Soil Formation and Classification

The National Cooperative Soil Survey identifies and maps over 20,000 different kinds of soil in the United States. Most soils are given a name, which generally comes from the locale where the soil was first mapped. Named soils are referred to as soil series.

Soil survey reports include the soil survey maps and the names and descriptions of the soils in a report area. These soil survey reports are published by the National Cooperative Soil Survey and are available to everyone.

Soils are named and classified on the basis of physical and chemical properties in their horizons (layers). “Soil Taxonomy” uses color, texture, structure, and other properties of the surface two meters deep to key the soil into a classification system to help people use soil information. This system also provides a common language for scientists.

Soils and their horizons differ from one another, depending on how and when they formed. Soil scientists use five soil factors to explain how soils form and to help them predict where different soils may occur. The scientists also allow for additions and removal of soil material and for activities and changes within the soil that continue each day.

Soil Forming Factors

Parent material. Few soils weather directly from the underlying rocks. These “residual” soils have the same general chemistry as the original rocks. More commonly, soils form in materials that have moved in from elsewhere. Materials may have moved many miles or only a few feet. Windblown “loess” is common in the Midwest. It buries “glacial till” in many areas. Glacial till is material ground up and moved by a glacier. The material in which soils form is called “parent material.” In the lower part of the soils, these materials may be relatively unchanged from when they were deposited by moving water, ice, or wind.

Sediments along rivers have different textures, depending on whether the stream moves quickly or slowly. Fast-moving water leaves gravel, rocks, and sand. Slow-moving water and lakes leave fine textured material (clay and silt) when sediments in the water settle out.

Climate. Soils vary, depending on the climate. Temperature and moisture amounts cause different patterns of weathering and leaching. Wind redistributes sand and other particles especially in arid regions. The amount, intensity, timing, and kind of precipitation influence soil formation. Seasonal and daily changes in temperature affect moisture effectiveness, biological activity, rates of chemical reactions, and kinds of vegetation.

Topography. Slope and aspect affect the moisture and temperature of soil. Steep slopes facing the sun are warmer, just like the south-facing side of a house. Steep soils may be eroded and lose their topsoil as they form. Thus, they may be thinner than the more nearly level soils that receive deposits from areas upslope. Deeper, darker colored soils may be expected on the bottom land.

Biological factors. Plants, animals, micro-organisms, and humans affect soil formation. Animals and micro-organisms mix soils and form burrows and pores. Plant roots open channels in the soils. Different types of roots have different effects on soils. Grass roots are “fibrous” near the soil surface and easily decompose, adding organic matter. Taproots open pathways through dense layers. Micro-organisms affect chemical exchanges between roots and soil. Humans can mix the soil so extensively that the soil material is again considered parent material.

The native vegetation depends on climate, topography, and biological factors plus many soil factors such as soil density, depth, chemistry, temperature, and moisture. Leaves from plants fall to the surface and decompose on the soil. Organisms decompose these leaves and mix them with the upper part of the soil. Trees and shrubs have large roots that may grow to considerable depths.

Time. Time for all these factors to interact with the soil is also a factor. Over time, soils exhibit features that reflect the other forming factors. Soil formation processes are continuous. Recently deposited material, such as the deposition from a flood, exhibits no features from soil development activities. The previous soil surface and underlying horizons become buried. The time clock resets for these soils. Terraces above the active floodplain, while genetically similar to the floodplain, are older land surfaces and exhibit more development features.

These soil forming factors continue to affect soils even on “stable” landscapes. Materials are deposited on their surface, and materials are blown or washed away from the surface. Additions, removals, and alterations are slow or rapid, depending on climate, landscape position, and biological activity.

When mapping soils, a soil scientist looks for areas with similar soil-forming factors to find similar soils. The colors, texture, structure, and other properties are described. Soils with the same kind of properties are given taxonomic names. A common soil in the Midwest reflects the temperate, humid climate and native prairie vegetation with a thick, nearly black surface layer. This layer is high in organic matter from decomposing grass. It is called a “mollic epipedon.” It is one of several types of surface horizons that we call “epipedons.” Soils in the desert commonly have an “ochric” epipedon that is light colored and low in organic matter. Subsurface horizons also are used in soil classification. Many forested areas have a subsurface horizon with an accumulation of clay called an “argillic” horizon.

