National Cooperative Soil Survey

National Conference

May 22 – 26, 2011

Asheville, North Carolina

North Carolina State University, Department of Soil Science

USDA, Natural Resources Conservation Service

Soil Science Society of North Carolina

CREDITS

Special thanks to all the individuals who planned and organized the field trips for this national conference, contacted presenters, obtained permissions for use, and pulled together these two events.

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Also, thanks to these folks who supplied materials for this tour book

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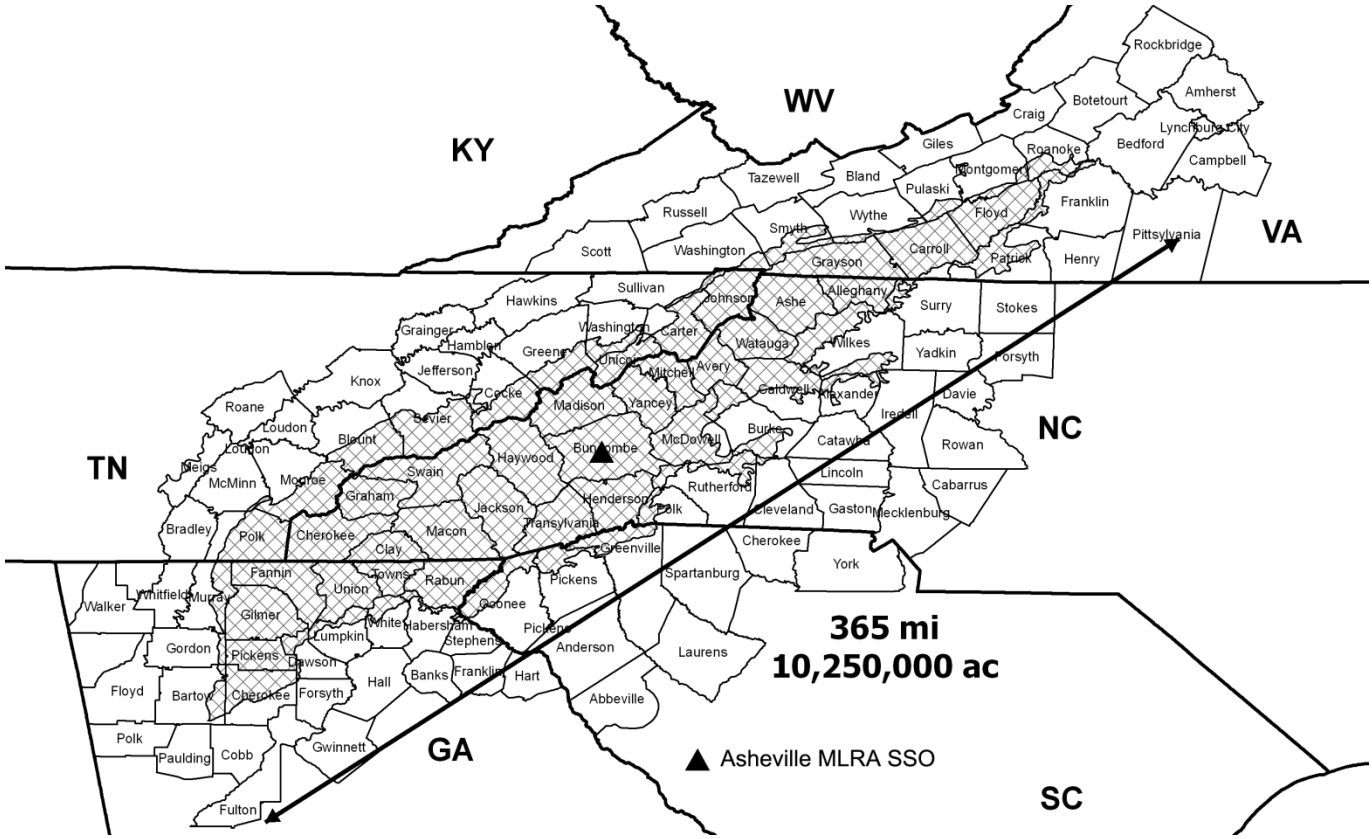
We also wish to thank the Waldroop family for allowing us to visit their farm for the pre-conference tour. They were also kind to let 260 FFA students trample across their fields to practice for this year’s state FFA Land Judging Career Development Event

I would also like to remember Tim Harlan who spent 18 years working for NRCS before leaving to co-found a new consulting business, Mountain Soil, Inc. Tim worked on soil surveys in the mountains including Avery County, Watauga County, Swain County and the Great Smoky Mountains National Park, Tennessee and North Carolina. His work has resulted in some of the soils and mapping concepts we will see this week on our tours. He will be missed but his work remains.

Roy Vick
State Soil Scientist/MLRA Leader

Asheville Soil Survey Office Area
MLRA 18-7
MLRA 130B – Southern Blue Ridge



MLRA 130B - Southern Blue Ridge

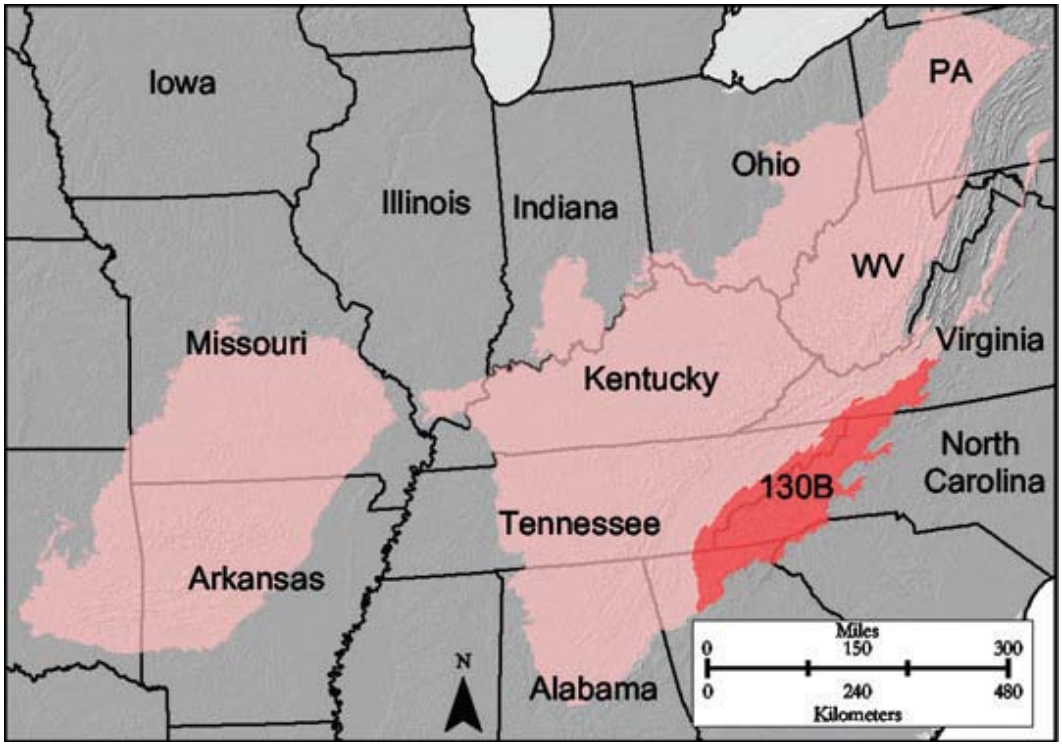


Figure 130B: Location of MLRA 130B in Land Resource Region N

Introduction

This area (shown in fig. 130B) is in North Carolina (51 percent), Tennessee (18 percent), Georgia (17 percent), Virginia (10 percent), and South Carolina (4 percent). It makes up about 16,080 square miles (41,665 square kilometers). It is locally known as the Southern Appalachians. It includes Lenoir, Morganton, Marion, Hendersonville, Waynesville, and Asheville, North Carolina; Gatlinburg, Tennessee; Damascus and Galax, Virginia; Walhalla, South Carolina; and Cleveland, Dahlonega, and Ellijay, Georgia. Interstate 40 crosses the parts of the area in Tennessee and North Carolina. Interstate 77 crosses the part in Virginia. Many national forests are in the area, including the Jefferson, Cherokee, Nantahala, Pisgah, and Chattahoochee National Forests. The Appalachian Trail begins on Springer Mountain in Georgia, near Amicalola State Park. The Great Smoky Mountains National Park is in this MLRA. The Mount Rogers National Recreation Area is in the part of the MLRA in Virginia. The Cherokee Indian Reservation is west of Waynesville, North Carolina.

Physiography

This MLRA is mainly in the Southern Section of the Blue Ridge Province of the Appalachian Highlands. The southern tip of the MLRA and two protruding areas to the east are in the Piedmont Uplands Section of the Piedmont Province of the Appalachian Highlands. This MLRA consists of several distinct topographic areas, including the Blue Ridge Escarpment on the eastern edge of the area, the New River Plateau on the northern end, interior low and intermediate mountains throughout the MLRA, intermountain basins between the major mountains, and the high mountains making up the bulk of the MLRA. Elevation ranges from about 900 feet (275 meters) at the south and southwest boundaries of the area to more than 6,600 feet (2,010 meters) at the crest of the Great Smoky and Black Mountain ranges.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Upper Tennessee (0601), 46 percent; Kanawha (0505), 13 percent; Middle Tennessee-Hiwassee (0602), 12 percent; Edisto-Santee (0305), 9 percent; Alabama (0315), 8 percent; Ogeechee-Savannah (0306), 6 percent; Pee Dee (0304), 4 percent; Chowan-Roanoke (0301), 1 percent; and Apalachicola (0313), 1 percent. From north to south, the major rivers in this area are the New River in Virginia; the Yadkin, Catawba, French Broad, Little Tennessee, and Hiwassee Rivers in North Carolina; the Saluda, Seneca, Chattooga, and Tugaloo Rivers in South Carolina; and the Toccoa and Coosawattee Rivers in Georgia. The Tugaloo River is a headwater stream of the Savannah River, and the French Broad, Little Tennessee, Hiwassee, and Ocoee Rivers also flow into Tennessee in this area. The Hiwassee River in Tennessee and the Conasauga River in Georgia have been designated National Wild and Scenic Rivers in this area. The Chattooga River (made famous in the motion picture "Deliverance") in South Carolina is a National Scenic River.

