or silica, alone or in combination; (2) evidence of removal of carbonates; (3) residual concentration of sesquioxides; (4) coatings of sesquioxides that make the horizon conspicuously lower in value, higher in chroma, or redder in hue than overlying and underlying horizons without apparent illuviation of iron; (5) alteration that forms silicate clay or liberates oxides or both and that forms granular, blocky, or prismatic structure if volume changes accompany changes in moisture content; or (6) any combination of these.

¹Coprogenous earth, diatomaceous earth, marl.

²Rock structure includes fine stratification in unconsolidated or weakly consolidated sediment or pseudomorphs of weathered minerals retaining their positions relative to each other and to unweathered minerals in saprolite from consolidated rocks.

<u>Old</u>	<u>New</u>	
B1	BA or BE	
B&A	B/E	
B2	B or BW	
B3	BC or CB	
C	C	<u>C horizons or layers</u> : Horizons or layers, excluding hard bedrock, that are little affected by pedogenic processes and lack properties of O, A, E, or B horizons.
R	R	<u>R Layers</u> : Hard bedrock, granite, basalt, quartzite, and indurated limestone or sandstone are examples of bedrock that are designated R.

Subordinate Distinctions Within Master Horizons and Layers

Lower case letters are used as suffixes to designate specific kinds of master horizons and layers. The symbols and their meanings are as follows:

<u>Old</u>	<u>New</u>	
a	<u>a</u>	High decomposed organic materials
b	<u>b</u>	Buried genetic horizon
cn	<u>c</u>	Concretions or hard nonconcretionary nodules
--	<u>e</u>	Organic material of intermediate decomposition
f	<u>f</u>	Frozen soil
g	<u>g</u>	Strong gleying
h	<u>h</u>	Illuvial accumulation of organic matter
--	<u>i</u>	Slightly decomposed organic material
ca	<u>k</u>	Accumulation of carbonates
m	<u>m</u>	Cementation or induration
sa	<u>n</u>	Accumulation of sodium
--	<u>o</u>	Residual accumulation of sesquioxides
p	<u>p</u>	Plowing or other disturbance
si	<u>q</u>	Accumulation of silica
r	<u>r</u>	Weathered or soft bedrock
ir	<u>s</u>	Illuvial accumulation of sesquioxides and organic matter
t	<u>t</u>	Accumulation of silicate clay
--	<u>v</u>	Plinthite
--	<u>w</u>	Development of color or structural B
x	<u>x</u>	Fragipan character
cs	<u>y</u>	Accumulation of gypsum
sa	<u>z</u>	Accumulation of salts more soluble than gypsum

Horizon Depth and Thickness

Depth and Thickness of Horizons and Layers: A description of a pedon includes the thickness and the depth limits of each layer. Depths are measured from the soil surface.

Horizon Boundary

Boundaries of Horizons and Layers: A boundary is a surface or transitional layer between two adjoining horizons or layers.

Distinctness: Distinctness is defined in terms of thickness of the transition zone.

- a - Abrupt: Less than 2 cm thick
- c - Clear: 2 to 5 cm thick
- g - Gradual: 5 to 15 cm thick
- d - Diffuse: More than 15 cm thick

Topography: Topography of boundaries is described with the following terms.

- s - Smooth: The boundary is a plane with few or no irregularities.
- w - Wavy: The boundary has undulations in which depressions are wider than they are deep.
- i - Irregular: The boundary has pockets that are deeper than they are wide.
- b - Broken: At least one of the horizons or layers separated by the boundary is discontinuous and the boundary is interrupted.

Soil Color

Munsell color standards: The Munsell color system uses three elements of color -- hue, value, and chroma -- to make up a specific color notation. The notation is recorded in the form: hue, value/chroma -- for example, 5Y 6/3.

Soil Texture and Rock Fragments

Soil Texture: Soil texture refers to the physical composition of soil defined in terms of the relative proportions, by weight, of each separate. Definitions of the soil texture classes according to distribution of size classes of mineral particles less than 2 mm in diameter are as follows:

Sands: 85 percent or more sand and the percentage of silt plus 1-1/2 times the percentage of clay is 15 or less.

- cos - Coarse sand: 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.
- s - Sand: 25 percent or more very coarse, coarse, and medium sand (but less than 25 percent very coarse and coarse sand) and less than 50 percent either fine sand or very fine sand.
- f - Fine sand: 50 percent or more fine sand; or less than 25 percent very coarse, coarse, and medium sand and less than 50 percent very fine sand.
- vfs - Very fine sand: 50 percent or more very fine sand.

Loamy sands: At the upper limit 85 to 90 percent sand and the percentage of silt plus 1.5 times the percentage of clay is 15 or more; at the lower limit 70 to 85 percent sand and the percentage of silt plus twice the percentage of clay is 30 or less.