Soil Orders

Soil taxonomy at the highest hierarchical level identifies 12 soil orders. The names for the orders and taxonomic soil properties relate to Greek, Latin, or other root words that reveal something about the soil. Sixty-four suborders are recognized at the next level of classification. There are about 300 great groups and more than 2,400 subgroups. Soils within a subgroup that have similar physical and chemical properties that affect their responses to management and manipulation are families. The soil series is the lowest category in the soil classification system.

Soil Order	Formative Terms	Pronunciation
Alfisols	Alf, meaningless syllable	Pedalfer
Andisols	Modified from ando	Ando
Aridisols	Latin, aridies, dry	Arid
Entisols	Ent, meaningless	Recent
Gelisols	Latin gelare, to freeze	Jell
Histosols	Greek, histos, tissue	Histology
Inceptisols	Latin, incepum, beginning	Inception
Mollisols	Latin, mollis, soft	Mollify
Oxisols	French oxide	Oxide
Spodosols	Greek spodos, wood ash	Odd
Ultisols	Latin ultimus, last	Ultimate
Vertisols	Latin verto, turn	Invert

Maps

The distribution of these soil orders in the United States corresponds with the general patterns of the soil forming factors across the country. A map of soil orders is useful in understanding broad areas of soils. Detailed soil maps found in soil survey reports, however, should be used for local decision making. Soil maps are like road maps, for very general overview, a small scale map in an atlas is helpful, but for finding a location of a house in a city, a large scale detailed map should be used.

More detailed information on soil orders is available in “Soil Taxonomy” pp. 837-850, Chapter 22.

Formative Elements in Names of Soil Suborders

Formative Element	Derivation	Sounds Like	Connotation
Alb	L, *albus,* white	Albino	Presence of albic horizon
Anthr	Modified from Gr. anthropes, human	Anthropology	Modified by humans
Aqu	L. *aqua,* water	Aquifer	Aquic conditions
Ar	L. *Arare*, to plow	Arable	Mixed horizons
Arg	Modified from argillic horizon; L. *argilla*, white clay	Argillite	Presence of argillic horizon
Calc	L. calcis, lime	Calcium	Presence of a calcic horizons
Camb	L. cambiare, to exchange	Am	Presence of a cambic horizon
Cry	G. kryos, icy cold	Cry	Cold
Dur	L. durus, hard	Durable	Presence of a duripan
Fibr	L. *fibra,* fiber	Fibrous	Least decomposed stage
Fluv	L. *fluvius,* river	Fluvial	Flood plain
Fol	L. *folia*, leaf	Foliage	Mass of leaves
Gyps	L. gypsum, gypsum	Gypsum	Presence of a gypsic horizon
Hem	Gr h*emi,* half	Hemisphere	Intermediate stage of decomposition
Hist	Gr. histos, tissue	Histology	Presence of organic materials
Hum	L. *humus,* earth	Humus	Presence of organic matter
Orth	Gr. *orthos,* true	Orthodox	The common ones
Per	L. Per, throughout in time	Perennial	Perudic moisture regime
Psamm	Gr. *psammos,* sand	Sam	Sandy texture
Rend	Modified from Rendzina	End	High carbonate content
Sal	L. base of sal, salt	Saline	Presence of a salic horizon
Sapr	Gr. *sapros,* rotten	Sap	Most decomposed stage

Torr	L. *torridus,* hot and dry	Or	Torric moisture regime
Turb	L. Turbidis, disturbed	Turbulent	Presence of cryoturbation
Ud	L. *udus,* Humid	You	Udic moisture regime
Vitr	L. vitrum, glass	It	Presence of glass
Ust	L. *ustus,* burnt	Combustion	Ustic moisture regime
Xer	Gr. *xeros, dry*	Zero	Xeric moisture regime