Geology

The bedrock geology in this area consists mostly of Precambrian metamorphic rock formations with a few small bodies and windows of igneous and sedimentary rocks. The degree of metamorphism varies but generally decreases westward. The higher grade metamorphic rocks include formations of gneiss, schist, and amphibolite. Low-grade metamorphic formations in the southwestern part of the MLRA include distinct and interbedded bodies of metasandstone, slate, phyllite, metasiltstone, and metaconglomerate. Surficial deposits include colluvial material on fans and aprons along the ridges and alluvial material along the major streams.

Climate

The average annual precipitation in this area generally is 36 to 60 inches (915 to 1,525 millimeters), generally increasing with elevation. It is 60 to 90 inches (1,525 to 2,285 millimeters) in southwestern North Carolina and northeastern Georgia and can be as much as 119 inches (3,025 millimeters) on the higher peaks in the MLRA. Much of the precipitation occurs as snow at the higher elevations. The amount of precipitation is lowest in the fall. The average annual temperature ranges from 46 to 60 degrees F (8 to 16 degrees C), decreasing with elevation. The freeze-free period averages 185 days and ranges from 135 to 235 days. The freeze-free period is shorter at high elevations and on valley floors because of cold air drainage. Microclimate differences resulting from aspect significantly affect the type and vigor of the plant communities in the area. South- and west-facing slopes are warmer and drier than north- and east-facing slopes and those shaded by the higher mountains.

Soils

The dominant soil orders in this MLRA are Inceptisols and Ultisols. The soil moisture regime is udic. The soil temperature regime typically is mesic, but it is frigid at elevations above 4,200 feet (1,280 meters). Soil depth ranges from shallow to very deep. The general textural class is loamy or clayey.
In areas at elevations of less than 3,500 feet (1,065 meters), the soils on uplands generally are red, fine-loamy or fine Typic Hapludults (Evard, Junaluska, and Hayesville series). Humic Hapludults (Trimont and Snowbird series) are on north and east aspects. Soils that formed in colluvium in coves are Typic Dystrudepts (Tate, Greenlee, and Northcove series), Typic Hapludults (Lonon and Keener series), or Humic Hapludults (Saunook and Thunder series).

At elevations between 3,500 and 4,200 feet (1,065 and 1,280 meters), the soils on uplands generally are brown, fine-loamy or coarse-loamy Dystrudepts. Humic Dystrudepts (Plott, Porters, and Cheoah series) are common on north and east aspects, and Typic Dystrudepts (Edneyville, Chestnut, Ditney, and Stecoah series) are common on south and west aspects. Soils that formed in colluvium in coves are Humic Dystrudepts (Cullasaja, Spivey, Tuckasegee, and Santeetlah series) or Humic Hapludults (Saunook and Thunder series).

In areas at elevations above 4,200 feet (1,280 meters), the soils on uplands generally are brown, fine-loamy or coarse-loamy Humic Dystrudepts with a frigid soil temperature regime (Burton, Oconaluftee,

and Breakneck series). Soils that formed in colluvium also are Humic Dystrudepts (Balsam and Chiltoskie series).

Soils that formed in alluvium vary with stream gradient, energy, and entrenchment into the valley floor. In the upper reaches of watersheds where flood plains are narrow, the soils are Oxyaquic and Fluvaquentic Dystrudepts (Dellwood, Reddies, and Cullowhee series). In the lower and broader river valleys, Udipsamments (Biltmore series) and coarse-loamy Dystrudepts (Rosman series) are in areas closest to rivers and streams on flood plains. Humaquepts (Ela, Nikwasi, and Toxaway series) are in low-lying, frequently flooded or ponded areas. Ultisols are most common on the more stable stream terraces. Fine-loamy Aquic and Typic Hapludults (Dillard and Statler series) are on low terraces, and fine Typic Hapludults (Braddock and Unison series) are on high terraces.

Biology

This area supports a wide diversity of plant and animal life because of highly varied topography and climatic conditions. The kind of vegetation changes with elevation and slope aspect. At the lower elevations, below 3,000 feet (915 meters), the most common trees are white oak, black oak, scarlet oak, chestnut oak, hickory, eastern white pine, Virginia pine, and pitch pine. Yellow-poplar and northern red oak are common in the northern part of the MLRA. At the middle elevations, the most common trees are yellow-poplar, black cherry, black birch, sugar maple, northern red oak, American basswood, eastern hemlock, and yellow buckeye. At the higher elevations, above 5,000 feet (1,525 meters), red spruce and Fraser fir are the dominant tree species. In some areas at a high elevation, grassy and heath “balds” are evident. These are large meadows or treeless areas. Grassy balds are dominated by grass species and are home to rare shade-intolerant plant varieties. Heath balds support shrubs, such as rhododendron, mountain laurel, blueberry, flame azalea, hawthorn, huckleberry, and sand myrtle.

The diverse plant communities provide habitat for many species of wildlife. Black bear, white-tailed deer, and wild turkey are plentiful. The higher elevations provide suitable habitat for the birds and animals that are common in northern latitudes, such as northern saw-whet owl, Canada warbler, common raven, northern flying squirrel, and red squirrel.

Land Use

More than two-thirds of this area is forestland used for timber production, watershed protection, recreation, and wildlife habitat. The federally owned forestland in the area is mainly U.S. Forest Service or National Park Service land. The small acreage of cropland is used for vegetables, fruit orchards, native ornamental crops, and Christmas trees as well as corn and small grain. About 10 percent of the MLRA is in pastured areas used for dairy, beef, and wool production. The largest urban area in this MLRA is Asheville, North Carolina. The MLRA is a popular area for tourism and retirement living. As a result, steady or rapid urban growth occurs in many areas.

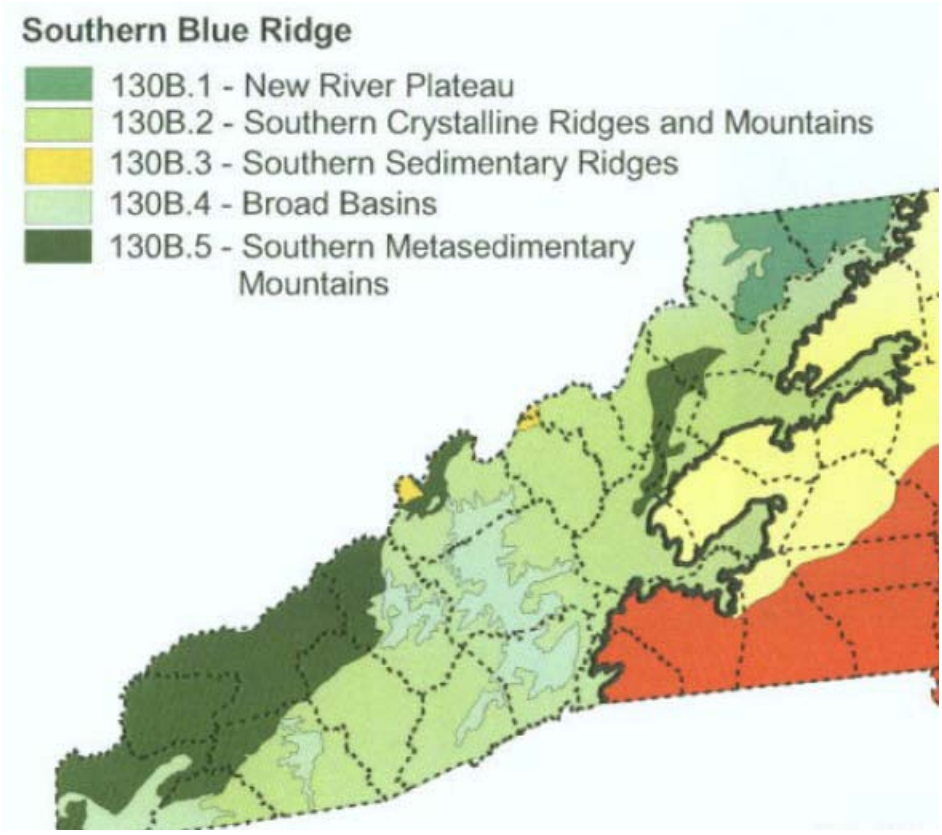
Erosion from poorly constructed and maintained access roads is a major management concern in this area. Sediment from access roads and urban development is the main pollutant of streams in the area.

Poor air quality, especially in summer, is both a health and economic problem. Air pollution flowing from the industrial Midwest affects people who are sensitive to pollutants, such as ozone, and those who suffer from breathing disorders. At high elevations, air pollution and acid deposition are thought to be partially responsible for damage to the spruce and fir forests.

Proper woodland management is extremely important since privately held forestland makes up a significant portion of the land area in this MLRA. Proper design and construction of access roads and stabilization of roadbanks can minimize the impact of timber management on water quality.

Conservation practices in agricultural areas include field borders, grassed waterways, diversions, and riparian buffers along streams. Prescribed grazing and proper forage, nutrient, and pest management practices are critical in maintaining the productivity of grazing land.

