Chapter 7: Soils of the Southeastern US

It's sometimes easy to take the soil beneath our feet for granted. Yet soil has always been with us—it is the foundation of our houses and roads, and from the soil comes our food, fiber, and paper. Soil is the interface between living earth and solid rock, between biology and geology. The engineer, the scientist, and the gardener may all look at the soil beneath them in different ways, but perhaps no one has a more integral relationship with soil than a farmer. The economic success of producing crops is intimately tied to the quality of the soil upon which those crops grow, and the most successful farmers are well versed in the science of their soil. Soils store and purify water, and they exchange gases with the **atmosphere**. They support agriculture and natural ecosystems and provide a grassy surface for our parks and fodder for our gardens. Everyone, everywhere, every day, depends upon the soil.

What is Soil?

Generally, **soil** refers to the top layer of earth—the loose surface of earth as distinguished from rock—where vegetation grows. The word is derived (through Old French) from the Latin *solum*, which means "floor" or "ground." Soil is one of the most important resources we have—the most basic resource upon which all terrestrial life depends. The Southeast has a wide variety of soils, and each type of soil has a story to tell of its origin.

Soils form from the top down, and typically reach a depth of about one meter (3.3 feet) at their more developed stages, although some can reach much deeper. Soils are composed of a mixture of two key ingredients. The first is plant litter, such as dead grasses, leaves, and fallen debris. Worms, bacteria, and fungi do the job of breaking these down into nutritious organic matter that helps soil to nourish future plant growth. The second important component of soil is sediment derived from the **weathering** of rock that is then transported by **wind**, water, or gravity. Both of these components influence the texture (*Figure 7.1*) and consistency of the soil, as well as the **minerals** available for consumption by plants.

All soils might seem alike, but there can be vast differences in soil properties even within small areas! A single acre may contain several different soil types, each with its own assets and drawbacks. Some types of soil are clayey or prone to flooding, while others are stable enough to be used as a foundation for buildings. The most identifiable physical properties of soils are texture, structure, and **color**, which provide the basis for distinguishing soil **horizons**. Texture refers to the percentage of sand, silt, and clay that makes up the soil. Soil textures have specific names, as indicated in *Figure 7.1*.

atmosphere • *a layer of gases surrounding a planet.*

soil • *the collection of natural materials that collect on Earth's surface, above the bedrock.*

weathering • *the breakdown of rocks by physical or chemical means.*

wind • *the movement of air from areas of high pressure to areas of low pressure.*

mineral • *a naturally occurring solid with a specific chemical composition and crystalline structure.*

horizon • *a layer in the soil, usually parallel to the surface, which has physical characteristcs (usually color and texture) that are different from the layers above and below it.*

CHAPTER AUTHORS

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Soils

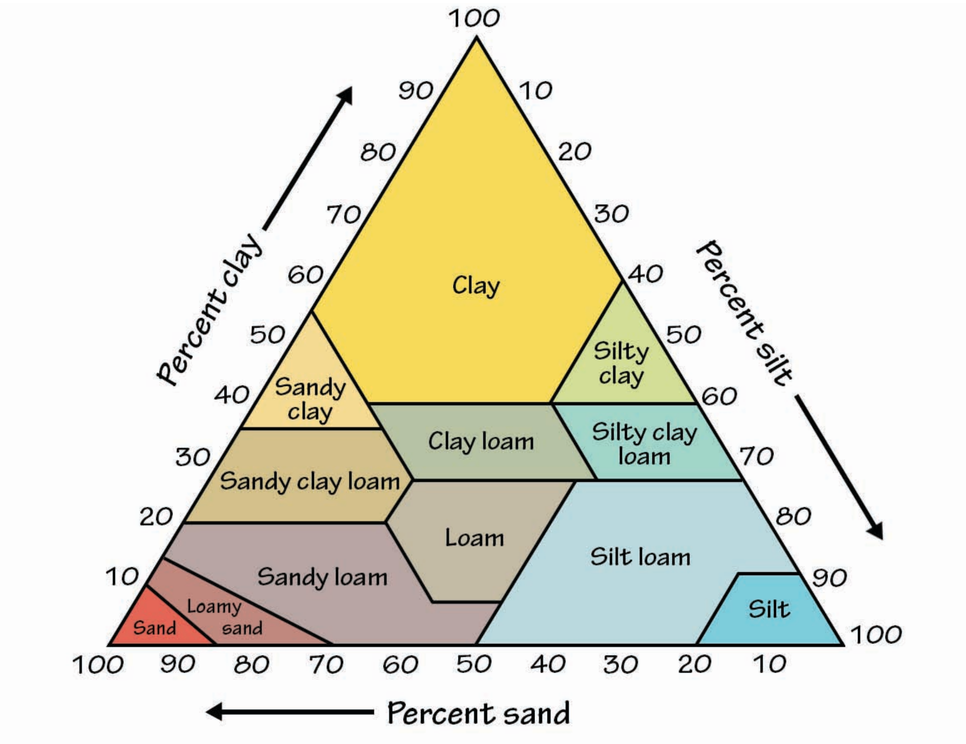


Figure 7.1: Soil texture triangle.

Generally, the best agricultural soils are those with about equal amounts of **clay**, **silt**, and **sand**. A soil of that type is called a **loam**. Soils that are mostly sand do not hold water very well and dry quickly, while soils with too much clay may never dry out. Soil structure refers to the way the soil forms clumps, known as **peds**. Peds are identified by the shape of the soil clods, which take the form of balls, blocks, columns, and plates. These structures are easiest to see in recently plowed fields, where the soil is often granular and loose or lumpy. Soil color is its most obvious physical property. The color is influenced by mineral content, the amount of organic material, and the amount of water it routinely holds. The colors are identified by a standard soil color chart called the Munsell chart.

Five main variables affect the characteristics of soil worldwide. In the Southeast, all soils are the products of subtle differences among these five factors:

1. *Parent material* is the original geologic material from which the soil formed. This can be bedrock, preexisting soils, or other materials such as **till**, **loess**, and rock fragments.

2. *Climate* strongly determines the temperature regime, amount of moisture, and type of **biota** that interact with the **parent material**. This affects the extent of chemical and physical weathering on the soil-forming material. For example, if a particular **climate** lacks precipitation, mechanical weathering from wind or ice fracturing will predominate.

Review

clay • *the common name for a number of very fine-grained, earthy materials that become plastic (flow or change shape) when wet.*

silt • *fine granular sediment most commonly composed of quartz and feldspar crystals.*

sand • *rock material in the form of loose, rounded, or angular grains, and formed as a result of the weathering and decomposition of rocks.*

loam • *a soil containing equal amounts of clay, silt, and sand.*

till • *unconsolidated sediment that is eroded from the bedrock, then carried and eventually deposited by glaciers as they recede.*

loess • *very fine grained, wind-blown sediment, usually rock flour left behind by the grinding action of flowing glaciers.*

biota • *the organisms living in a given region, including plants, animals, fungi, protists, and bacteria.*

If, however, a climate has abundant precipitation, chemical **erosion** from water will be accelerated, resulting in substantial leaching.

3. *Topography*, or landscape, of the area is related to the relative position of the soil on the landscape. This includes the presence or absence of hills and the slopes between high and low areas. As the slope increases, water can carry larger sediment sizes, allowing for large sediment loads during major precipitation events. **Topography** also influences natural drainage. Gravity moves water down slopes to depressions or streams and pulls free water downward through the soil. Soils on hills tend to be dry, and soils in depressions and valleys are often wet or saturated. Areas with steep slopes that are susceptible to frequent erosion typically have very young soils, as they do not have long to develop before the ingredients are rearranged and the clock is reset. Flatter, more arid areas may have more time to develop, but they have significantly less plant life and will produce a very different soil than will a wetter environment. Slope also frequently determines the types of vegetation covering a soil—for example, different slopes on the same hill might receive varying amounts of sunlight during the growing season—which in turn can cause the characteristics of the soils to diverge if differing forms of vegetation dominate opposite slopes.

4. *Biota or living organisms* that live on or in the material affect soil development through their influence on the amount and distribution of organic matter in the soil. For example, plants contribute significantly to the formation of **humus**, and animals alter a soil's characteristics by leaving behind decayed remains and wastes. Decomposers like bacteria and fungi help to free up the nutrients locked away in these remains and wastes, and these freed nutrients are then recycled and used by new life forms within the same soil. In fact, more than 90% of the nutrients used by a forest in a given year are derived from the decomposition of old organic matter fallen to the forest floor. Animal burrows also create spaces in the soil horizons that allow for deeper penetration of air and water, which, in turn, aid plant development by helping to dissolve mineral nutrients into a form that plants can absorb and process. For its part, organic matter impacts the water-holding capacity of the soil, the soil's fertility, and root penetration.

5. *Time* is required for soils to develop while the four elements mentioned above interact. Older soils have deeper and thicker **subsoils** than do younger soils, but only if other soil forming factors remain constant. For example, it takes approximately 500 years to generate 2.5 centimeters (1 inch) of new **topsoil** beneath grass or forest—but it only takes a few years for erosion and weathering to destroy the same amount of unprotected topsoil.