- lcos - Loamy coarse sand: 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.
- ls - Loamy sand: 25 percent or more very coarse, coarse, and medium sand (but less than 25 percent very coarse and coarse sand) and less than 50 percent either fine sand or very fine sand.
- lfs - Loamy fine sand: 50 percent or more fine sand; or less than 50 percent very fine sand and less than 25 percent very coarse, coarse, and medium sand.
- lvfs - Loamy very fine sand: 50 percent or more very fine sand.

Sandy loams: 20 percent or less clay and 52 percent or more sand and the percentage of silt plus twice the percentage of clay exceeds 30; or less than 7 percent clay, less than 50 percent silt, and between 43 and 52 percent sand.

- cosl - Coarse sandy loam: 25 percent or more very coarse and coarse sand and less than 50 percent any other single grade of sand.
- sl - Sandy loam: 30 percent or more very coarse, coarse, and medium sand (but less than 25 percent very coarse and coarse sand) and less than 30 percent either fine sand or very fine sand.
- fsl - Fine sandy loam: 30 percent or more fine sand and less than 30 percent very fine sand; or between 15 and 30 percent very coarse, coarse, and medium sand; or more than 40 percent fine and very fine sand, at least half of which is fine sand, and less than 15 percent very coarse, coarse, and medium sand.
- vfsl - Very fine sandy loam: 30 percent or more very fine sand; or more than 40 percent fine and very fine sand, at least half of which is very fine sand, and less than 15 percent very coarse, coarse, and medium sand.
- l - Loam: 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand.
- sil - Silt loam: 50 percent or more silt and 12 to 27 percent clay; or 50 to 80 percent silt and less than 12 percent clay.
- si - Silt: 80 percent or more silt and less than 12 percent clay.
- scl - Sandy clay loam: 20 to 35 percent clay, less than 28 percent silt, and 45 percent or more sand.
- cl - Clay loam: 27 to 40 percent clay and 20 to 45 percent sand.
- sicl - Silty clay loam: 27 to 40 percent clay and less than 20 percent sand.
- sc - Sandy clay: 35 percent or more clay and 45 percent or more sand.
- sic - Silty clay: 40 percent or more clay and 40 percent or more silt.
- c - Clay: 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

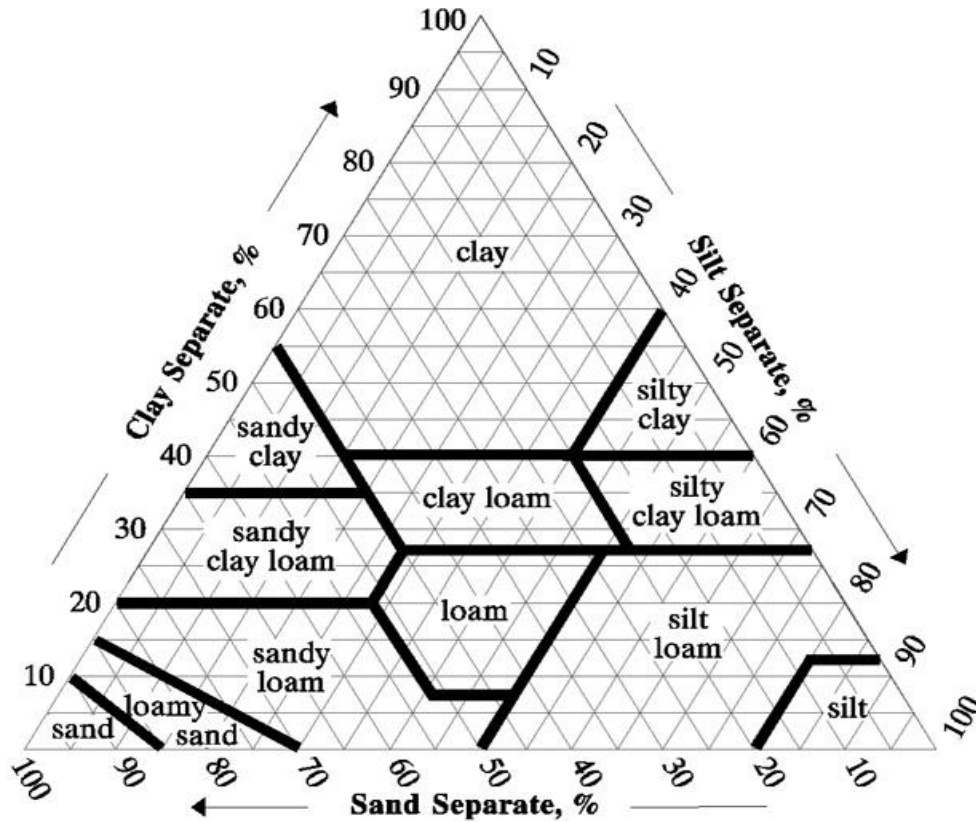


Figure 1. Textural triangle adapted from Soil Survey Staff, 1962, 1975.