Common Resource Areas
Subdivisions of MLRAs in Western North Carolina



130B.1	New River Plateau	High, hilly plateau punctuated by scattered isolated knobs (monadnocks). Inceptisols, Alfisols, and Ultisols are common. Stoniness and limited depth to bedrock are characteristics of these soils. Woodland remains on steeper slopes.
130B.2	Southern Crystalline Ridges and Mountains	Pronounced ridges and mountain massed separated by high gaps and coves. Mountain flanks are steep and well dissected. Typically, Inceptisols, (Dystrudepts) and Ultisols (Hapludults) developed from the bedrock. Stoniness and steepness are characteristics of these soils.
130B.3	Southern Sedimentary Ridges	High, steeply sloping ridges and deep, narrow valleys. Ridge crests are underlain by resistant sandstone and quartzite, while side slopes consist of phyllite, shale, siltstone, and sandstone. Typically, Inceptisols (Dystrudepts) developed from bedrock.
130B.4	Broad Basins	This CRA consists of intermontane area of open low mountains, rolling foothills, and moderately broad mountain valleys. Moderate gradient streams with cobbles and boulders. Mostly forested; some pasture and row crops.
130B.5	Southern Metasedimentary Mountains	This CRA consists of low to high mountains, gently rounded to steep slopes, narrow valleys. High gradient, bedrock and boulder-bottomed, cool, clear streams, plain forest. Mostly forested; large areas of public lane (Chattahoochee National Forest); tourism, recreation hunting, some pasture and orchards on less steep land.

Preconference Soil Tour
May 22, 2011

Blue Ridge Parkway

Waterrock Knob

Geology Overview – Dr. Steven Yurkovich – Western Carolina University

Soil Formation in Frigid Temperature Regime – Anthony Kheil, NRCS, TN and Doug Thomas, NRCS retired

Coweeta Hydrologic Laboratory

Welcome – Dr. Jennifer Knoepp – USFS

Modeling factors of soil formation – Doug Thomas, NRCS retired

Landscape Relations and Soil Profiles – NRCS staff

Waldroop Farm

Soils in the valleys of the Southern Blue Ridge – Kent Clary, NRCS

Blue Ridge Parkway

NPS PHOTO
The Brinegar Cabin at Milepost 238.5 near Doughton Park in North Carolina

The Blue Ridge Parkway is history waiting to be discovered! Although the road is often seen primarily as a scenic byway with plenty of natural attractions, it is also a cross-section of Appalachian mountain history. Stretching almost 500 miles along the crest of the Blue Ridge mountains through North Carolina and Virginia, it encompasses some of the oldest settlements of both pre-historic and early European settlement. Visitors can trace much of the history of Appalachian culture by observing overlook signs, visitor center exhibits, restored historic structures, and developed areas, all of which reveal points of particular interest. For a complete listing of the Parkway's historic attractions, contact the areas you will be visiting. In the meantime, here are some of the highlights:

Native American Culture and Influence

The Cherokee Indians of North Carolina, and the Monacan, Saponi, and Tutelo Indians of western Virginia, were among the earliest inhabitants of the Blue Ridge, leaving artifacts and changes in the landscape as evidence of their existence. Many of the fields still visible at the base of the mountains date back centuries to ancient American Indian agricultural methods of burning and deadening the trees and underbrush to provide needed grazing and crop land. Mountain and river names along the Parkway also reflect the American Indian influence. The best place to learn about the pre-history of the Appalachian chain in Virginia is at the Peaks of Otter Visitor Center museum (milepost 85.9). Arrowheads and early tools found in the Peaks area are exhibited. In North Carolina, the Parkway enters the Cherokee Indian Reservation at milepost 457.7 and features an informational display on the reservation at the Lickstone Parking Overlook (milepost 458.9).

European Homesteads

There are many surviving examples of early European pioneer structures along the Parkway, beginning at Milepost 5.8 at the Humpback Rocks Visitor Center and Mountain Farm exhibit. The easy Mountain Farm Self-Guiding Trail takes you through a collection of 19th century farm buildings, and in the summer months there are often living history demonstrations. The Visitor Center exhibits represent the most complete effort at interpreting the Blue Ridge region with stories about early housing, community, entertainment, and transportation. At the Peaks of Otter (Milepost 85.9) there is a moderate loop trail leading to the Johnson Farm, in which generations of the Johnson family lived and worked with other members of the now-vanished community. Another structure of interest here is Polly Woods Ordinary, representative of the early days of tourism in the area. The Trail Cabin (Milepost 154.6), Puckett Cabin (Milepost 189.9), Brinegar Cabin (Milepost 238.5), Caudill Cabin (Milepost 241), and Sheets Cabin (Milepost 252.4) are all 19th-century log cabins illustrating the occasional isolated existence of mountain residents and the efforts of the original park planners to save log structures as opposed to other types of larger farm houses they found. The Jesse Brown Farmstead (Milepost 272.5) consists of a cabin, spring house, and the relocated Cool Springs Baptist Church.

Representative Industries Along the Parkway

Just about every form of 19th-century industrial development in the mountains has its story told somewhere along the Parkway. Yankee Horse Ridge Parking Area (milepost 34.4) has a short stretch of reconstructed narrow-gauge railroad track once known as the Irish Creek Railway, along with an exhibit on logging in the area. The James River Visitor Center (Milepost 63.6) has an exhibit on the ill-fated James River and Kanawha Canal, with a self-guiding

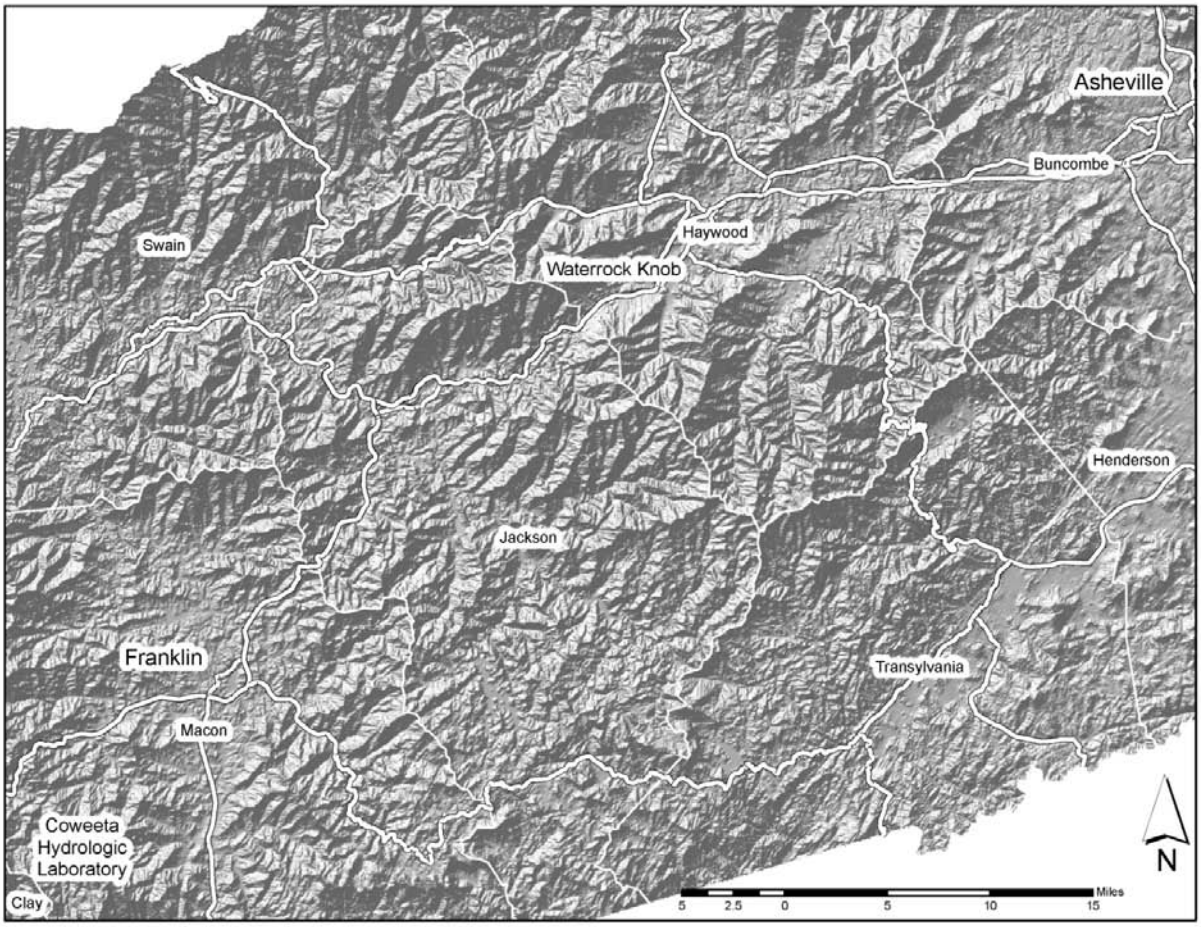
trail to a restored lock dating from the mid-19th century. Mining operations in the Appalachians are remembered in place names such as Iron Mine Hollow (mile posts 96.2, 96.4) and at an exhibit in the North Toe Valley Overlook, Milepost 318.4. Of all the points of interest on the Parkway, perhaps Mabry Mill (Milepost 176.2) is the best known. The Mabry Mill Trail features a black smith shop, wheel wright's shop, and whiskey still, as well as the most photographed structure on the Parkway, Mabry Mill itself. As anyone who has traveled in the Appalachians knows, mountain crafts are one of the most popular attractions. Traditional crafts and music still thrive in the Blue Ridge mountains of today. Along the Parkway in North Carolina are several places to view and purchase locally made items, such as the Northwest Trading Post (Milepost 258.6), the Moses Cone Estate and Parkway Craft Center (Milepost 294.1), and the Folk Art Center (Milepost 382).