Several types of **chemical reactions** are important for soil development; of these, acid-base reactions are some of the most important and complex. When carbon dioxide (CO_2) dissolves in water it forms weak carbonic acid. CO_2 found

Review

parent material • *the original geologic material from which soil formed.*

climate • *a description of the average temperature, range of temperature, humidity, precipitation, and other atmospheric/hydrospheric conditions a region experiences over a period of many years (usually more than 30).*

erosion • *the transport of weathered materials.*

humus • *a soil horizon containing organic matter.*

subsoil • *the layer of soil beneath the topsoil, composed of sand, silt and/or clay.*

topsoil • *the surface or upper layer of soil, as distinct from the subsoil, and usually containing organic matter.*

chemical reaction • *a process that involves changes in the structure and energy content of atoms, molecules, or ions but not their nuclei.*

in soil water can come from the atmosphere, where it dissolves in rainwater. Even more CO_2 usually comes from the soil itself, where it is produced by respiring organisms. The amount of CO_2 in soil gases can easily reach levels ten times higher than the amount found in the atmosphere (over 4000 ppm in soil vs. 400 ppm in the atmosphere), making soil water potentially more acidic than rainwater. As this acidic water slowly reacts with fresh minerals, it buffers the soil's pH and keeps it in a range (6–8) preferred by many organisms. Acid-driven weathering breaks down the soil's primary **igneous** minerals, typically transforming them to **silica**-rich clays. As the soil's primary minerals are depleted, it loses the ability to buffer acidity, and the pH of highly weathered soil can drop to around 4. These weathered soils tend to be rich in **aluminum**, **iron**, and **titanium**.

In highly weathered settings, soil loses most of its nutrients, and the store of nutrients that remains is mostly found in organic matter. In weathered soils, only the top 25 centimeters (10 inches) or so may be very biologically active, and rooting depths are very shallow. If this thin layer is lost to erosion, the underlying mineral soil may be infertile and incapable of rapid recovery.

Soil Orders

Just as rocks are classified into different types based on how they formed (igneous, **metamorphic**, or **sedimentary**), their mineral composition, and other characteristics, soils also have their own classification scheme. Soil develops in horizons, or layers, whose formation is dependent on the available ingredients, environmental conditions, and the time it takes to mature. Since the organic and chemical processes that form soils first impact the top of the soil column and then work their way downward, horizontal layers of soil with different characteristics are formed, resulting in divergent colors, textures, and compositions.

A vertical cross-section of all the horizons or layers of soil present in a given area is referred to as a soil profile. Some horizons are completely absent in certain profiles while others are common to most. Each horizon corresponds to a stage in the weathering of rock and decay of plant matter, and each is found at a specific position beneath the surface (*Figure 7.2*). The *O horizon* at the top of the profile contains partially decayed plant material and transitions down to the *A horizon*, which contains mineral matter with a mix of humus and is commonly referred to as topsoil. Below the A horizon lies the *B horizon* or subsoil, which contains mineral material that has leached from above. The *C horizon* at the base of the soil profile contains partially altered parent material.

Soils can also be categorized by their location (northern vs. southern soils), the type of vegetation growing on them (forest soils vs. desert soils), their topographic position (hilltop soils vs. valley soils), or other distinguishing features. The system used to classify soils based on their properties is called **soil taxonomy** *(Figure 7.3)*, and it was developed by the United States Department of Agriculture (USDA) with the help of soil scientists from across the country. It provides a convenient, uniform, and detailed classification of soils throughout the US (*Figure 7.4*), allowing for an easier understanding of how and why different regions have developed unique soils.

igneous rocks • *rocks derived from the cooling of magma underground or molten lava on the Earth's surface.*

silica • *a chemical compound also known as silicon dioxide (SiO_2).*

aluminum • *a metallic chemical element (Al), and the most abundant metal in the Earth's crust.*

iron • *a metallic chemical element (Fe).*

titanium • *a metallic chemical element (Ti) that is important because of its lightweight nature, strength and resistance to corrosion.*

metamorphic rocks • *rocks formed by the recrystallization and realignment of minerals in pre-existing sedimentary, igneous, and metamorphic rocks when exposed to high enough temperature and/or pressure.*

sedimentary rock • *rock formed through the accumulation and consolidation of grains of broken rock, crystals, skeletal fragments, and organic matter.*

Soils

7

Soil Orders

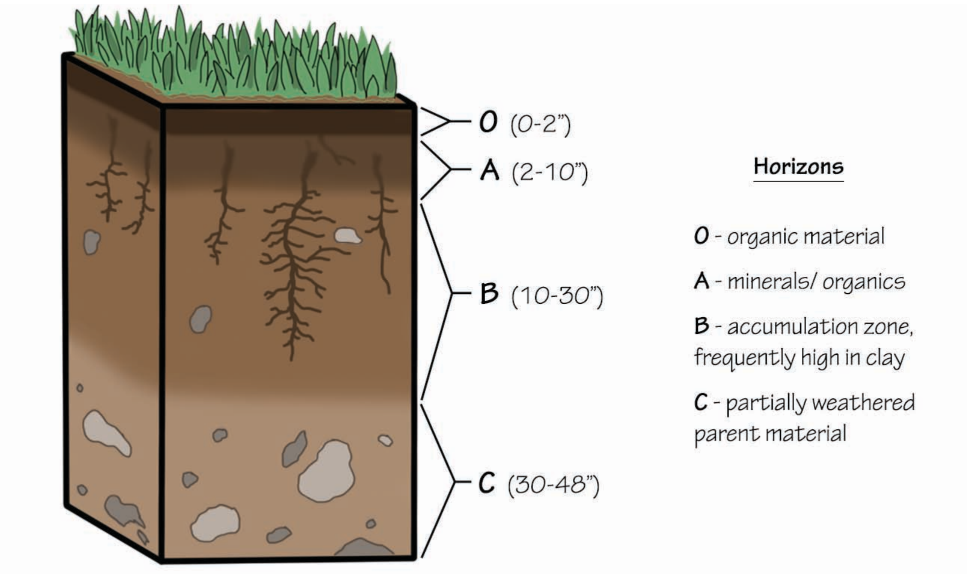


Figure 7.2: A typical soil profile shows the transition from the parent material (C horizon) to the highly developed or changed horizons (O through B). Not every soil profile will have all the horizons present.

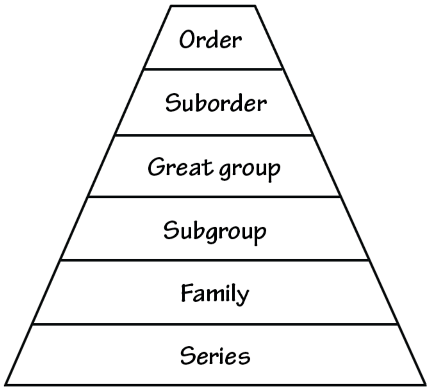


Figure 7.3: Soil taxonomy.

In soil taxonomy, all soils are arranged into one of 12 major units, or **soil orders**. These 12 orders are defined by diagnostic horizons, composition, soil structures, and other characteristics. Soil orders depend mainly on climate, parent material, and the organisms within the soil. These orders are further broken down into 64 suborders based on properties that influence soil development and plant growth, with the most important property being how wet the soil is throughout the year. The suborders are, in turn, separated into great groups (300+) and subgroups (2400+). Similar soils within a subgroup are grouped into even more selective families (7500+), and similar soils within families are grouped together into the most exclusive category of all: a series. There are more than 19,000 soil series described in the United States, with more being defined every year.