st	- stones and stony	sl	- sandy loam
cob	- cobbles and cobbly	fsl	- fine sandy loam
g	- gravel and gravelly	vfs	- very fine sandy loam
vcos	- very coarse sand	l	- loam
cos	- coarse sand	si	- silt
s	- sand	sil	- silt loam
fs	- fine sand	scl	- sandy clay loam
vfs	- very fine sand	cl	- clay loam
lcos	- loamy coarse sand	sicl	- silty clay loam
ls	- loamy sand	sc	- sandy clay
lfs	- loamy fine sand	sic	- silty clay
cosl	- coarse sandy loam	c	- clay

Organic Soils: The terms peat, muck, and mucky peat are used for organic materials in a manner similar to the way in which mineral textural terms are used.

Rock Fragments Terminology: Rock fragments are unattached pieces of rock 2 mm in diameter or larger. Rock fragments are described in terms that characterize their size and shape and, for some, the kind of rock. There are several classes: pebbles, cobbles, channers, flagstones, stones, and boulders.

Rock fragments in the soil: The volume of rock fragments is estimated in the field. The following classes are used:

- - Less than 15 percent by volume: No special term is used; or "nongravelly" and "nonstony" are used in writing for contrast with soils having less than 15 percent pebbles, cobbles, stones, or boulders.
- g - 15 to 35 percent by volume: The adjective term of the dominant kind of rock fragment is used as modifier of the textural term: "gravelly loam," "stony loam," "bouldery loam."
- vg - 35 to 60 percent by volume: The adjective term of the dominant kind of rock fragment is used with the word "very" as a modifier of the textural term: "very gravelly loam," "very bouldery loam."
- eg - More than 60 percent by volume: If enough fine earth is present to determine the texture class (approximately 5 percent or more by volume) the adjective term of the dominant kind of rock fragment is used with the word "extremely" as a modifier of the textural term: "extremely gravelly loam," "extremely bouldery loam." If there is too little fine earth to determine the texture class (less than about 5 percent by volume) the terms "gravel," "cobbles," "stones," and "boulders" are used in the place of fine earth texture.

Soil Structure

Soil structure refers to the natural organization of soil particles into units. Layers that lack structure are structureless.

Shape: The following terms describe the basic shapes and related arrangement of peds:

- pl - Platy: The peds are flat and platelike.
- pr - Prismatic: The individual peds are bounded by flat or slightly rounded vertical faces.
- cpr - Columnar: The peds are similar to prisms and are bounded by flat or slightly rounded vertical faces. However, the tops of columns, in contrast to those of prisms, are very distinct and normally rounded.
- sbk - Subangular Blocky: The structure is described as if the faces are a mixture of rounded and plane faces and the angles are mostly rounded.
- abk - Angular Blocky: The structure is described as angular blocky if the faces intersect at relatively sharp angles.
- gr - Granular: The peds are approximately spherical or polyhedral and are bounded by curved or very irregular faces that are not casts of adjoining peds.

Size: Five classes describe the size of peds: very fine, fine, medium, coarse, very coarse. Visual determination of size classes are quickly made by referring to size patterns in Figure 2.

Grade: Grade describes the distinctness of peds and the relationship of cohesion within peds and adhesion between peds. Three classes are used plus nonstructural grades.

- 1 - Weak: The peds are barely observable in place. When gently disturbed, the soil material parts into a mixture of entire and broken peds and much material that exhibits no ped faces.
- 2 - Moderate: The peds are well formed and evident in undisturbed soil. When disturbed, the soil material parts into a mixture of many entire peds, some broken peds, and little material that is not in peds.

- 3 - Strong: The peds are distinct in undisturbed soil. They separate cleanly when the soil is disturbed.
- 4 - Massive: no aggregation.
- 5 - Single Grain: No aggregation in sands.

Consistence

Soil consistence describes the cohesion among soil particles and the adhesion of soil to other substances.

Strength: Soil strength is the degree of resistance to breaking or crushing when force is applied.