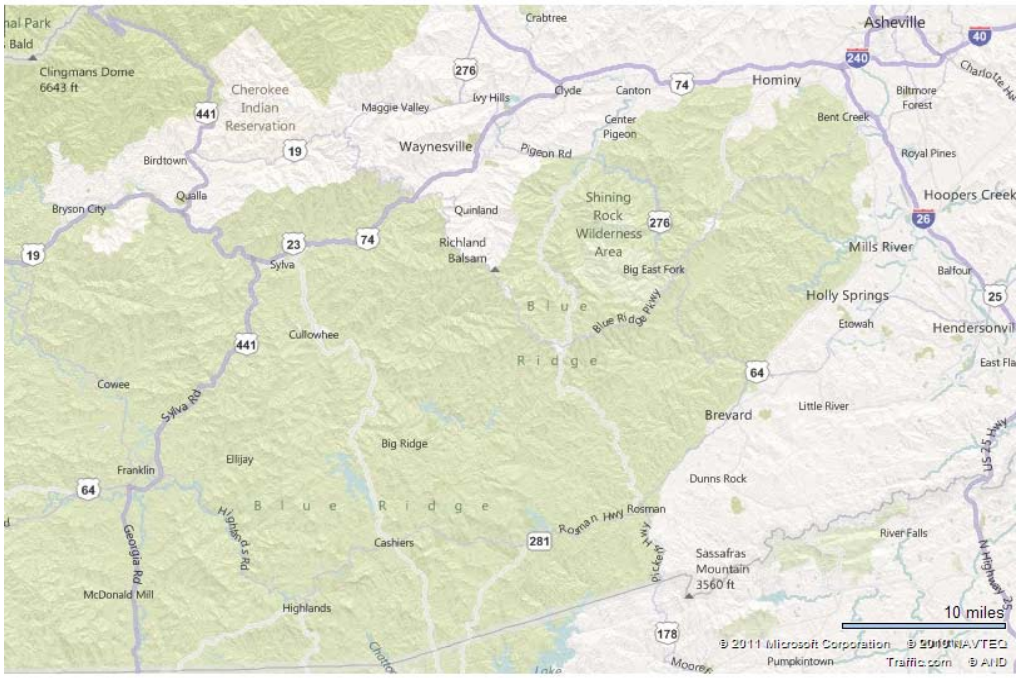
The Modern Era

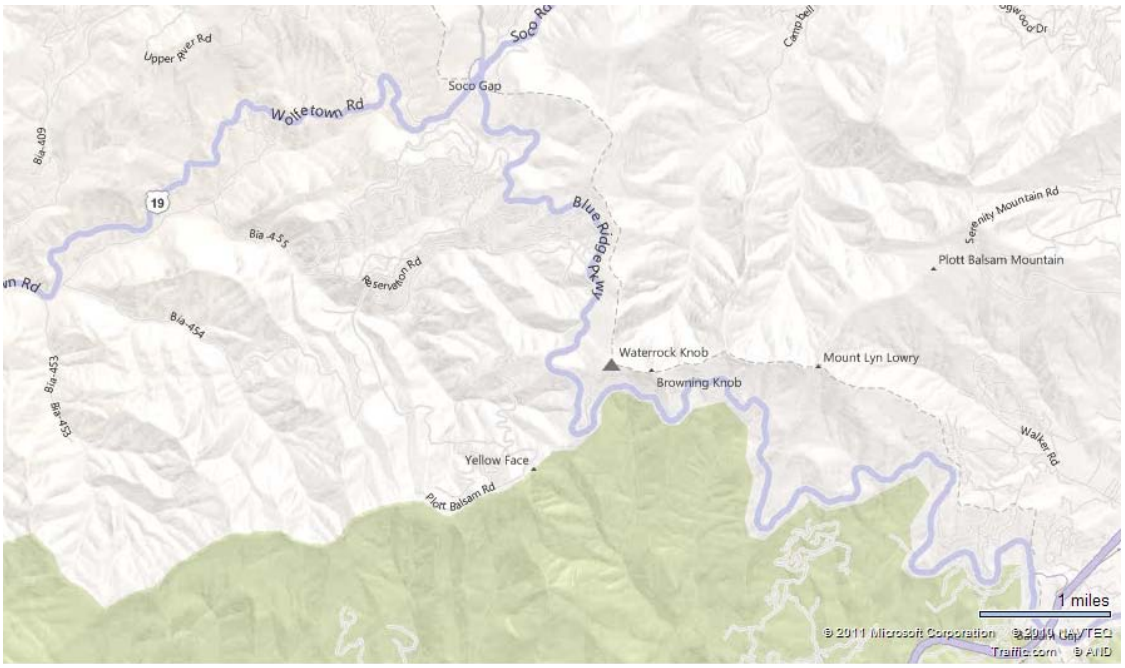
By the 20th century, the Blue Ridge was viewed as a desirable location for men of wealth to build retreats. The Moses H. Cone and Julian Price Memorial Parks (Mileposts 292 - 298) are examples of this. The Cone estate includes a turn-of-the-century manor house and 24 miles of carriage roads, while the Julian Price Park offers several short trails and a lake.
The most obvious modern contributor to the landscape is of course the Parkway itself, conceived and designed as a scenic motor road and conservator of the natural and historical treasures of the Blue Ridge. Today, it is the most visited site in the National Park system.

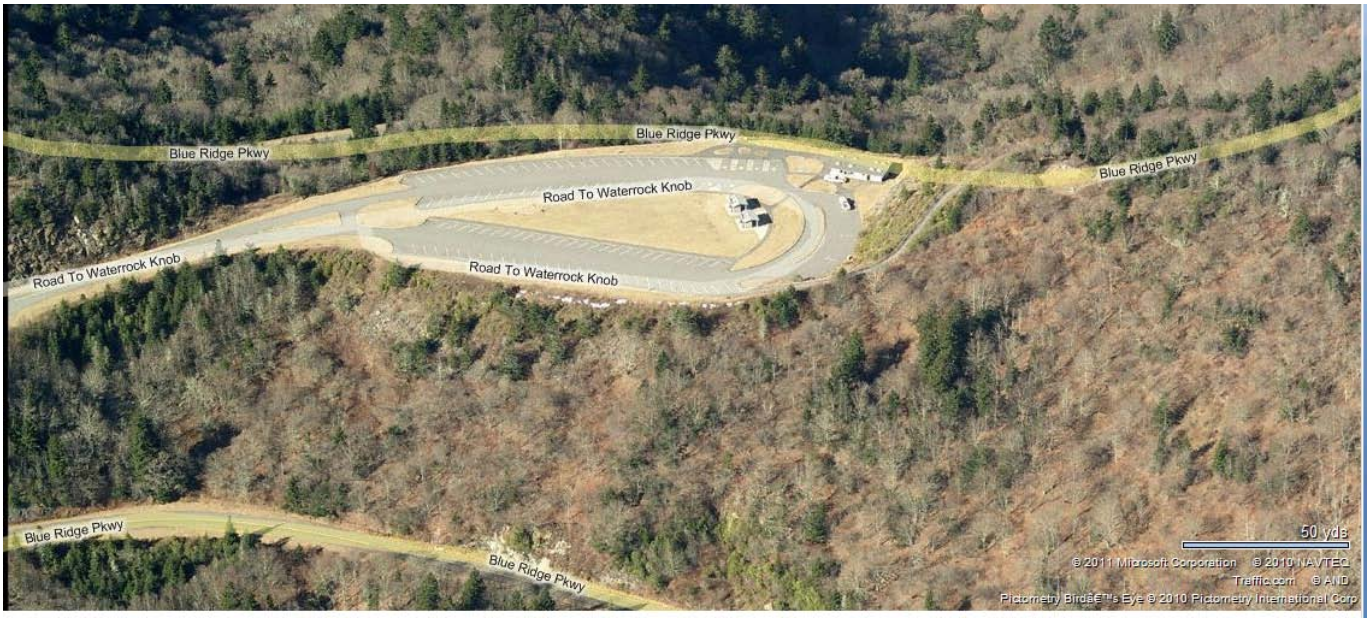
Did You Know?
The first contract for work on the Blue Ridge Parkway, awarded to Nello Teer Construction Company of Durham, NC in the height of the Great Depression, was for over $316,000. Teer purchased a new steam shovel for the project!