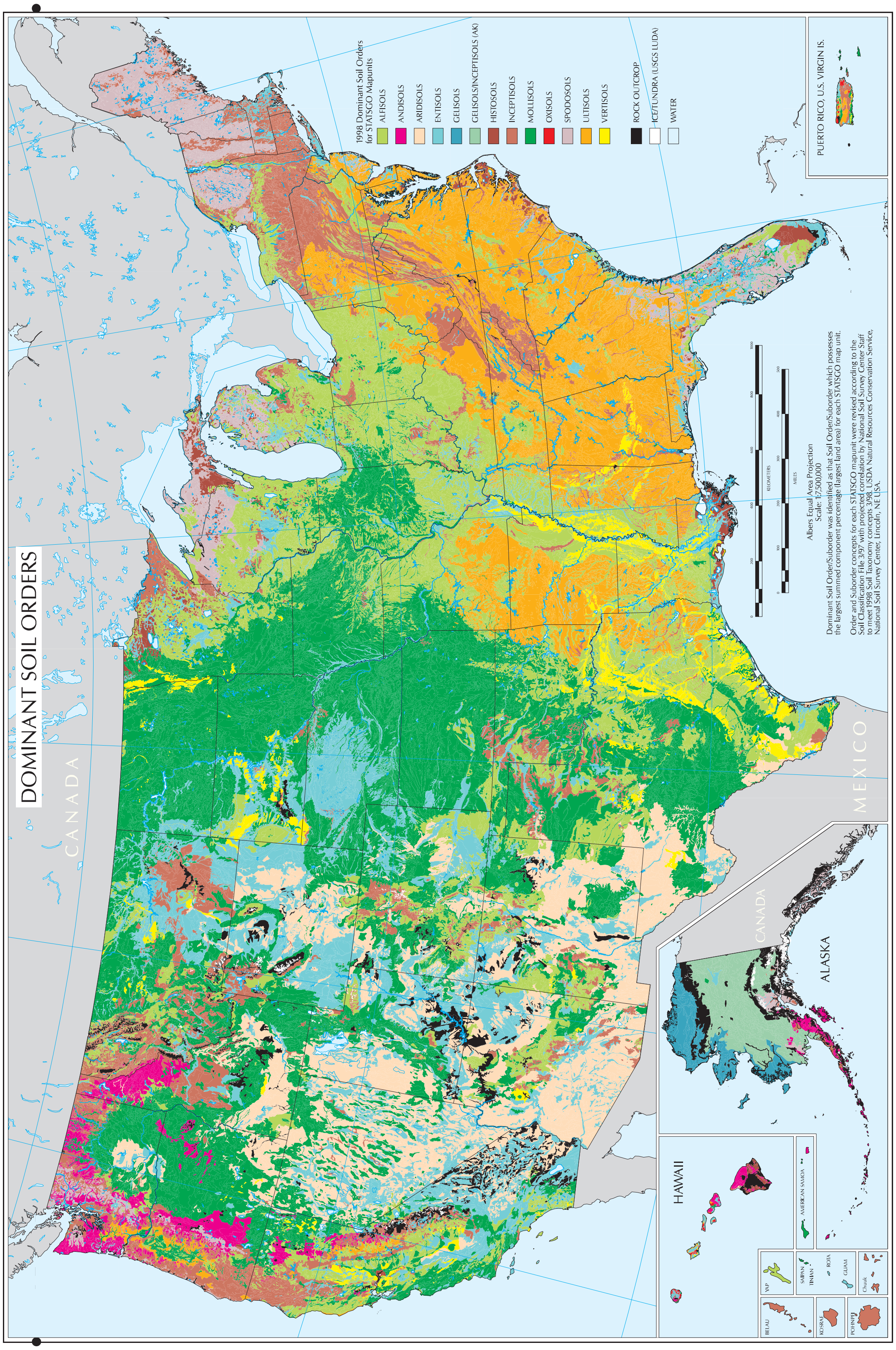
soil taxonomy *• the system used to classify soils based on their properties.*

soil orders *• the twelve major units of soil taxonomy, which are defined by diagnostic horizons, composition, soil structures, and other characteristics.*

7

Soils

Soil Orders



Dominant Soil Order/Suborder was identified as that Soil Order/Suborder which possesses the largest summed component percentage (largest land area) for each STATSGO map unit.

Order and Suborder concepts for each STATSGO mapunit were revised according to the Soil Classification File 3/97 with projected correlation by National Soil Survey Center Staff to meet 1998 Soil Taxonomy concepts 3/98. USDA Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE USA.

Figure 7.4: Dominant soil orders of the United States. (See TFG website for full-color version.)

The 12 soil orders

Name	Description	Controlling Factors	Percentage of global ice-free land surface	Percentage of US ice-free land surface
Alfisols	Highly fertile and productive agricultural soils in which clays often accumulate below the surface. Found in humid and subhumid climates.	climate and organisms	~10%	~14%
Andisols	Often formed in volcanic materials, these highly productive soils possess very high water- and nutrient-holding capabilities. Commonly found in cool areas with moderate to high levels of precipitation.	parent material	~1%	~2%
Aridisols	Soils formed in very dry (arid) climates. The lack of moisture restricts weathering and leaching, resulting in both the accumulation of salts and limited subsurface development. Commonly found in deserts.	climate	~12%	~8%

Soil Orders

Entisols	Soils of relatively recent origin with little or no horizon development. Commonly found in areas where erosion or deposition rates outpace rates of soil development, such as floodplains, mountains, and badland areas.	time and topography	~16%	~12%
Gelisols	Weakly weathered soils formed in areas that contain permafrost within the soil profile.	climate	~9%	~9%
Histosols	Organic-rich soils found along lake coastal areas where poor drainage creates conditions of slow decomposition and peat (or muck) accumulates.	topography	~1%	~2%
Inceptisols	Soils that exhibit only moderate weathering and development. Often found on steep (relatively young) topography and overlying erosion-resistant bedrock.	time and climate	~17%	~10%
Mollisols	Agricultural soils made highly productive due to a very fertile, organic-rich surface layer.	climate and organisms	~7%	~22%

Oxisols	Very old, extremely leached and weathered soils with a subsurface accumulation of iron and aluminum oxides. Commonly found in humid, tropical environments.	climate and time	~8%	~.02%
Spodosols	Acidic soils in which aluminum and iron oxides accumulate below the surface. They typically form under pine vegetation and sandy parent material.	parent material, climate, and organisms	~4%	~4%
Ultisols	Soils with subsurface clay accumulations that possess low native fertility and are often red hued (due to the presence of iron oxides). Found in humid tropical and subtropical climates.	climate, time, and organisms	~8%	~9%
Vertisols	Clayey soils with high shrink/swell capacity. During dry periods, these soils shrink and develop wide cracks; during wet periods, they swell with moisture.	parent material	~2%	~2%

Soil Orders

Dominant Soils of the Southeast

The Southeastern US contains a diverse variety of soils, and 8 of the 12 soil orders are present there.

Alfisols are partially leached soils with a high degree of fertility in which clays often accumulate below the surface. They tend to develop in cooler, more forested environments, and commonly form a band separating humid areas from more arid areas. Alfisols are found widely distributed throughout the Southeast, and they form a belt that extends along the Mississippi River and through Kentucky (*Figure 7.5*).

Entisols are soils of recent origin with poorly developed horizons, typically formed near **floodplains**. Entisols are common in the Coastal Plain region (where young, unconsolidated sediments dominate) as well as along streams and river valleys throughout the Southeast (*Figure 7.6*).

Inceptisols are soils with poorly developed horizons that are associated with steep slopes and erosion-resistant parent material. They are widely distributed in the Southeast, but are heavily concentrated in the Blue Ridge and Piedmont region where the landscape is typical for the development of this soil type. (*Figure 7.7*)

Histosols are carbon-rich soils, where half or more of the upper 80 centimeters (32 inches) is organic. They contain high concentrations of organic matter, due to their development in wetland environments with poor drainage and a slow rate of decomposition. They are saturated year round, and are often called bogs, moors, **peats**, or mucks. They are mainly associated with bogs and mucks in Florida and along the North Carolina coast (*Figure 7.8*).

Mollisols are the dominant soils of grasslands. The thick, black A horizon makes these soils extremely productive and valuable to agriculture. While these soils are extensive in the Great Plains of the Midwest, in the Southeast they are found only in Florida and a few other rare locations (*Figure 7.9*).

Spodosols are acidic soils with an accumulation of iron and aluminum in the humus. These soils support cool, moist **coniferous** stands of forest and are found primarily in Florida and along the Atlantic Coastal Plain (*Figure 7.10*).

Ultisols are weathered soils rich in the clay mineral **kaolinite.** They form in warm, humid climates with distinctive wet-dry seasons. Although they have low native fertility, they can become highly productive agricultural soils with the proper use of fertilizer. Ultisols are the most common soil in the Southeast and often support forest vegetation (*Figure 7.11*).

Vertisols are very dark soils, rich in swelling clays. Their distinguishing feature is that they form deeply cracked surfaces during dry periods, but swell again in the wet season, sealing all the cracks. As a result, they are very difficult soils to build roads or other structures on. These soils are most commonly associated with the Black Belt agricultural region in Alabama and Mississippi, and with the Mississippi River Valley (*Figure 7.12*).

***floodplain* •** *the land around a river that is prone to flooding.*

***peat* •** *an accumulation of partially decayed plant matter.*

***conifer* •** *a woody plant bearing cones that contain its seeds.*

***kaolinite* •** *a silicate clay mineral, also known as china clay.*

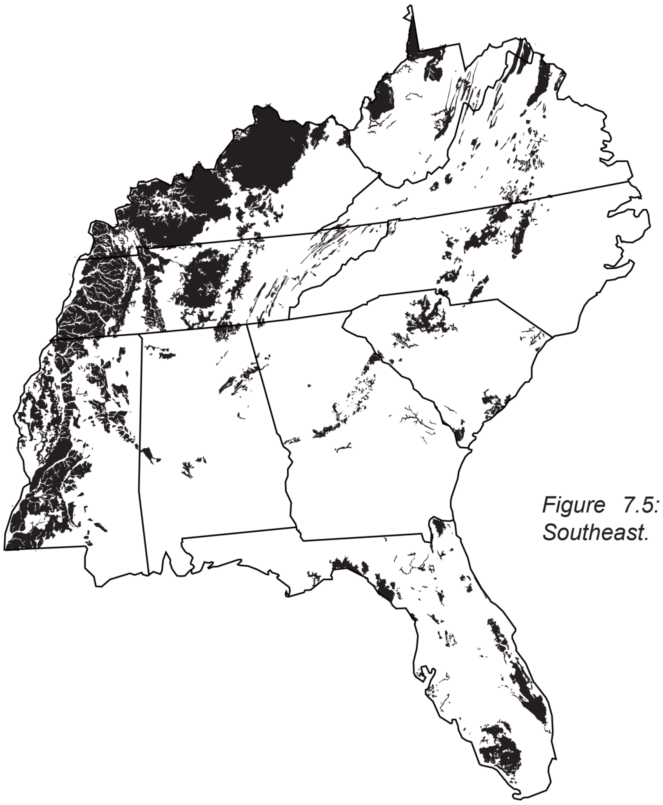


Figure 7.5: Alfisols of the Southeast.