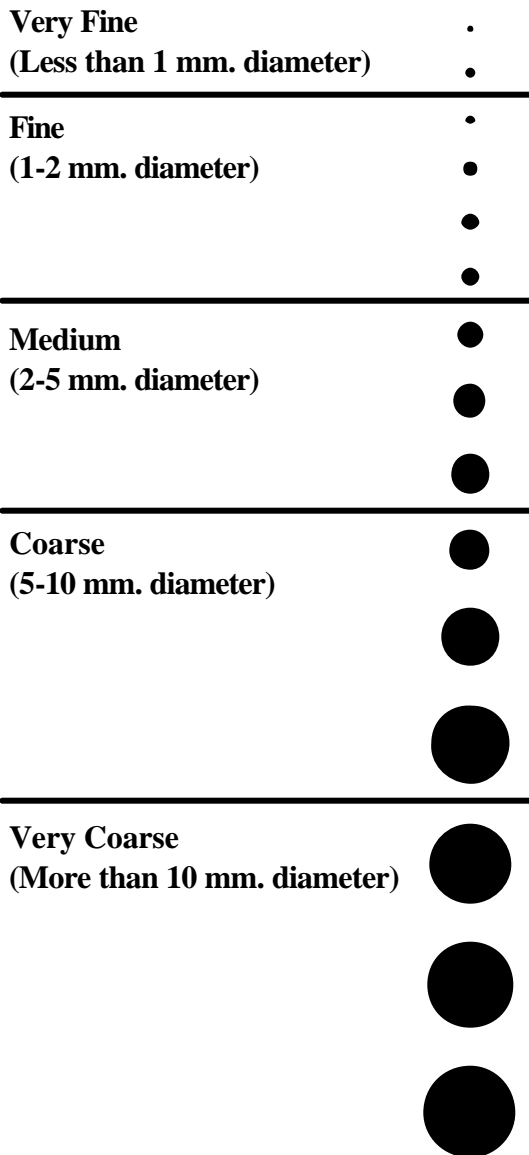
Dry Consistence:

- lo - Loose, coherent: structureless.
- so - Weakly coherent: easily crushes to powder or single grain.
- sh - Slightly hard: easily broken between thumb and forefinger.
- h - Hard: can be broken in the hands without difficulty but difficult to break between thumb and forefinger.
- vh - Very hard: can be broken in hands with difficulty.
- eh - Extremely hard: cannot be broken in hands.

Moist Consistence:

- lo - Loose, noncoherent: structureless.
- vfr - Very friable: crushes under gentle pressure.
- fr - Friable: crushes easily under gentle to moderate pressure between thumb and forefinger.
- fi - Firm: crushes under moderate pressure between thumb and forefinger but resistance is distinctly noticeable.
- vfi - Very firm: crushes under strong pressure, barely crushable between thumb and forefinger.
- efi - Extremely firm: crushes under very strong pressure, cannot be crushed between thumb and forefinger.
- br* - (when describing fragipans) Very firm and brittle: (when moist) brittle in 60 percent or more of the matrix to qualify for fragipan.