Asheville to Coweeta Hydrologic Laboratory

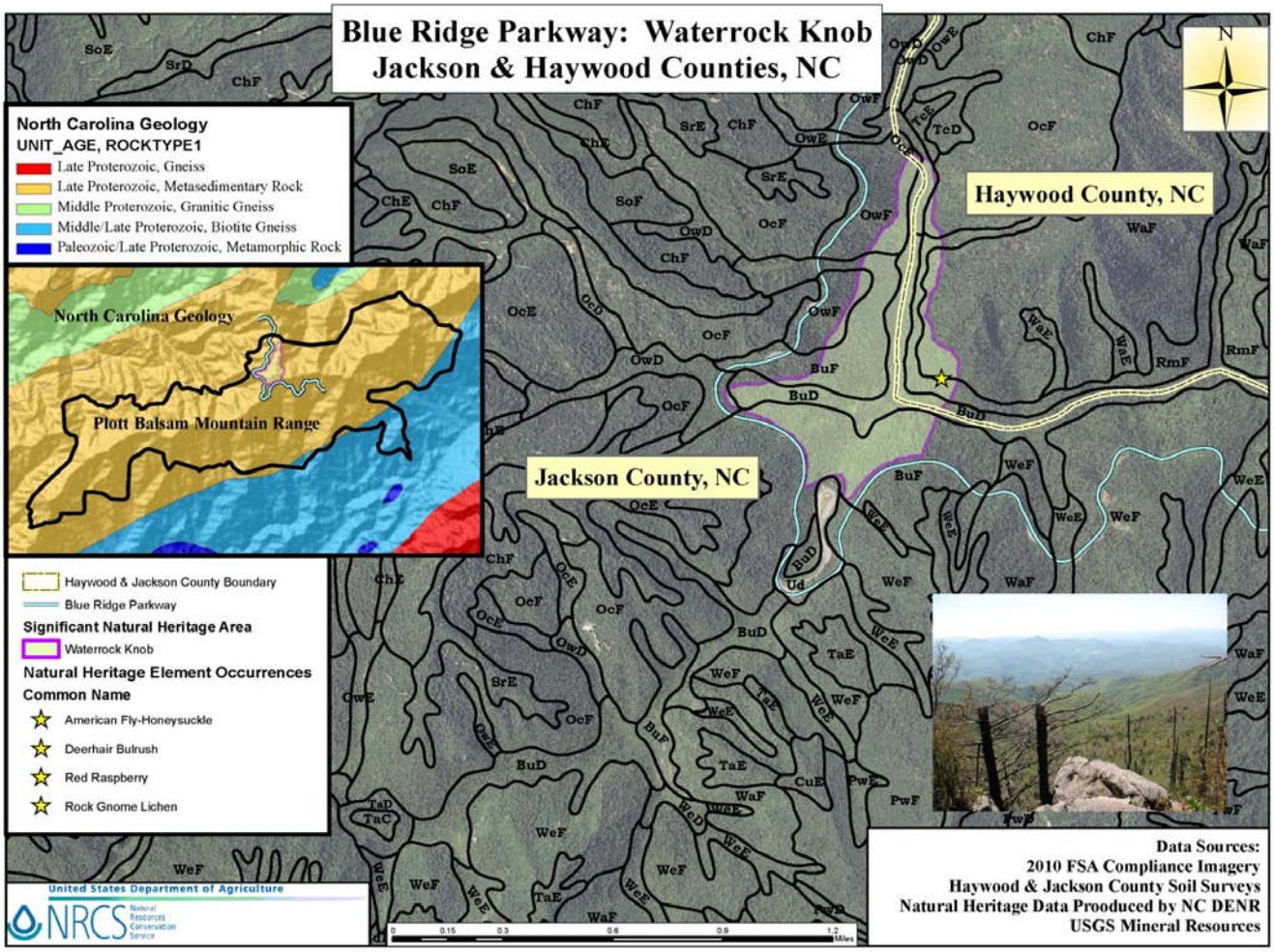


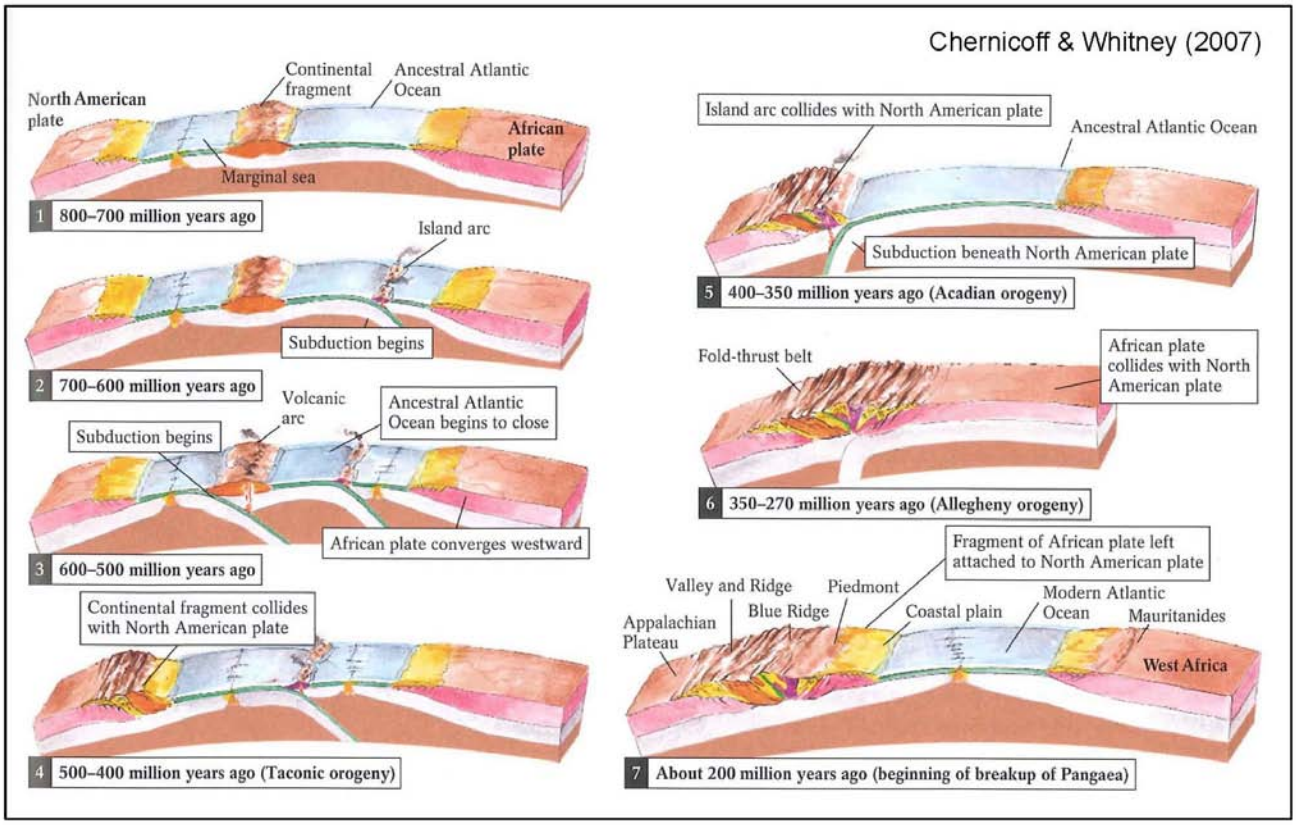


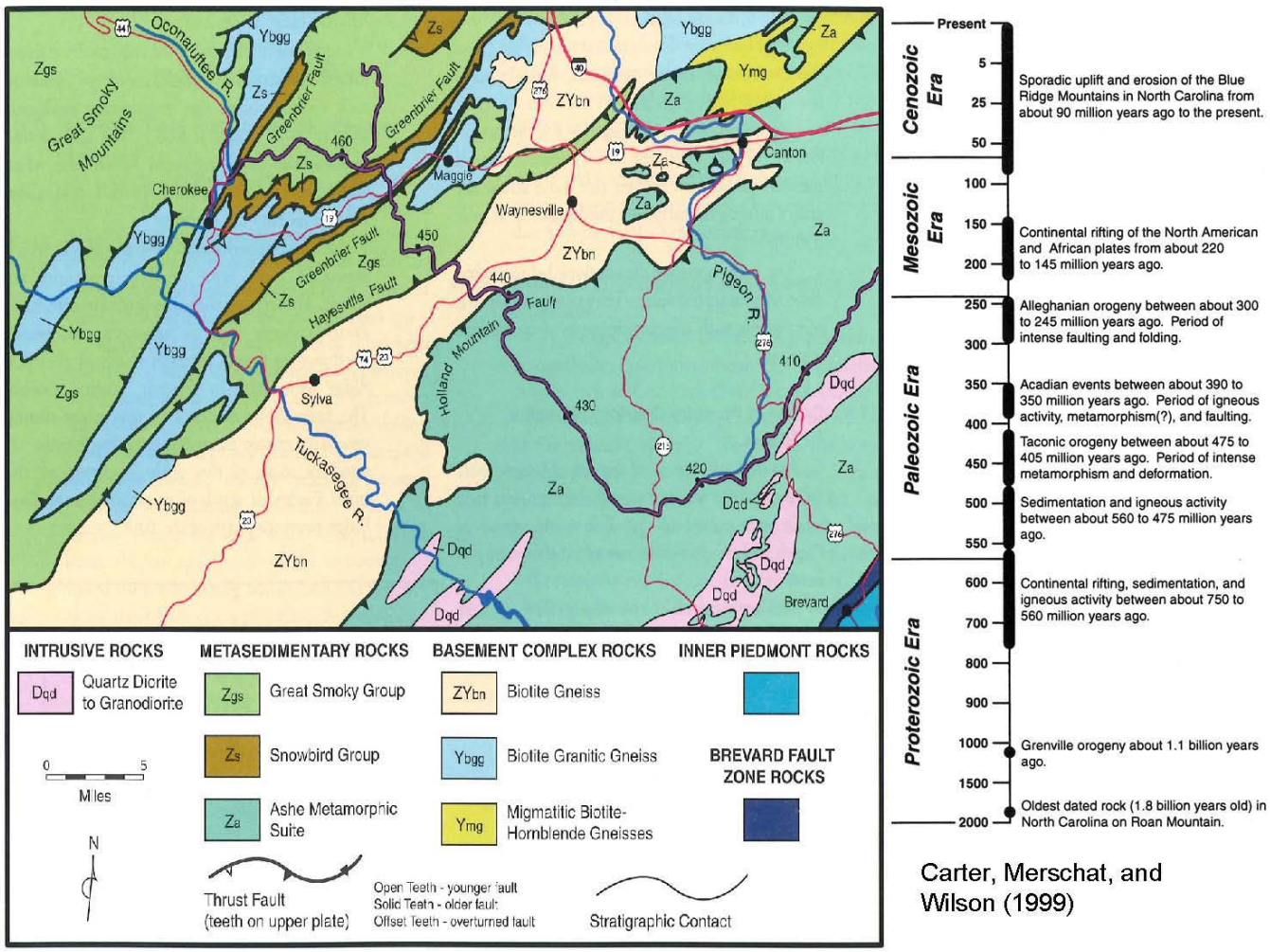




Bird’s Eye View of Waterrock Knob Parking


Blue Ridge Parkway: Waterrock Knob
Jackson & Haywood Counties, NC
North Carolina Geology
UNIT_AGE, ROCKTYPE1
Late Proterozoic, Gneiss
Late Proterozoic, Metasedimentary Rock
Middle Proterozoic, Granitic Gneiss
Middle/Late Proterozoic, Biotite Gneiss
Paleozoic/Late Proterozoic, Metamorphic Rock
North Carolina Geology
Plott Balsam Mountain Range
Haywood County, NC
Jackson County, NC
Haywood & Jackson County Boundary
Blue Ridge Parkway
Significant Natural Heritage Area
Waterrock Knob
Natural Heritage Element Occurrences
Common Name
American Fly-Honeysuckle
Deerhair Bulrush
Red Raspberry
Rock Gnome Lichen
United States Department of Agriculture
NRCS
Data Sources:
2010 FSA Compliance Imagery
Haywood & Jackson County Soil Surveys
Natural Heritage Data Prooduced by NC DENR
USGS Mineral Resources


Chernicoff & Whitney (2007)
North American plate
Continental fragment
Ancestral Atlantic Ocean
African plate
Marginal sea
1 800–700 million years ago
Island arc
Subduction begins
2 700–600 million years ago
Volcanic arc
Ancestral Atlantic Ocean begins to close
Subduction begins
African plate converges westward
3 600–500 million years ago
Continental fragment collides with North American plate
4 500–400 million years ago (Taconic orogeny)
Island arc collides with North American plate
Ancestral Atlantic Ocean
Subduction beneath North American plate
5 400–350 million years ago (Acadian orogeny)
Fold-thrust belt
African plate collides with North American plate
6 350–270 million years ago (Allegheny orogeny)
Fragment of African plate left attached to North American plate
Valley and Ridge
Piedmont
Appalachian Plateau
Blue Ridge
Coastal plain
Modern Atlantic Ocean
Mauritanides
West Africa
7 About 200 million years ago (beginning of breakup of Pangaea)



Carter, Merschat, and Wilson (1999)

Taxonomic Classification of the Soils

Soil name	Family or higher taxonomic classification
Balsam	Loamy-skeletal, isotic, frigid Humic Dystrudepts
Biltmore	Mixed, mesic Typic Udipsamments
Braddock	Fine, mixed, semiactive, mesic Typic Hapludults
Brasstown	Fine-loamy, mixed, subactive, mesic Typic Hapludults
Burton	Fine-loamy, isotic, frigid Humic Dystrudepts
Cashiers	Fine-loamy, micaceous, mesic Typic Dystrudepts
Chandler	Coarse-loamy, micaceous, mesic Typic Dystrudepts
Cheoah	Fine-loamy, isotic, mesic Humic Dystrudepts
Chestnut	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Cleveland	Loamy, mixed, active, mesic Lithic Dystrudepts
Cowee	Fine-loamy, parasesquic, mesic Typic Hapludults
Craggey	Loamy, isotic, frigid Humic Lithic Dystrudepts
Cullasaja	Loamy-skeletal, isotic, mesic Humic Dystrudepts
Cullowhee	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Fluvaquentic Dystrudepts
Dellwood	Sandy-skeletal, mixed, mesic Oxyaquic Dystrudepts
Dillard	Fine-loamy, mixed, semiactive, mesic Aquic Hapludults
Dillsboro	Fine, mixed, active, mesic Humic Hapludults
Edneyville	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Ellijay	Fine, ferruginous, mesic Rhodic Kanhapludalfs
Evard	Fine-loamy, parasesquic, mesic Typic Hapludults
Fannin	Fine-loamy, paramicaceous, mesic Typic Hapludults
Hemphill	Fine, mixed, active, mesic Umbric Endoaqualfs
Junaluska	Fine-loamy, mixed, subactive, mesic Typic Hapludults
Nikwasi	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, nonacid, mesic Cumulic Humaquepts
Oconaluftee	Fine-loamy, isotic, frigid Humic Dystrudepts
Plott	Fine-loamy, isotic, mesic Humic Dystrudepts
Reddies	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Oxyaquic Dystrudepts
Rosman	Coarse-loamy, mixed, superactive, mesic Fluventic Humic Dystrudepts
Santeetlah	Fine-loamy, isotic, mesic Humic Dystrudepts
Saunook	Fine-loamy, mixed, superactive, mesic Humic Hapludults
Soco	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Spivey	Loamy-skeletal, isotic, mesic Humic Dystrudepts
Statler	Fine-loamy, mixed, active, mesic Humic Hapludults
Stecoah	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Sylva	Coarse-loamy, mixed, semiactive, acid, mesic Humic Endoaquepts