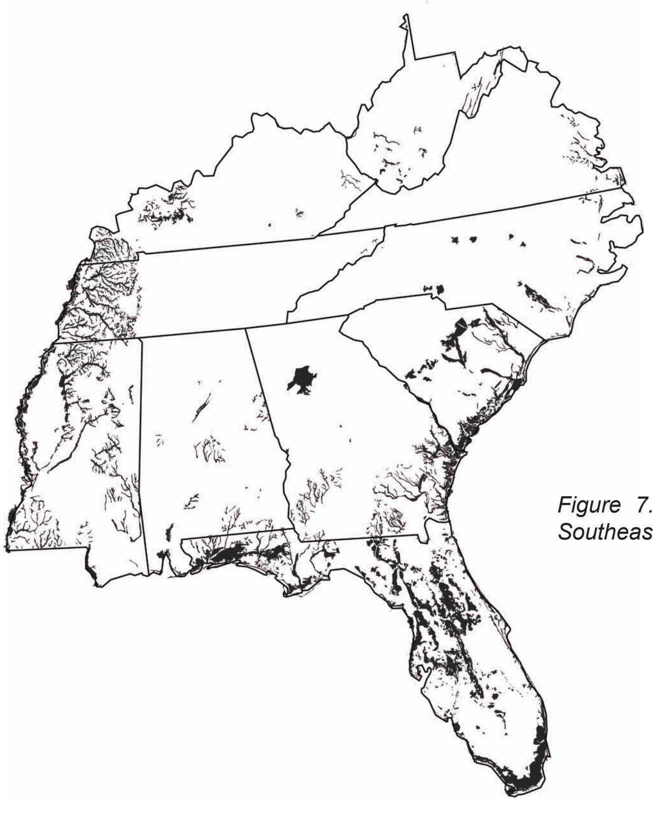


Figure 7.6: Entisols of the Southeast.

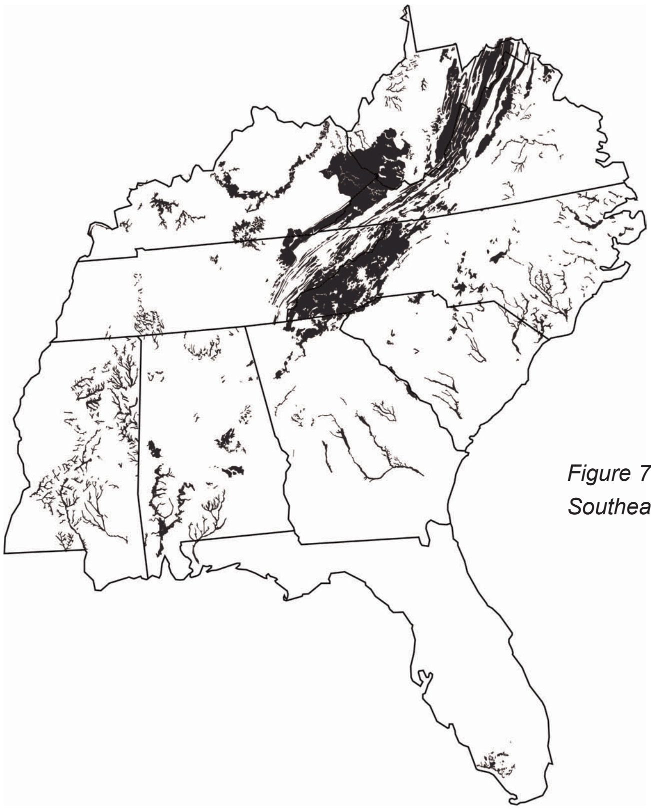


Figure 7.7: Inceptisols of the Southeast.

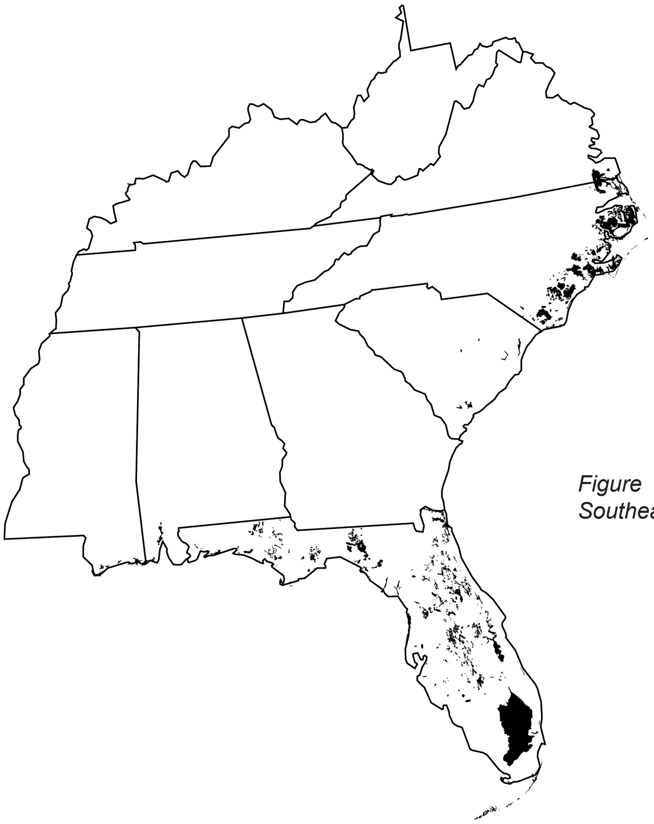


Figure 7.8: Histosols of the Southeast.

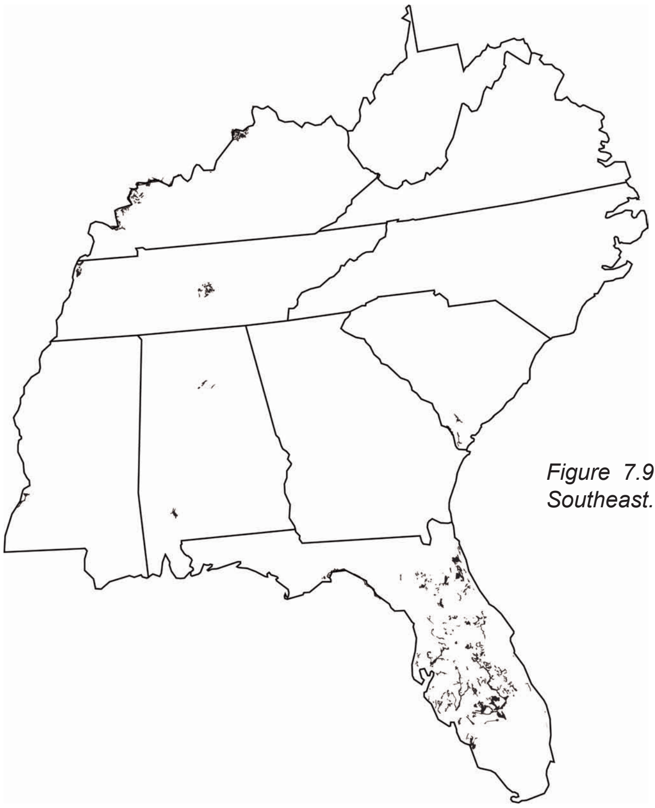


Figure 7.9: Mollisols of the Southeast.

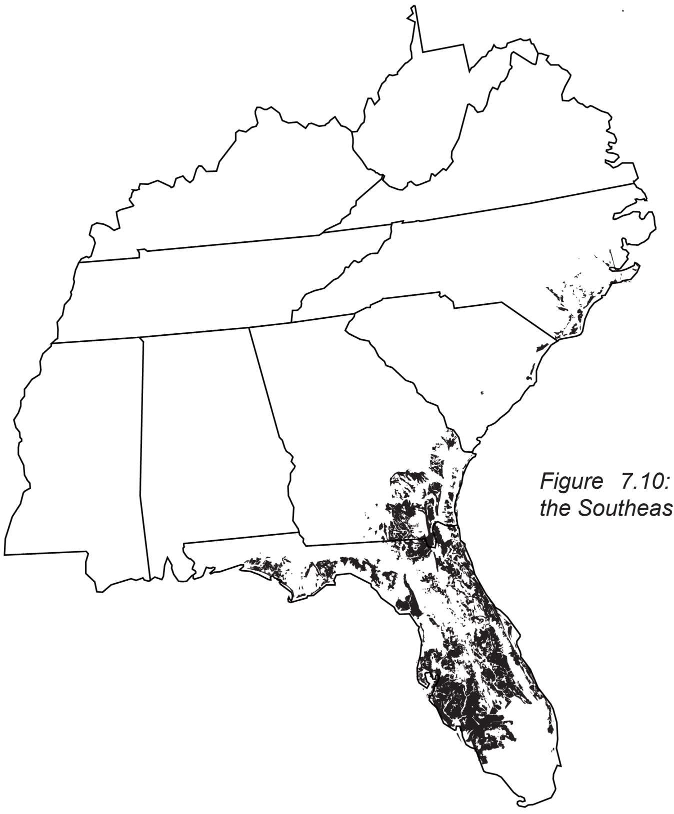


Figure 7.10: Spodosols of the Southeast.