Granular and Crumb



Angular and Subangular Blocky Structures

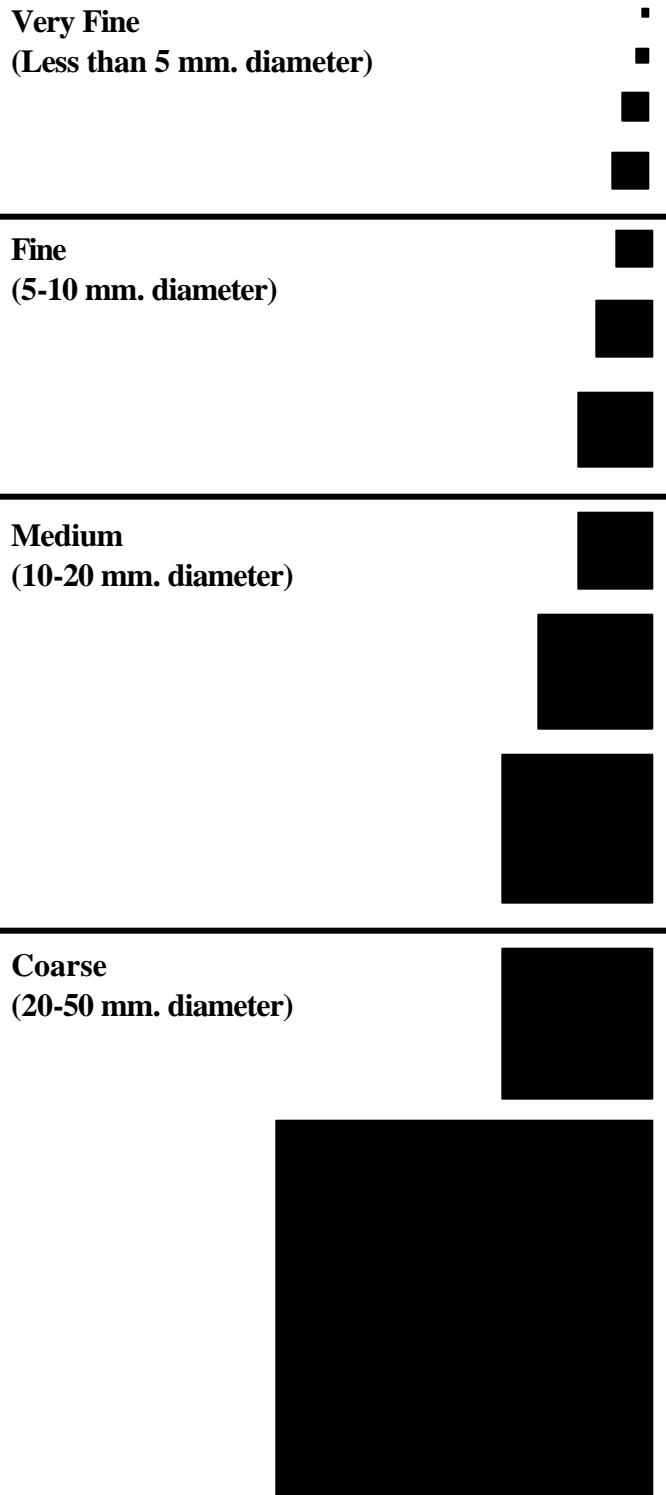


Figure 2. Visual diagrams for soil structure size classes. See the following page for additional size classes.

Platy Structures

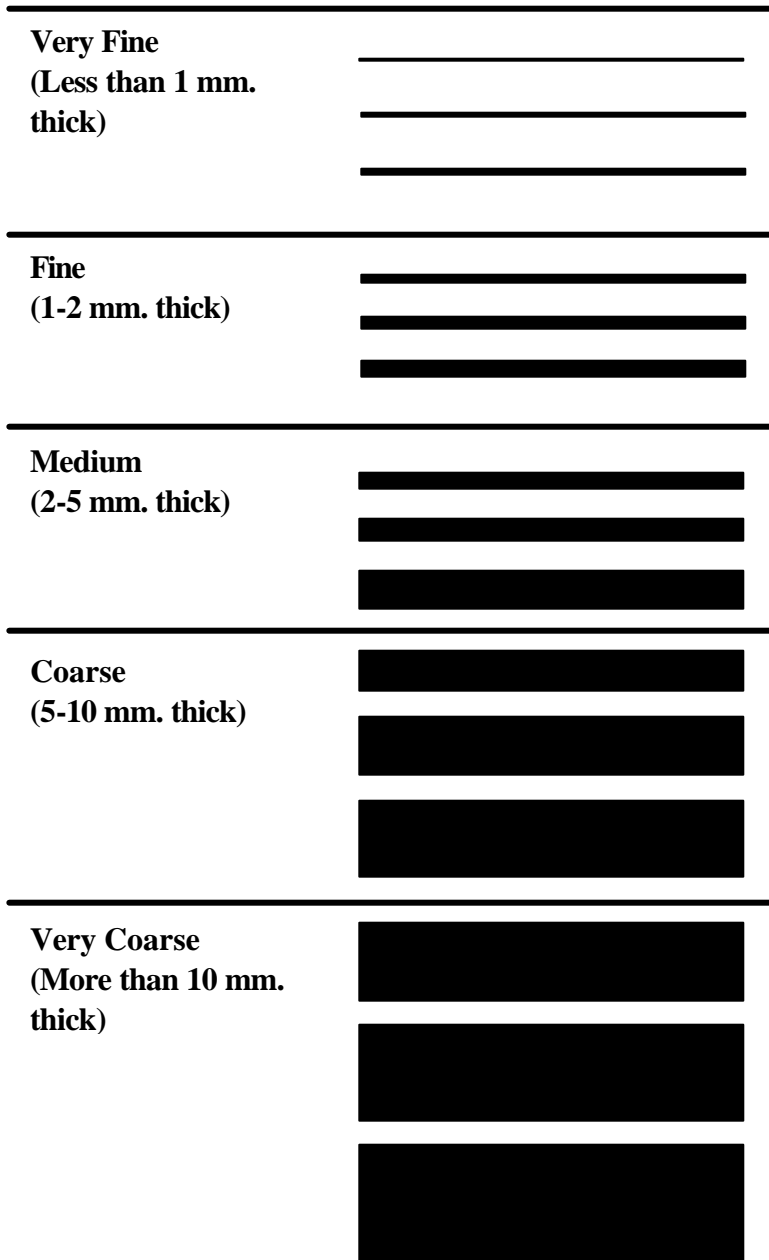


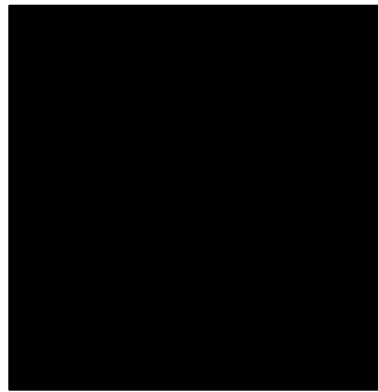
Figure 2. Continued visual diagrams for soil structure size classes.