Tanasee	Fine-loamy, isotic, frigid Humic Dystrudepts
Trimont	Fine-loamy, mixed, active, mesic Humic Hapludults
Tsali	Loamy, mixed, subactive, mesic, shallow Typic Hapludults
Tuckasegee	Fine-loamy, isotic, mesic Humic Dystrudepts
Udorthents	Udorthents
Wayah	Fine-loamy, isotic, frigid Humic Dystrudepts
Whiteside	Fine-loamy, mixed, active, mesic Aquic Hapludults

BURTON SERIES

The Burton series consists of moderately deep, well drained soils on ridges and side slopes at high elevations in the Southern Blue Ridge mountains, MLRA 130B. They formed in residuum that is affected in the upper part by soil creep, and weathered from felsic to mafic igneous and high-grade metamorphic rocks. Near the type location, mean annual air temperature is about 40 degrees F., and mean annual precipitation is 80 inches. Slope ranges from 2 to 95 percent.

TAXONOMIC CLASS: Fine-loamy, isotic, frigid Typic Humudepts

TYPICAL PEDON: Burton sandy clay loam on a 10 percent ridge top at an elevation of 5,673 feet--heath bald vegetation. (Colors are for moist soil unless otherwise stated.)

Oe--0 to 2 inches; mat of decomposing leaves and twigs laced with many fine to coarse live roots.

A1--2 to 9 inches; very dark brown (10YR 2/2) sandy clay loam; weak, fine granular structure; very friable; many very fine to coarse roots; 8 percent gravel and cobbles, and 3 percent stones by volume; common very fine and fine flakes of mica; very strongly acid; clear smooth boundary.

A2--9 to 17 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak medium and coarse subangular blocky structure; very friable; common very fine to coarse roots; 10 percent gravel and cobbles by volume; common very fine and fine flakes of mica; very strongly acid; clear smooth boundary. (Combined thickness of the A horizon is 10 to 20 inches.)

Bw--17 to 26 inches; dark yellowish brown (10YR 4/6) sandy loam; weak medium and coarse subangular blocky structure; very friable; few very fine and fine roots; 11 percent gravel and cobbles; common very fine and fine flakes of mica; very strongly acid; clear smooth boundary. (6 to 14 inches)

Cr--26 to 29 inches; weathered, partially consolidated bedrock that can be dug with difficulty with hand tools, few fine and medium roots in cracks that are spaced more than 4 inches apart; abrupt smooth boundary. (0 to 6 inches)

R--29 inches; hard, high-grade metagraywacke and kyanite garnet mica schist bedrock.

TYPE LOCATION: Buncombe County, North Carolina; 18 miles north east of Asheville on Blue Ridge Parkway, 0.25 miles west of Craggey Garden overlook to shelter, 600' south of shelter along trail: USGS Craggey Pinnacle topographic quadrangle; lat. 35 degrees 41 minutes 47 seconds N. and long. 82 degrees 23 minutes 00 seconds W., NAD 27.

This series was formerly placed in a coarse-loamy particle-size class. Laboratory PSA (pipette method) and corresponding field texture estimates (feel method) indicate control section clay contents of generally 12 to 24 percent, with most pedons marginally coarse-loamy. Fine-loamy particle-size class placement is based on the presence of amorphous (non-crystalline) clay-size material associated with the relatively high organic matter content found in these soils. Although field estimates, laboratory measurements, and calculated values may vary, clay content in the particle-size control section is generally less than 25 percent. Although Burton soils may exhibit some of the characteristics of andic soil properties, they lack the volcanic glass found in soils of similar taxa in the Western United States.

Diagnostic horizons and features recognized in this pedon are:

Umbric epipedon - the zone from the mineral soil surface to a depth of 17 inches (A1 and A2 horizons)
Cambic horizon - the zone between 17 and 26 inches (Bw horizon)
Paralithic contact - weathered bedrock contact at 26 inches (upper boundary of Cr horizon).
Lithic contact - the occurrence of hard bedrock at a depth of 29 inches (R horizon)
Isotic mineralogy class - In more than one-half of the control section, a 1500 kPa water to clay ratio of 0.6 or more and a pH in NaF solution of more than 8.4.