Soil Orders

sandstone • *sedimentary rock formed by cementing together grains of sand.*

limestone • *a sedimentary rock composed of calcium carbonate ($CaCO_3$).*

shale • *a dark, fine-grained, laminated sedimentary rock formed by the compression of successive layers of silt- and clay-rich sediment.*

Paleozoic • *a geologic time interval that extends from 541 to 252 million years ago.*

inland sea • *a shallow sea covering the central area of a continent during periods of high sea level.*

suture • *the area where two continental plates have joined together through continental collision.*

terrane • *a piece of crustal material that has broken off from its parent continent and become attached to another plate.*

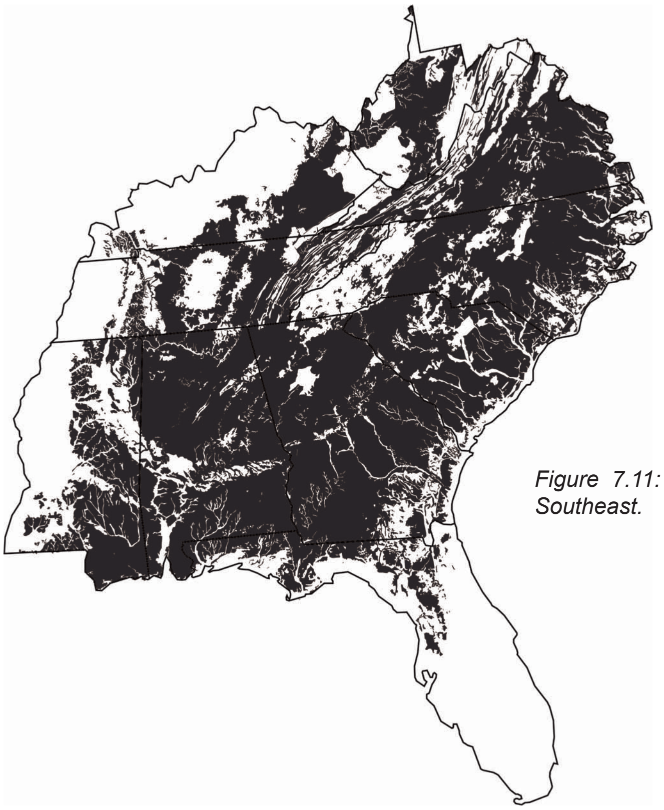


Figure 7.11: Ultisols of the Southeast.

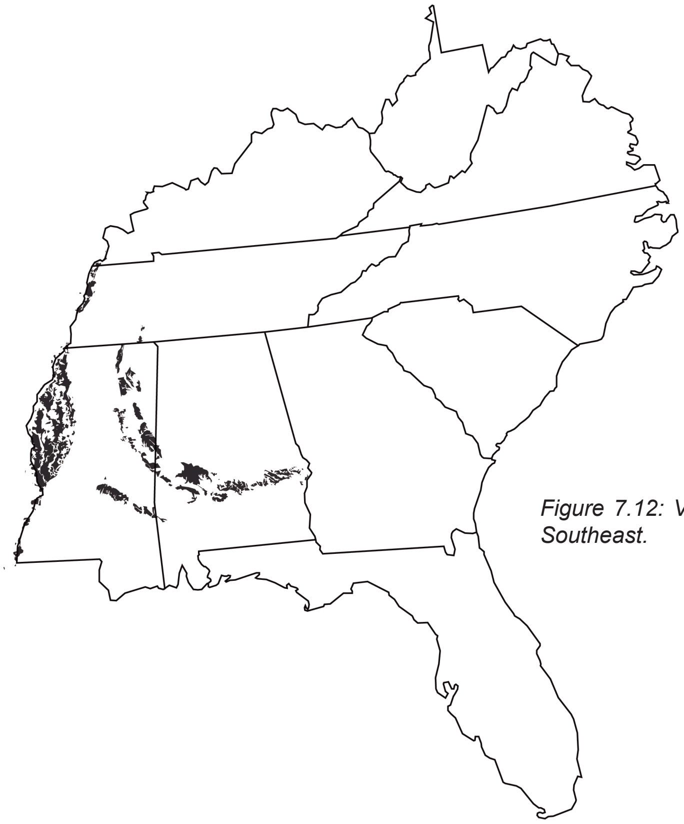


Figure 7.12: Vertisols of the Southeast.

Geology of the Southeast: Parent Material

The Southeast is home to a variety of parent materials—the minerals and organic matter from which its soils are derived (*Figure 7.13*). Mineral material determines a soil's overall fertility and the vegetation it supports.

Weathered sedimentary rock is one of the most ubiquitous parent materials in the Southeast. **Sandstone**, siltstone, **limestone**, and **shale** are common bedrocks throughout the Inland Basin and Coastal Plain; over time, erosional processes have contributed to the formation of soils from all of these sedimentary substrates. Much of this rock was laid down during the **Paleozoic,** when a shallow **inland sea** repeatedly flooded the landscape.

During the Paleozoic, the Blue Ridge and Piedmont was a **suture** zone for **terranes** and **volcanic islands**, and the site of multiple continent-continent collisions that folded and **faulted** rock layers to form igneous and metamorphic rocks. Today, an ancient core of erosion-resistant **Precambrian** rock is exposed in the Blue Ridge Mountains, and many soils there are derived largely from the erosion of these materials.

Alluvium makes up a portion of the parent material found along the Mississippi River, throughout Mississippi and western Tennessee. Glaciation during the **Quaternary** lead to the accumulation of loess deposits (*Figure 7.14*), which were carried by wind and deposited by river **systems**. These glacial sediments are responsible for the development of some extremely productive agricultural soils.

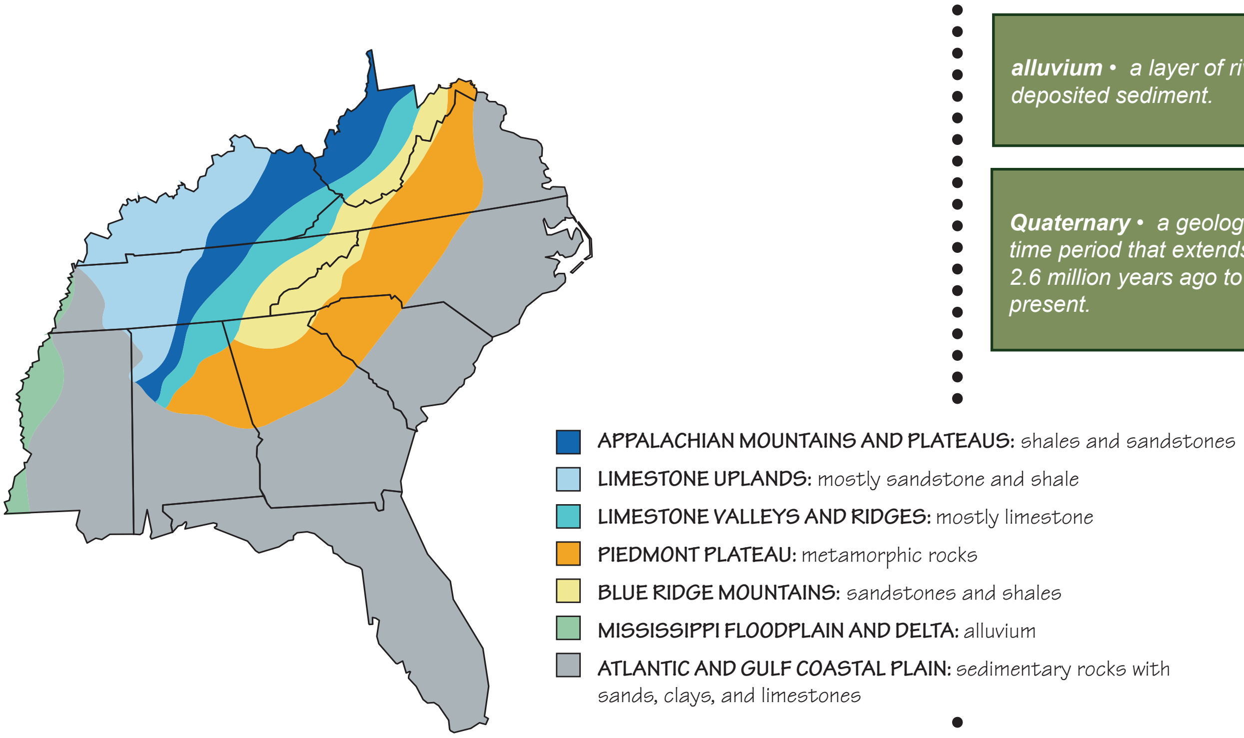


Figure 7.13: Physiographic and regolith map of the Southeast.
(See TFG website for full-color version.)