Formative Elements in Names of Soil Great Groups

Formative Element	Derivation	Sounds Like	Connotation
Acr	Modified from Gr. *Akros*, at the end	Act	Extreme weathering
Al	Modified from aluminum	Algebra	High aluminum, low iron
Alb	L. *Albus,* white	Albino	An albic horizon
Anhy	Gr. *anydros,* waterless	Anhydrous	Very dry
Anthr	Modified from Gr. *anthropos,* human	Anthropology	An anthropic epipedon
Aqu	L. *aqua,* water	Aquifer	Aquic conditions
Argi	Modified from argillic horizon; L. argilla, *white clay*	Argillite	Presence of an argillic horizon
Calci, calc	L. *calcis,*lime	Calcium	A calcic horizon
Cry	Gr. *kryos,* icy cold	Cry	Cold
Dur	L. *durus,* hard	Durable	A duripan
Dystr, dys	Modified from Gr. *dys,* ill; dystrophic infertile	Distant	Low base saturation
Endo	Gr. *endon, endo,* within	Endothermic	Implying a ground water table
Epi	Gr. *epi,* on, above	Epidermis	Implying a perched water table
Eutr	Modified from Gr. *eu,* good;	You	High base saturation

	euthrophic, fertile		
Ferr	L. *ferrum*, iron	Fair	Presence of iron
Fibr	L. *fibra,* fiber	Fibrous	Least decomposed stage
Fluv	L. *fluvius,* river	Fluvial	Flood plain
Fol	L. *folia,* leaf	Foliage	Mass of leaves
Fragi	Modified from L. *fragilis,* brittle	Fragile	Presence of fragipan
Fragloss	Compound of fra (g) and gloss		See the formative elements "frag" and "gloss"
Fulv	L. *fulvus,* dull brownish yellow	Full	Dark brown color, presence of organic carbon
Glac	L. *glacialis,* icy	Glacier	Ice lenses or wedges
Gyps	L. *gypsum*, gypsum	Gypsum	Presence of gypsic horizon
Gloss	Gr. *glossa,* tongue	Glossary	Presence of a glossic horizon
Hal	Gr. *hals,* salt	Halibut	Salty
Hapl	Gr. *haplous,* simple	Haploid	Minimum horizon development
Hem	G. *hemi*, half	Hemisphere	Intermediate stage of decomposition
Hist	Gr. *histos,* tissue	History	Presence of organic materials
Hum	L. *humus,* earth	Humus	Presence of organic matter
Hydr	Gr. *hydo*, water	Hydrophobia	Presence of water
Kand, kan	Modified from kandite	Can	1:1 layer silicate clays
Luv	Gr. *louo,* to wash	Ablution	Illuvial
Melan	Gr. *melasanos,* black	Me + Land	Black, presence of organic carbon
Moll	L. *mollis*, soft	Mollusk	Presence of a mollic epipedon
Natr	Modified from *natrium*, sodium	Date	Presence of natric horizon
Pale	Gr. *paleos,* old	Paleontology	Excessive development

Petr	Gr. comb. form *of petra,* rock	Petrified	A cemented horizon
Plac	Gr. base of *plax,* flat stone	Placard	Presence of thin pan
Plagg	Modified from Ger. *plaggen,* sod	Awe	Presence of plaggen epipedon
Plinth	Gr. *plinthos*, brick	In	Presence of plinthite
Psamm	Gr. *psammos,* sand	Sam	Sandy texture
Quartz	Ger. *quarz*, quartz	Quarter	High quartz content
Rhod	Gr. base of *rhodon,* rose	Rhododendron	Dark red color
Sal	L. base of *sal*, salt	Saline	Presence of salic horizon
Sapr	Gr. *saprose,* rotten	Sap	Most decomposed stage
Somb	F. *sombre,* dark	Somber	Presence of sombric horizon
Sphagn	Gr. *sphagnos,* bog	Sphagnum	Presence of Sphagnum
Sulf	L. *sulfur,* sulfur	Sulfur	Presence of sulfides or their oxidation products
Torr	L. *torridus,* hot and dry	Torrid	Torric moisture regime
Ud	L. *udus,* humid	You	Udic moisture regime
Umbr	L. *umbra,* shade	Umbrella	Presence of umbric epipedon
Ust	L. *ustus,*burnt	Combustion	Ustic moisture regime
Verm	L. base of *vermes,* worm	Vermilion	Wormy, or mixed by animals
Vitr	L. vitrum, glass	It	Presence of glass
Xer	Gr. *xeros,* dry	Zero	Xeric moisture regime