Sampled as on Sep 01, 1991 : Burton ; Coarse-loamy, mixed, frigid Typic Haplumbrept
Revised to correlated on Aug 01, 1996 : Burton ; Fine-loamy, isotic, frigid Andic Haplumbrept

SSL - Project CP92NC019 MOUNTAIN SOILS - BUNCOMBE COUNTY
- Site ID 91NC021007 Lat: 35° 41' 45.00" north Long: 82° 22' .00" west MLRA: 130
- Pedon No. 92P0087
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
92P00636	Oa	OA	0-7				FSL	SL
92P00637	A1	A1	7-23				FSL	SL
92P00638	A2	A2	23-38				FSL	SL
92P00639	Bw	BW	38-63				SL	SL

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	1.31	(NA)
Clay, carbonate free, Weighted Average	11	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	59	% wt
Volume, >2mm, Weighted Average	5	% vol
Clay, total, Weighted Average	11	% wt
LE, Whole Soil, Summed to 1m	0	cm/m

Weighted averages based on control section: 25-63 cm

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - Weight - - - - - - - -)				>2 mm
	Depth			< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	wt % whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - - -)				soil
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
92P00636	0-7	Oa	S	10.6	24.4	65.0	1.8		16.6	7.8	10.4	22.6	18.5	9.8	3.7	tr	tr	--	55	
92P00637	7-23	A1	S	13.3	25.0	61.7	2.0		17.4	7.6	11.1	19.8	18.4	8.9	3.5	1	1	1	52	3
92P00638	23-38	A2	S	11.1	26.7	62.2	1.1		18.4	8.3	10.4	18.8	16.8	10.8	5.4	2	1	2	54	5
92P00639	38-63	Bw	S	10.4	23.5	66.1	--		16.6	6.9	10.6	21.1	17.1	11.2	6.1	5	3	7	62	15

*** Primary Characterization Data ***

Pedon ID: 91NC021007 (Buncombe, North Carolina) Print Date: Apr 29 2011 3:47PM

Sampled As : Burton Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa	-2- Oven Dry	-3- Cole Whole Soil	-4- (Water Content) 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- (Ratio/Clay) CEC7	-13- 1500 kPa
				(g cm^{-3})			(% of < 2mm)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a		4B5	4C1		8D1	8D1
92P00636	0-7	Oa	S	0.51	0.58	0.044			47.1	34.1		1.044	0.07		3.58	3.22
92P00637	7-23	A1	S	0.90	1.13	0.078			60.3	17.2		1.031	0.38		1.83	1.29
92P00638	23-38	A2	S	0.88	1.03	0.053			52.6	13.6		1.030	0.34		1.88	1.23
92P00639	38-63	Bw	S	1.06	1.13	0.020			42.8	8.2		1.020	0.34		1.02	0.79

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (Atterberg) Limits LL	-2- PI	-3- (Bulk Density) Field	-4- Recon 33 kPa	-5- Recon Oven Dry	-6- (Water Content) Field	-7- Recon 33 kPa	-8- Sieved Samples 6 kPa	-9- 10 kPa	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa	-13- 500 kPa
				pct <0.4mm		(g cm^{-3})			(% of < 2mm)							
															4B1a	
92P00636	0-7	Oa	S												47.1	
92P00637	7-23	A1	S												24.1	
92P00638	23-38	A2	S												20.7	
92P00639	38-63	Bw	S												16.7	

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (Total) C	-2- N	-3- S	-4- Org C	-5- C/N Ratio	-6- (Dith-Cit Ext) Fe	-7- Al	-8- Mn	-9- (Ammonium Oxalate Extraction) Al+½Fe	-10- ODOE	-11- Fe	-12- Al	-13- Si	-14- Mn	-15- (Na Pyro-Phosphate) C	-16- Fe	-17- Al	-18- Mn
				(% of <2 mm)					(% of < 2mm)								mg kg^{-1}	(% of < 2mm)			
					6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9b	6G12b	6V2b	6D5b		6C8a	6G10	
92P00636	0-7	Oa	S		1.121		16.34		2.0	0.6	tr	0.98	0.53	0.99	0.49	0.05	227.7		1.4	0.6	
92P00637	7-23	A1	S		0.455		6.55		2.4	0.9	0.1	1.42	0.48	1.20	0.82	0.04	400.8		1.5	1.0	
92P00638	23-38	A2	S		0.328		4.76		2.1	1.0	0.1	1.83	0.44	1.28	1.18	0.11	579.6		1.1	1.2	
92P00639	38-63	Bw	S		0.100		1.32		1.4	0.6	tr	1.42	0.14	0.64	1.10	0.24	461.1		0.4	0.6	

CEC & Bases

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
	Depth			Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH_4 OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH_4OAC
Layer	(cm)	Horz	Prep	(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	6D3b	5A3a	5A8b	5A3b	5G1	5C3	5C1
92P00636	0-7	Oa	S	1.1	0.5	0.1	0.7	2.4	56.4	6.1	10.2	58.8	38.0	8.5	72	4	6
92P00637	7-23	A1	S	0.1	0.1	0.1	0.1	0.4	38.9	4.2	1.0	39.3	24.4	4.6	91	1	2
92P00638	23-38	A2	S	tr	tr	0.1	tr	0.1	32.5	3.2	0.6	32.6	20.9	3.3	97	tr	0
92P00639	38-63	Bw	S	--	--	0.1	tr	0.1	16.5	1.1	tr	16.6	10.6	1.2	92	1	1

Salt

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
	Depth			Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
Layer	(cm)	Horz	Prep	(- - - - - mmol(+) L^{-1} - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - - -)		%	
																						5D2	
92P00636	0-7	Oa	S																			tr	
92P00637	7-23	A1	S																			tr	
92P00638	23-38	A2	S																			tr	
92P00639	38-63	Bw	S																			1	

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - -)						(- - Carbonate - -) As $CaCO_3$		(- - Gypsum - - - -) As $CaSO_4*2H_2O$		Resist
	Depth				$CaCl_2$ 0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - - - - - - - - - % - - - - - - - - - - - -)				cm^{-1}
				8C1g	4C1a2a	4C1a2a			8C1d					
92P00636	0-7	Oa	S	3.6	3.7	4.0			7.9					
92P00637	7-23	A1	S	4.1	4.2	4.4			10.8					
92P00638	23-38	A2	S	4.2	4.4	4.5			11.3					
92P00639	38-63	Bw	S	4.5	4.7	4.9			11.2					

*** Primary Characterization Data ***

Pedon ID: 91NC021007 (Buncombe, North Carolina) Print Date: Apr 29 2011 3:47PM

Sampled As : Burton Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

Phosphorous				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-
					(- - - - Phosphorous - - - -)								
				Melanic Index	NZ	Acid Oxal	Bray 1	Bray 2	Olsen	H_2O	Citric Acid	Mehlich III	Extr NO_3
Layer	Depth (cm)	Horz	Prep		%	(- - - - mg kg^{-1} - - - -)							mg kg^{-1}
					6S4								
92P00636	0-7	Oa	S		71								
92P00637	7-23	A1	S		88								
92P00638	23-38	A2	S		87								
92P00639	38-63	Bw	S		79								

*** Primary Characterization Data ***

Pedon ID: 91NC021007 (Buncombe, North Carolina) Print Date: Apr 29 2011 3:47PM

Sampled As : Burton Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray						Thermal			Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract	7A2i						7A4b			7C3								tion
Layer	(cm)	Horz	ion	(- - - - peak size - - - -)						(- - - - % - - - -)			(- - - - % - - - -)							mg g^{-1}	
92P00638	23-38	A2	tcly	GI 2	KK 1	MM 1	MT 1	MI 1			KK 37	GI 22		9	4.4			--			
92P00639	38-63	Bw	tcly	GI 3	KK 1	CL 1					GI 27	KK 19		23	5.7			--			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

CL - Chlorite GI - Gibbsite KK - Kaolinite MI - Mica MM - Montmorillonite-Mica

MT - Montmorillonite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray				Thermal						Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a					tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00638	23-38	A2	fs										53	QZ 52	BT 27	MS 10	OT 8	OP 1	PR 1		
														FK tr	GN tr						
92P00639	38-63	Bw	fs										37	BT 49	QZ 36	MS 13	OT 1	OP 1	FK tr		
														GN tr							

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite FK - Potassium Feldspar GN - Garnet MS - Muscovite OP - Opaques

OT - Other PR - Pyroxene QZ - Quartz

*** Primary Characterization Data ***

Pedon ID: 91NC021007 (Buncombe, North Carolina) Print Date: Apr 29 2011 3:47PM

Sampled As : Burton Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

Fine Earth Mineralogy (<2.0 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray				Thermal						Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract																	7D2	tion
Layer	(cm)	Horz	ion	(- - - - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00636	0-7	Oa	feth																	32.0	
92P00637	7-23	A1	feth																	25.0	
92P00638	23-38	A2	feth																	23.0	
92P00639	38-63	Bw	feth																	14.0	

FRACTION INTERPRETATION:

feth - Fine Earth, <2 mm

MINERAL INTERPRETATION:

eg - Surface Area

WAYAH - PEDON DESCRIPTION – FRIGID TEMPERATURE REGIME - UPLANDS

Description Date: 4/1/1985

Describer: W.Lynn, M.Sherrill, D.Thomas, B.Hale

Site ID: 85NC099001

Soil Name as Described/Sampled: Wayah

Soil Name as Correlated: Wayah

Classification: Fine-loamy, isotic, frigid Andic Haplumbrepts

Geomorphic Setting: on backslope of side slope of hillside or mountainside
on backslope of side slope of mountains or deeply dissected plateaus

Particle Size Control Section: 25 to 100 cm.

Diagnostic Features: umbric epipedon 0 to 36 cm.
cambic horizon 25 to 74 cm.