volcanic island • *one of a string of islands created when molten rock rises upward through oceanic crust.*

fault • *a fracture in the Earth's crust in which the rock on one side of the fracture moves measurably in relation to the rock on the other side.*

Precambrian • *a geologic time interval that spans from the formation of Earth (4.6 billion years ago) to the beginning of the Cambrian (541 million years ago).*

alluvium • *a layer of river-deposited sediment.*

Quaternary • *a geologic time period that extends from 2.6 million years ago to the present.*

relief *• the change in elevation over a distance.*

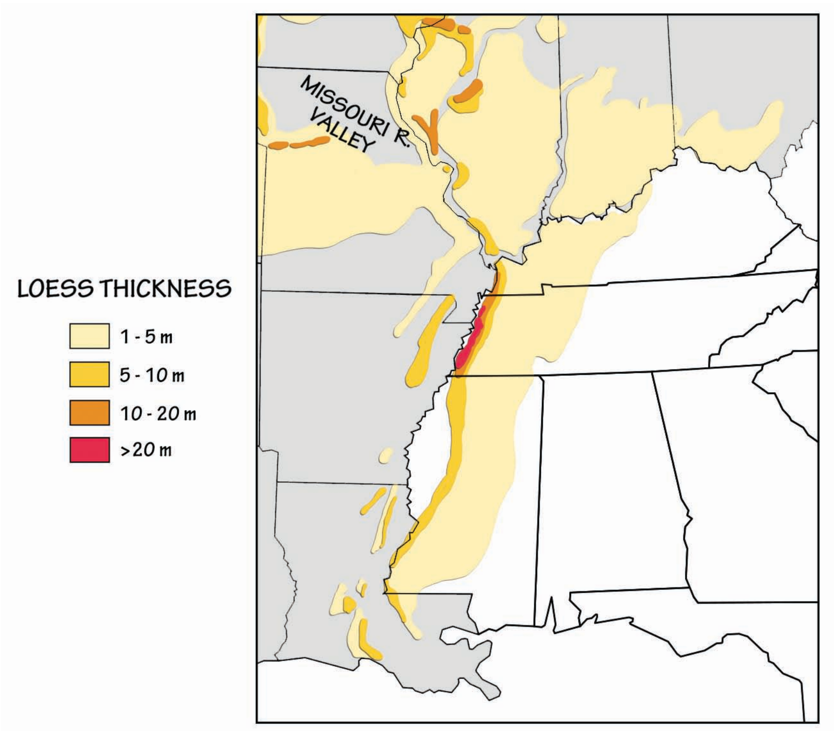


Figure 7.14: Loess deposits in the Southeast and surrounding states. (See TFG website for full-color version.)

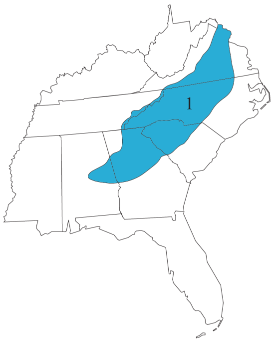
Soils of the Blue Ridge and Piedmont
Region 1

The soils of the Blue Ridge and Piedmont are widely varied, reflecting differences in the region's **relief**, bedrock, and climate. The intense tectonic events that shaped the region's rocks and mountainous topography have directly contributed to the availability of specific parent materials and the formation of the Blue Ridge and Piedmont's different soils.

See Chapter 2: Rocks to learn about the metamorphic rocks of the Blue Ridge and Piedmont.

Soils that develop from bedrock in the Blue Ridge vary in quality with relief, parent material, and climate. Steeper topography often causes relatively higher rates of erosion, which contributes to thin soil cover and limits agriculture in some areas. Inceptisols, in particular, are found on reasonably steep slopes and arise from parent material that is quite resistant to weathering. Not surprisingly, they are concentrated in the Blue Ridge, and can be found beneath most of the region's coniferous and hardwood forest (*Figure 7.15*).

The Piedmont's gently rolling topography is much less rugged than that of the Blue Ridge (though also dominated by igneous and metamorphic rocks), and



Region 1

feldspar • *an extremely common group of rock-forming minerals found in igneous, metamorphic and sedimentary rocks.*

oxidation • *a chemical reaction involving the loss of at least one electron when two substances interact.*

lime • *an inorganic white or grayish-white compound made by roasting limestone (calcium carbonate, $CaCO_3$) until all the carbon dioxide (CO_2) is driven off.*

7.15: An example of an Inceptisol soil. These soils are formed from resistant rocks on steeper slopes and are prevalent in the Blue Ridge Mountains.

is generally deeply weathered, creating thick soil profiles. The Piedmont is characterized by fine soils that are utilized for grazing, as well as for row crops such as corn and tobacco. These soils are typically 15–20 meters (50–65 feet) thick, and can be as much as 100 meters (330 feet) thick in certain areas thanks to low rates of erosion.

See Chapter 4: Topography to learn how the Piedmont's landscape differs from that of the Blue Ridge.

Ultisols, common throughout the Southeast, are rich in kaolinite, halloysite, and dickite clays formed by the intense weathering of **feldspar**-rich igneous and metamorphic rocks. These soils are well known in the Piedmont for their reddish color, caused by iron **oxides** in the clay (*Figures 7.16 and 7.17*). There is a tradition of handmade red clay pottery in central and northern Georgia, made from Ultisol clays. Ultisols tend to be acidic and are therefore poorly suited to agriculture, although they can be improved using fertilizer and **lime**.

Entisols in the Blue Ridge and Piedmont belong to the suborder Arents, which are defined by their homogenous nature due to plowing or other human-induced mixing. These soils are used mostly for pasture, cropland, or urban development. Moist Alfisols are found in a band hugging the boundary between the Piedmont and the Coastal Plain. These soils generally form in forested areas as a result of weathering processes that leach minerals from the surface layer into the subsoil, where nutrients are retained.

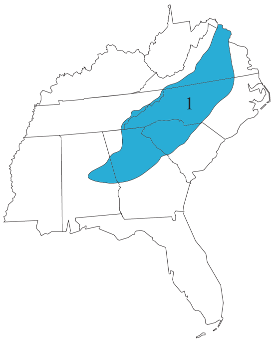
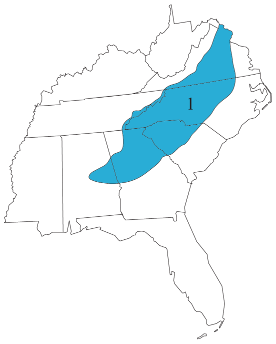


Figure 7.16: Ultisols, commonly called red clay soils, are especially common in North Carolina's Piedmont.

Figure 7.17: Sweet potatoes grown in red Ultisol soils at Kirby Farms in Mechanicsville, Virginia lie ready for harvest,



Soils of the Inland Basin
Region 2

Most soils of the Inland Basin developed on a variety of marine sedimentary rocks, including limestone, sandstone, and shale. Soil cover here is thick along river valleys, and thinner in the region's eastern, more mountainous part. These variable influences have led to a wide array of agricultural land uses. For example, soils developed above **phosphate**-bearing limestone bedrock in central Kentucky are favored for pastureland, and are part of the reason for the success of the area's thoroughbred horse industry. Crops sustained in the Inland Basin region include corn, soybean, small grains, hay, and tobacco.

phosphate *• an inorganic salt of phosphoric acid, and a nutrient vital to biological life.*

The prevalence of productive Alfisols in the Inland Basin has enabled a rich agricultural industry in the region, particularly in Kentucky and central Tennessee. These moisture-rich soils, members of the suborder Udalfs, consist of deep silty loam with a red clay subsoil and formed largely from a combination of loess and the underlying limestone bedrock (*Figure 7.18*).