Angular and Subangular Blocky Structures

Very Fine
(Less than 10 mm. diameter)



Fine
(10-20
mm.)



Medium
(20-50 mm.)

Coarse
(20-50 mm.)

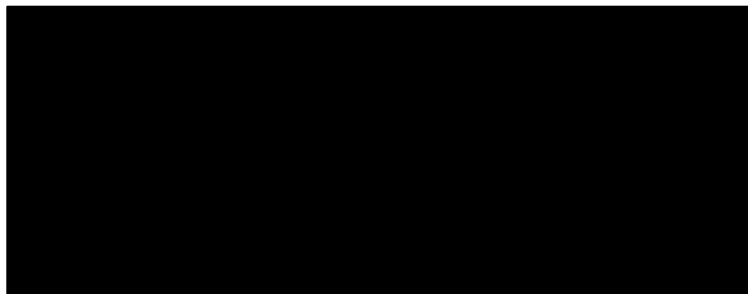
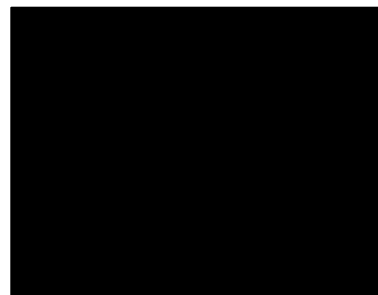


Figure 2. Continued visual diagrams for soil structure size classes.

Stickiness refers to the capacity of a soil to adhere to other objects. The classes for stickiness follow:

- so - Nonsticky: After release of pressure, practically no soil material adheres to thumb or forefinger.
- ss - Slightly sticky: After release of pressure, soil material adheres perceptibly to both thumb and forefinger, but as the fingers are separated, the material tends to come off one or the other rather cleanly.
- s - Sticky: After release of pressure, soil material adheres to both thumb and forefinger and tends to stretch slightly rather than pull completely free from either finger.
- vs - Very sticky: After release of pressure, soil material adheres so strongly to both thumb and forefinger that it stretches decidedly when the fingers are separated, and soil material remains on both fingers.

Plasticity is the degree to which soil is permanently deformed, without rupturing, by force applied continuously in any direction.

- po - Nonplastic: No thread can be formed.
- sp - Slightly plastic: Thread can be formed and mass is deformed by very slight force.
- p - Plastic: Thread can be formed and mass is deformed by slight force.
- vp - Very plastic: Thread can be formed and mass is deformed by moderate or strong force.

Cementation: Refers to brittle hard consistence caused by some cementing agent such as silica or CaCO_3 which, unlike clay, does not deform under pressure.

- cw - Weakly cemented: Mass is brittle and hard cut can be broken in the hands.
- cs - Strongly cemented: Mass is brittle, cannot be broken in hands, easily broken with hammer.
- ci - Indurated: Very strongly cemented; brittle, does not soften under prolonged wetting; breaks only with a sharp blow with a hammer; rings.

Smeariness: The extent to which a soil exhibits smeariness determines whether or not it is thixotropic.

- ws - Weakly smeary: Under moderately strong force between thumb and forefinger, the soil material changes suddenly to fluid, the fingers skid, and the soil smears.
- ms - Moderately smeary: Under moderate force between thumb and forefinger, the soil material changes suddenly to fluid, the fingers skid, and the soil smears.
- ss - Strongly smeary: Under slight force between thumb and forefinger, the soil material suddenly changes to fluid, the fingers skid, and the soil smears and is very slippery. After the soil smears, free water is easily seen on the fingers.

Fluidity: Soils that are saturated much of the time are likely to have a very low bearing capacity when wet.

- sf - Slightly fluid: When a specimen is squeezed in the hand, some material tends to flow between the fingers, but after full pressure is applied, most of the residue is left in the hand.
- vf - Very fluid: When a specimen is squeezed in the hand, soil material flows easily between the fingers, and after full pressure is applied, little or no residue is left in the hand.

Clay Skins and Other Ped Surface Features

Kinds: Surface features are distinguished by differences in texture, color, packing, orientation of particles, or reaction to various tests.

Clay skins (synonymous with clay films) are thin layers of oriented translocated clay.

Clay bridges link together adjacent mineral grains at contact points.

Sand or silt coats are sand or silt grains adhering to a surface.

Other coats are described by properties that can be observed in the field. The coats may be composed of iron, aluminum or manganese oxides, organic matter, salts, or carbonates.

Stress surfaces are smoothed surfaces that have greater density than the adjacent soil.

Slickensides are stress surfaces that are polished and striated.