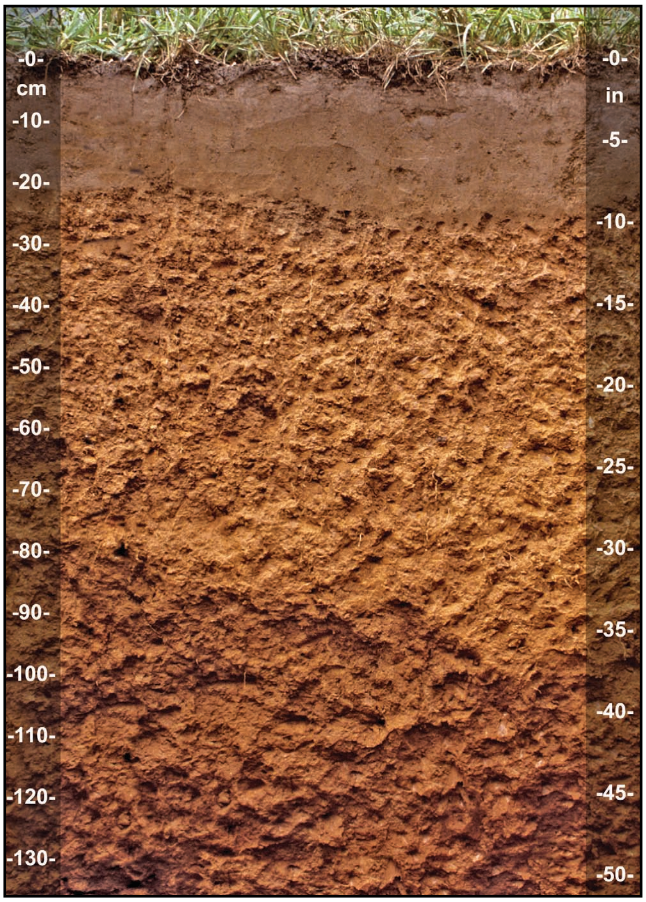
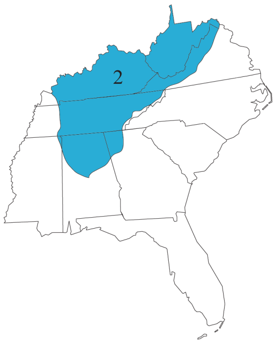


Figure 7.18: The Crider series, an Alfisol and the Kentucky state soil.



Cretaceous • *a geologic time period spanning from 144 to 66 million years ago.*

Cenozoic • *the geologic time period spanning from 66 million years ago to the present.*

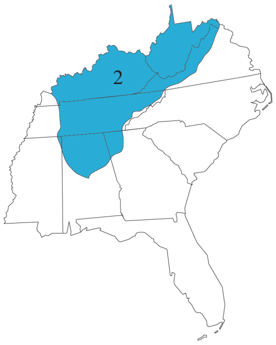
carbonate rocks • *rocks formed by accumulation of calcium carbonate, often made of the skeletons of aquatic organisms.*

Ultisols in the Inland Basin are typically found in or near more mountainous areas, where they originally weathered from exposed sedimentary rocks such as sandstone, siltstone, and shale. These soils, heavily leached and often acidic, are lower in fertility, with most nutrients concentrated in the uppermost horizon. They have little to no humus.

The steep slopes of the Appalachian Mountains in Kentucky, West Virginia, and Virginia are the perfect environment for the formation of Inceptisols, which support the region's dense mountain forests (*Figure 7.19*).

Figure 7.19: Inceptisol soils, rocky and poorly developed, carpet this forest path in Seneca Rocks, West Virginia.

Other soil types that appear in the Inland Basin are uncommon. Entisols, young soils lacking in horizons, are found scattered along streams and river valleys where unconsolidated sediment has been transported from the steep surrounding slopes. Wet Mollisols are found in central Tennessee, while a few fertile prairie Mollisols appear along Kentucky's northern border.



Soils of the Coastal Plain

Region 3

The soils of the Coastal Plain developed on loose, unconsolidated, generally flat layers of sediment, which resulted from **Cretaceous** and **Cenozoic** sea level fluctuation and the erosion of the Appalachian Mountains. Because of their young age and the nature of the underlying sediment, Coastal Plain soils are generally poorly developed. Although the Southeast's coastal climate is highly favorable for agriculture, production is dependent on the soils' variable characteristics (such as drainage, soil thickness, and weathering of minerals within the soil). In most parts of the Coastal Plain, areas rich in well- to moderately well-drained loamy soils are prime sites for agriculture including cotton, peanuts, soybean, tobacco, and corn.

As in the rest of the southeastern regions, Ultisols are the most prevalent soils in the Coastal Plain, covering large swaths of Virginia, North and South Carolina, Georgia, Alabama, and Mississippi with red-hued, clay-enriched soil.

Entisol soils are found where erosion and deposition occur faster than the rate of soil formation, and typically appear in floodplains where alluvial sediments are deposited. The western parts of Kentucky, Tennessee, and Mississippi contain Entisols that developed in deep loess deposits. Wind and water brought these materials to the area, and today water erosion serves to wash these deposits away (*Figure 7.20*). The consequences of soil erosion are a significant environmental issue for the western edge of the Coastal Plain. Conservation tillage and no-till practices are recommended when using these soils for agriculture, as the soil resource is highly sensitive to loss. Florida and other states along the Atlantic Coastal Plain also have significant deposits of shallow, sandy Entisols derived from **carbonate** and **siliciclastic** sediment (*Figure 7.21*).

See Chapter 2: Rocks for more about the interplay between carbonate and weathered siliciclastic sediments in the Coastal Plain.

In the coastal lowlands along the Atlantic and Gulf Coasts, poorly drained soils become common. The coastal lowlands are home to the largest swamps in the nation, including the Florida Everglades and the Okefenokee Swamp on the Georgia-Florida border. These swamps and many surrounding areas contain Spodosol soils, waterlogged mixtures of organic matter and aluminum characterized by a shallow, fluctuating **water table** (*Figure 7.22*). The Coastal Plain's Spodosols support water-loving plants, mosses, and **trees** such as cypress and palm; they are not good soils for most agriculture. Saturated Histosol soils filled with decomposing organic material are also found throughout Florida and the Carolinas' coastal plain. These soils form from the slow decomposition of organic detritus in wetland environments (*Figure 7.23*). Swampy, waterlogged soils are often drained to accommodate human settlement, which causes them to condense and **subside**. This is a particular problem near the Everglades

siliciclastic *• pertaining to rocks that are mostly or entirely made of silicon-bearing clastic grains weathered from silicate rocks.*

water table *• the upper surface of groundwater.*

tree *• any woody perennial plant with a central trunk.*

subsidence *• the sinking of an area of the land surface.*

Figure 7.20: Unconsolidated loess-based Entisol soils blanket the Mississippi River valley and bluffs. Erosion is a major concern.

Figure 7.21: A gopher tortoise exits a burrow dug in Florida's sandy Entisols.

Figure 7.22: This alligator in Georgia's Okefenokee Swamp lies on mud composed of waterlogged Spodosols.

Figure 7.23: A mucky Histosol from South Carolina's coastal wetlands.

chalk • a soft, fine-grained, easily pulverized, white-to-grayish variety of limestone, composed of the shells of minute planktonic single-celled algae.

permeability • a capacity for fluids and gas to move through fractures within a rock, or the spaces between its grains.

in southern Florida, where extensive draining has contributed to severe soil loss and compromised the local ecosystem.

See Chapter 10: Earth Hazards to learn how draining and subsidence have affected the Florida Everglades.

Vertisol soils are rare in the Southeast, but can be found in a band running through central Mississippi and Alabama as well as throughout the Mississippi River floodplain. The Vertisols in the Gulf Coastal Plain contain high percentages of smectite clays, which shrink and form wide cracks at the surface during dry periods (*Figure 7.24*). The cracks, which can be up to a meter (three feet) deep, seal shut again when moisture enters the soil. Because these soils shrink and swell so readily, it is extremely difficult—and even dangerous—to build structures or roads on top of them. The action of shrinking and swelling within the soil also prevents the formation of distinct horizons. Vertisols along the Mississippi floodplain are saturated with water for extended periods and rarely form cracks. The Black Belt, an agricultural region that runs through Mississippi and Alabama, is dominated by drier soils that open and close depending upon the amount of precipitation. The area was named for its layer of organic-rich black topsoil that developed from underlying **chalk** sequences. Because the chalk is **impermeable** to groundwater, the overlying soils tend to dry out and crack during the summer.

Figure 7.24: Cracked Vertisols near Birmingham, Alabama.

Inceptisols are scattered along streams throughout the inland areas of the Coastal Plain. Moist Mollisols can be found throughout central Florida, where they are commonly used for agricultural purposes.

State Soils

Just as many states have official state flowers, birds, and **fossils**, they also have official soils. State soils are most often determined by a vote of soil scientists in the state, and, absent any political wrangling, usually represent the most productive soils and those that most closely resemble everyone's favorite soil: loam. As mentioned earlier, loam soils are almost equal parts sand, silt, and clay.

State Soils

fossil • *preserved evidence of ancient life.*

hectare • *a metric unit of area defined as 10,000 square meters.*

Alabama

Bama soils are well-drained Ultisols that cover more than 146,000 **hectares** (360,000 acres) of western and central Alabama. These thick deposits of loamy **fluvial** or marine sediments are found parallel to major river systems, and are used in the cultivation of corn and cotton as well as pastureland.

Florida

The Myakka soil is native to Florida and does not occur in any other state. A type of Spodosol, it is the most extensive soil in the state and covers over 607,000 hectares (1.5 million acres) of land. This wet, sandy soil originates from marine deposits, and is a major component of flatwood ecosystems.

Georgia

The state soil of Georgia is the Tifton series, loamy Ultisols of marine origin. These soils are some of the most important agricultural soils in the state, found on more that 810,000 hectares (two million acres) of land and underlying about 27% of Georgia's prime farmland. The principle crops grown on Tifton soils include soybeans, corn, cotton, and peanuts.