Amount: The area occupied by a particular surface feature over the extent of the horizon is described. Amount can be characterized by a fraction or percentage or by the following classes:

- vi - Very few: Occupies less than 5 percent of the total area of the kind of surface described.
- 1 - Few: Occupies 5 to 25 percent of the total area of the kind of surface described.
- 2 - Common: Occupies 25 to 50 percent of the total area of the kind of surface described.
- 3 - Many: Occupies more than 50 percent of the total area of the kind of surface described.

Distinctness: Distinctness refers to the ease and degree of certainty with which a surface feature can be identified. Three distinctness classes are used.

- f - Faint: Evident only on close examination with 10X magnification and cannot be identified positively in all places without greater magnification.
- d - Distinct: Can be detected without magnification, although magnification or tests may be needed for positive identification.
- p - Prominent: Conspicuous without magnification when compared with a surface broken through the soil.

Location: The various features may be on some or all surfaces of peds, channels, pores, primary particles or grains, soil fragments, rock fragments, nodules, or concretions.

- pf - Clay films occur on ped faces.
- po - Clay films line tubular or interstitial pores.
- br - Oriented clay occurs as bridges holding mineral grains together.
- co - Colloid stains mineral grains.

Pores

All pores smaller than 10 mm in diameter are described in terms of the following quantity classes:

- 1 - Few: Less than 1 per unit area of the specified size.
- 2 - Common: 1 to 5 per unit area of the specified size.
- 3 - Many: More than 5 per unit area of the specified size.

Four size classes of pores are recognized:

- | | | | |
|----|---|--|------------|
| vf | - | <u>Very fine</u> : Less than 0.5 mm in diameter. | |
| f | - | <u>Fine</u> : 0.5 to 2 mm in diameter. | Scale - mm |
| m | - | <u>Medium</u> : 2 to 5 mm in diameter. | 0 10 20 30 |
| c | - | <u>Coarse</u> : more than 5 mm in diameter. | _____ |

Roots

All roots smaller than 10 mm in diameter are described in terms of the following quantity classes:

- 1 - Few: Less than 1 per unit area of the specified size.
- 2 - Common: 1 to 5 per unit area of the specified size.
- 3 - Many: More than 5 per unit area of the specified size.

The size or diameter classes are:

- | | | | |
|----|---|--|------------|
| vf | - | <u>Very fine</u> : Less than 1 mm in diameter. | |
| f | - | <u>Fine</u> : 1 to 2 mm in diameter. | Scale - mm |
| m | - | <u>Medium</u> : 2 to 5 mm in diameter. | 0 10 20 30 |
| c | - | <u>Coarse</u> : 5 mm or larger in diameter. | _____ |

Carbonates

Carbonates: Indicate effervescence with dilute (about 1 normal) HCl. Relative amounts are as follows:

- | | | |
|----|---|--|
| eo | - | <u>No effervescence</u> : No bubbles seen. |
| ve | - | <u>Very slightly effervescent</u> : Few bubbles seen. |
| e | - | <u>Slightly effervescent</u> : Bubbles are readily observed. |
| es | - | <u>Strongly effervescent</u> : Bubbles form a low foam. |
| ev | - | <u>Violently effervescent</u> : Thick form "jumps" up. |

Modifiers of soft masses:

Abundance (same as for mottles)

- f - Few: Less than 2% of surface area.
- c - Common: 2-20% of surface area.
- m - Many: 20% of surface area.

Sizes (same as for mottles)

- 1 - Fine: Less than 5 mm in diameter.
- 2 - Medium: 5 to 15 mm in diameter.
- 3 - Large: more than 15 mm in diameter.

Shapes

- r - Generally rounded or slightly oblong.
- i - Irregularly shaped.

Distribution

- d - Disseminated: Entire mass contains lime.
- s - Segregated: Lime is concentrated in areas.
- sf - Lime occurs in filaments or threads.
- ss - Lime occurs in seams.
- sm - Lime occurs in salt masses.
- sc - Lime occurs in concretions: Which can be removed from the mass and still retains a distinct shape -- soft masses crumble.

Mottling

The colors of concretions, nodules, coats of peds, fillings in burrows of animals, and the like are commonly described as properties of identifiable bodies or surfaces and are usually not called "mottles" in the description.

Quantity: The quantity can be indicated by one of three general classes based on the percentage of the observed surface that is occupied by mottles of a given kind.

- f - Few: Less than 2 percent.
- c - Common: 2 to 20 percent.
- m - Many: More than 20 percent.

Size: The size refers to the approximate dimensions of the mottles as seen on a plane surface. Three size classes are used:

- f - Fine: Smaller than 5 mm.
- m - Medium: 5 to 15 mm.
- c - Coarse: Larger than 15 mm.

A card having spots of various shapes in sizes that correspond to size classes is helpful for field use (Figure 3).

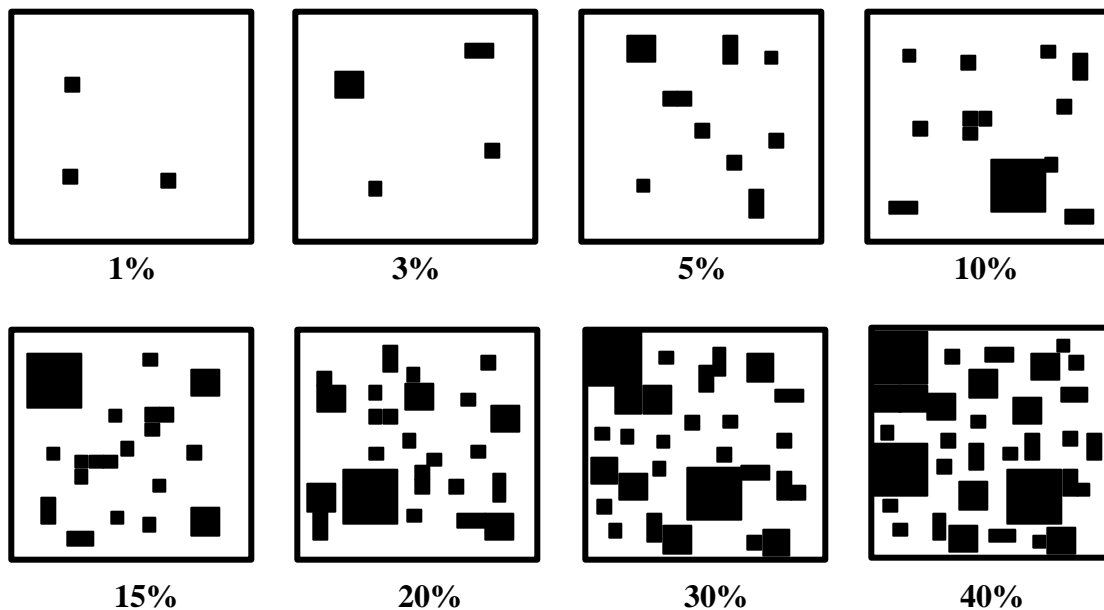


Figure 3. Chart for estimating proportions of mottles. Each fourth of any one square has the same amount of black (adapted from Folk 1951 and Olson 1976).

Contrast: The contrast refers to the degree of visual distinction that is evident between associated colors.

- f - Faint: Evident only on close examination.
- d - Distinct: Readily seen but contrast only moderately with the color to which they are compared.
- p - Prominent: Contrast strongly with the color to which they are compared.

Shape: The shape of some mottles is significant and is often described by common words like streaks, bands, tongues, tubes, and spots.

Concentration Within The Soil

Nodules and concentrations are discrete bodies strong enough and distinct enough to be removed from the soil intact. Nodules are formed by the filling of cicada larva channels and are distinguished from concretions on the basis of internal organization.

Amount or quantity: The amount or quantity of concentrations refers to the relative volume of a horizon or other specified unit occupied by the bodies.

Size: The size may be measured directly or given by the classes listed below. The following size classes are used:

- f - Fine: Smaller than 2 mm.
- m - Medium: 2 to 5 mm.

- co - Coarse: 5 to 20 mm.
- vco - Very coarse: 20 to 76 mm.
- eco - Extremely coarse: Larger than 76 mm.

Shape: The shape of bodies is variable. The definitions follow:

- r - Rounded: Approximately equidimensional, few sharp corners and at least approximately regular.
- c - Cylindrical: At least crudely cylindrical or tubular; one dimension is much greater than the other two.
- p - Platelike: Shaped crudely like a plate; one dimension is very much smaller than the other two. The term "platelike" is used to avoid confusion with platy structure.
- i - Irregular: Characterized by branches or convoluted or mycelial forms.

Composition: The composition of bodies is described if known and if important for understanding their nature or the nature of the soil in which they are observed.

Reaction

The numerical designation of reaction is expressed as pH. The descriptive terms to use for ranges in pH are as follows:

Extremely acid	Less than 4.5
Very strongly acid	4.5 - 5.0
Strongly acid	5.1 - 5.5
Moderately acid	5.6 - 6.0
Slightly acid	6.1 - 6.5
Neutral	6.6 - 7.3
Mildly alkaline	7.4 - 7.8
Moderately alkaline	7.9 - 8.4
Strongly alkaline	8.5 - 9.0
Very strongly alkaline	More than 9.0

Animals and Their Traces

Mixing, changing and moving of soil material by animals is a major factor affecting properties of some soils. Activities of worms, prairie dogs, moles, mice, gophers, shrews, woodchucks, squirrels, and rabbits are examples.