Kentucky

Highly productive Crider soils are used for crops or pasture over nearly 200,000 hectares (500,000 acres) of Kentucky's uplands. Grain, corn, soybeans, tobacco, and hay are grown on these well-drained, moderately permeable Alfisols.

Mississippi

Found along the bluffs of the Mississippi Delta and throughout the full length of the state, Natchez soils are used mostly for woodlands and pastures. These Inceptisols formed in deep loess under a warm and humid woodland environment. They are fertile and, with the proper management, can be very productive.

North Carolina

Cecil soils are Ultisols that developed over igneous and metamorphic rocks, and contain a topsoil of brown sandy loam with a thick red clay subsoil. They make up over 607,000 hectares (1.5 million acres) of North Carolina's Piedmont, about half of which is cultivated for tobacco, corn, cotton, and grains. If undisturbed, these soils commonly support forests dominated by oak, hickory, and pine.

State Soils

South Carolina
The state soil of South Carolina is the Lynchburg series, which consists of deep and poorly drained Ultisols that formed from sandy and loamy marine sediment. These soils are found along the Coastal Plain in interstream divides and shallow depressions. If they are drained, Lynchburg soils can be used as prime farmland.

Tennessee
Tennessee's state soil is the Dickson series, deep, moderately well-drained Ultisols that formed in a thick mantle of limestone and silt. These soils are most often found on level and gently sloping uplands, and are used to support corn, soybeans, and pasture.

Virginia
Pamunkey soils were first identified at a farm near Jamestown, Virginia, considered the oldest tilled farm in the United States. They are named for the Pamunkey Indian tribe, who first used these fertile Alfisols to sustain their agriculture. These soils formed in the James River drainage basin from sediments that originated in every physiographic province of Virginia.

West Virginia
Monongahela soils are deep, moderately well-drained Ultisols that are found on unflooded alluvial stream terraces. They are well suited to crop production, and are considered prime farmland and pastureland. The name "Monongahela" is derived from a Native American word that means "high banks or bluffs, breaking off and falling down in places."

Resources

Books and Articles

Lindbo, D. L. 2012. *Know Soil, Know Life*. Soil Science Society of America, Madison, WI, 206 pp.

Lindbo, D. L., & J. Mannes. 2008. *Soil! Get the Inside Scoop.* Soil Science Society of America, Madison, WI, 32 pp.

Logan, W. B. 1995. *Dirt: the Ecstatic Skin of the Earth*, Riverhead Books, New York, 202 pp.

Soil Survey Staff. 2014. *Keys to Soil Taxonomy, 12th edition*. US Department of Agriculture, Natural Resources Conservation Service, Washington, DC, 362 pp., http://www.nrcs.usda.gov/.wps/PA_NRCSConsumption/download?cid=stelprdb1252094&ext=pdf.

Soil Survey Staff. 2014. *Illustrated Guide To Soil Taxonomy.* US Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE, 498 pp., http://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=stelprdb1247203&ext=pdf.

Websites

K-12 Soil Science Teacher Resources, Soil Science Society of America, http://www.soils4teachers.org/.

Soil Survey Reports (by state and county/parish), The Cooperative Soil Survey, http://soils.missouri.edu/survey/selectstate.asp.

Soil Sustains Life, Soil Science Society of America, https://www.soils.org.

Soils Tutorial, The Cooperative Soil Survey, http://soils.missouri.edu/tutorial/index.asp.

The Twelve Soil Orders Soil Taxonomy, University of Idaho College of Agricultural and Life Sciences, http://www.cals.uidaho.edu/soilorders/.

Soils, USDA Natural Resources Conservation Service, http://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/. (Soil surveys by state, technical publications, soil data, and much more.)

Soils of the Southeast

Busscher, W. J., H. H. Schomberg, R. L. Raper, & D. Bumpe. 2010. Soil and water conservation in the southeastern United States: a look at conservation practices past, present, and future, in *Soil and Water Conservation Advances in the United States*, edited by T. M. Zobeck & W. F. Schillinger. *Soil Science Society of America Special Publication* 60: 183–200, http://www.ars.usda.gov/SP2UserFiles/Place/60820000/Manuscripts/2010/Man828.pdf.

Soil in Georgia, Georgia Soil and Water Conservation Commission, https://gaswcc.georgia.gov/soil-georgia.

Soils in Mississippi, Mississippi Agricultural and Forestry Experimental Station, Mississippi State University Extension Service, http://msucares.com/crops/soils/.

Soils of Alabama, by C. C. Marshall, Jr., 2014, Alabama A&M and Auburn Universities Extension, https://store.aces.edu/ItemDetail.aspx?ProductID=14604.

Soils of West Virginia, by John Sencindiver, 2010, e-WV: The West Virginia Encyclopedia, http://www.wvencyclopedia.org/articles/509.

Springer, M. E., & J. A. Elder. 1980. *Soils of Tennessee*. University of Tennessee Agricultural Experiment Station, Knoxville, TN, 66 pp.

Virginia State Soil: The Pamunkey Soil Series, Virginia Association of Professional Soil Scientists, http://vapss.org/StateSoil.html.

Watts, F. C., & M. E. Collins. 2008. *Soils of Florida*. Soil Science Society of America, Madison, WI, 88 pp.

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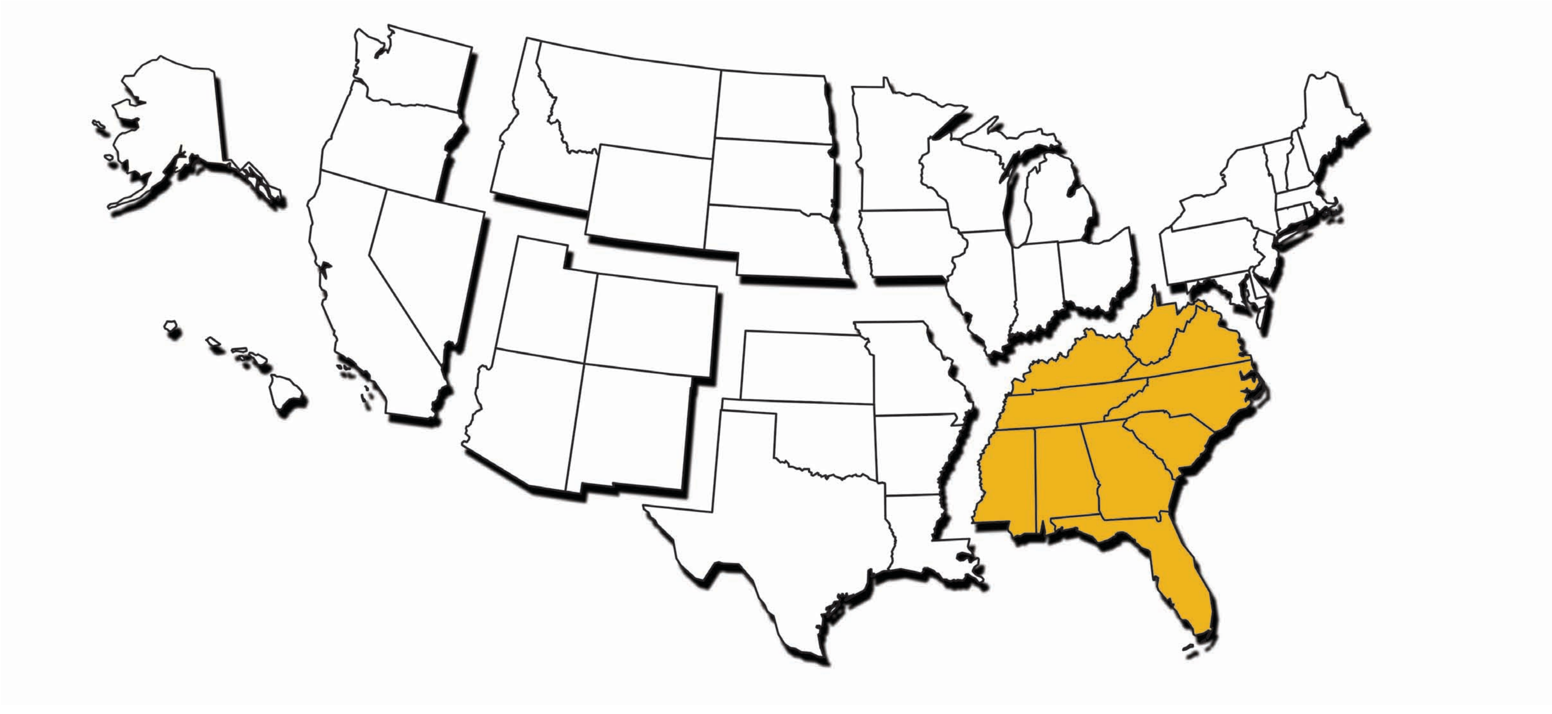

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On the back cover: Blended geologic and digital elevation map of the Southeastern US. Each color represents the age of the bedrock at the surface. Adapted from Barton, K. E., Howell, D. G., Vigil, J. F., *The North America Tapestry of Time and Terrain*, US Geological Survey Geologic Investigations Series I-2781, http://pubs.usgs.gov/imap/i2781.