Cont. Site ID: 85NC099001

State: North Carolina

County: Jackson

MLRA: 130 -- Blue Ridge

Latitude: 35 degrees 21 minutes 54.00 seconds north

Longitude: 82 degrees 59 minutes 34.00 seconds west

Datum:

Bedrock Depth:

Surface Fragments: 1.5 percent

Pedon ID: 85NC099001

Oi--6 to 0 centimeters; black (10YR 2/1) interior; 3/4-3'-5% coarse frag gravel size-15% stone size in location of pit. (Lab sample # 85P3256).

A--0 to 25 centimeters; black (10YR 2/1) interior mucky loam; weak fine granular structure; very friable; many fine roots throughout and many medium roots throughout; 5% coarse frag-gravel dominant size; extremely acid, pH 3.8, Hellige-Truog; clear smooth boundary. Split horizon at 10 cm for sampling. (Lab sample # 85P3257).

AB--25 to 36 centimeters; very dark grayish brown (10YR 3/2) interior loam; weak medium granular structure; very friable; common fine roots throughout and common medium roots throughout; 15% coarse frag-gravel dominant size; strongly acid, pH 5.5, Hellige-Truog; clear wavy boundary. (Lab sample # 85P3259).

Bw--36 to 74 centimeters; dark yellowish brown (10YR 4/6) interior sandy loam; weak medium subangular blocky structure; very friable; few fine roots throughout and few medium roots throughout; 20 mm to 75 m fragments 25% field estimates feldspar brick, mica gneiss-gravel dominant size 75- to 250-millimeter unspecified fragments and 25 percent metamorphic rock fragments; strongly acid, pH 5.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 85P3260).

C1--74 to 117 centimeters; pale brown (10YR 6/3) interior and light gray (10YR 7/2) interior and white (10YR 8/1) interior gravelly coarse sandy loam; massive; very friable; very strongly acid, pH 4.5, Hellige-Truog; gradual wavy boundary. White vein diagonally crossing pit face in C1 and C2 horizons was sampled. (Lab sample # 85P3262).

C2--117 to 152 centimeters; yellowish brown (10YR 5/8) interior and yellowish brown (10YR 5/6) interior and very pale brown (10YR 8/2) interior gravelly coarse sandy loam; massive; very friable; very strongly acid, pH 4.5, Hellige-Truog. (Lab sample # 85P3263).

*** Primary Characterization Data ***

Pedon ID: 85NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:20AM

Sampled as on Apr 01, 1985 : Wayah ; Coarse-loamy, mixed, frigid Typic Haplumbrept
Revised to correlated on Aug 01, 1996 : Wayah ; Fine-loamy, isotic, frigid Andic Haplumbrept

SSL - Project CP85NC171 NORTH CAROLINA MOUNTAIN SOILS
- Site ID 85NC099001 Lat: 35° 21' 54.00" north Long: 82° 59' 34.00" west MLRA: 130
- Pedon No. 85P0632
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
85P03256	Oi	OI	6-0					LCOS
85P03257	A1	A	0-10				L	SL
85P03258	A2	A	10-25				L	LS
85P03259	AB	AB	25-36				L	LS
85P03260	Bw1	BW	36-59				SL	SL
85P03261	Bw2	BW	59-74				SL	SL
85P03262	C1	C1	74-117				COSL	SL
85P03263	C2	C2	117-152				COSL	COSL

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	2.54	(NA)
Clay, carbonate free, Weighted Average	9	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	67	% wt
Volume, >2mm, Weighted Average	18	% vol
Clay, total, Weighted Average	9	% wt

Weighted averages based on control section: 25-100 cm

*** Primary Characterization Data ***

Pedon ID: 85NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:20AM

Sampled As : Wayah Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 85P0632

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - - Weight - - - - - - - -)				>2 mm
	Depth			< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	wt % whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - - -)				soil
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
85P03256	6-0	Oi	S	3.4	10.5	86.1			2.0	8.5	8.6	21.3	24.3	19.1	12.8	tr	--	29	84	62
85P03257	0-10	A1	S	12.2	27.7	60.1	2.8		17.2	10.5	11.8	15.7	14.5	12.0	6.1	2	2	--	50	4
85P03258	10-25	A2	S	2.9	23.4	73.7	--		12.9	10.5	17.7	27.6	16.0	9.0	3.4	2	tr	--	57	2
85P03259	25-36	AB	S	2.1	21.4	76.5	--		12.0	9.4	19.1	25.2	15.9	12.1	4.2	2	1	--	59	3
85P03260	36-59	Bw1	S	5.9	27.0	67.1	0.2		17.4	9.6	14.6	21.1	15.7	9.5	6.2	2	1	46	76	49
85P03261	59-74	Bw2	S	9.5	23.4	67.1	0.5		15.4	8.0	12.6	19.5	15.5	10.4	9.1	5	3	38	75	46
85P03262	74-117	C1	S	14.5	25.5	60.0	2.1		15.6	9.9	13.3	15.3	10.3	9.7	11.4	13	9	1	59	23
85P03263	117-152	C2	S	8.7	19.0	72.3	2.1		11.4	7.6	11.4	15.5	14.4	15.3	15.7	13	12	1	71	26

Bulk Density & Moisture

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(Bulk Density)		Cole	(- - - - - - - - - - - - Water Content - - - - - - - - - - -)						WRD	Aggst		
				33	Oven	Whole	6	10	33	1500	1500 kPa	Ratio	Whole	Stabl	(- - Ratio/Clay - -)	
	Depth			kPa	Dry	Soil	kPa	kPa	kPa	kPa	Moist	AD/OD	Soil	2- 0.5mm	CEC7	1500 kPa
Layer	(cm)	Horz	Prep	(- - - g cm^{-3} - - - -)			(- - - - - - - - - - - - - % of < 2mm - - - - - - - - - - - -)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a		4B5	4C1		8D1	8D1
85P03256	6-0	Oi	S							92.9		1.085			22.74	27.32
85P03257	0-10	A1	S	0.52	0.83	0.167			97.0	25.8		1.058	0.37		3.70	2.11
85P03258	10-25	A2	S	0.75	1.09	0.132			73.6	17.7		1.059	0.42		9.97	6.10
85P03259	25-36	AB	S	0.80	1.28	0.168			71.2	12.6		1.036	0.46		10.05	6.00
85P03260	36-59	Bw1	S	0.99	1.11	0.028			50.3	9.4		1.023	0.30		1.98	1.59
85P03261	59-74	Bw2	S	1.36	1.41	0.008			28.4	8.6		1.019	0.19		1.07	0.91
85P03262	74-117	C1	S	1.26	1.32	0.014			37.3	9.7		1.015	0.31		0.70	0.67
85P03263	117-152	C2	S							7.8		1.017			1.07	0.90

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Pedon ID: 85NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:20AM

Sampled As : Wayah Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 85P0632

Water Content				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(- - Atterberg - -)		(- - - - - Bulk Density - - - -)			(- -)		Water Content - - - - - - - - - - - - - -					
				(- - - Limits - - -)		Field	Recon	Recon	Field	Recon	(- - - - - - - - - - - - - - Sieved Samples - - - - - - - - - - - -)					
	Depth			LL	PI		33 kPa	Oven Dry		33 kPa	6 kPa	10 kPa	33 kPa	100 kPa	200 kPa	500 kPa
Layer	(cm)	Horz	Prep	pct <0.4mm		(- - - - - - - - g cm^{-3} - - - - - -)			(- -)		% of < 2mm - - - - - - - - - - - - - - - - -					
					4F											
85P03258	10-25	A2	S		NP											
85P03260	36-59	Bw1	S		NP											
85P03263	117-152	C2	S		NP											

Carbon & Extractions				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				(- - - - - Total - - - - -)			Org	C/N	(- - - Dith-Cit Ext - - -)			(- - - - - - Ammonium Oxalate Extraction - - - - -)						(- - - Na Pyro-Phosphate - - -)			
	Depth			C	N	S	C	Ratio	Fe	Al	Mn	Al+½Fe	ODOE	Fe	Al	Si	Mn	C	Fe	Al	Mn
Layer	(cm)	Horz	Prep	(- - - - - - % of <2 mm - - - - - -)					(- % of < 2mm - - - - - - - - - - - - - - -)								mg kg^{-1}	(- - - - - - % of < 2mm - - - - -)			
				6A2d	6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9a	6G12	6V2	6D5b		6C8a	6G10	
85P03256	6-0	Oi	S	35.44			32.95														
85P03257	0-10	A1	S	11.48	0.767		10.47	14	3.5	0.7	0.1	1.96	0.85	2.62	0.65	0.02	646.9		2.5	0.8	
85P03258	10-25	A2	S	6.02	0.347		6.11	18	3.8	1.7	0.1	2.98	0.70	2.59	1.68	0.05	825.0		2.4	1.8	
85P03259	25-36	AB	S	3.93	0.207		4.04	20	3.2	1.6	0.1	2.49	0.46	1.88	1.55	0.12	414.0		2.0	1.7	
85P03260	36-59	Bw1	S	1.14	0.070		1.11	16	2.2	0.8	0.1	1.70	0.14	1.19	1.11	0.24	507.7		0.7	0.7	
85P03261	59-74	Bw2	S	0.49	0.036		0.50	14	2.3	0.5	0.1								0.2	0.4	
85P03262	74-117	C1	S	0.13			0.17		3.3	0.5	0.2										
85P03263	117-152	C2	S	0.33			0.33		1.8	0.4	0.1										

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CEC & Bases

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH$_4$OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
	Depth			Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH$_4$ OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH$_4$OAC
Layer	(cm)	Horz	Prep	(- cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9a		5A3a	5A8b	5A3b	5G1	5C3	5C1
85P03256	6-0	Oi	S	5.6	1.9	0.3	2.6	10.4	96.3	8.0		106.7	77.3	18.4	43	10	13
85P03257	0-10	A1	S	0.2	0.4	0.2	0.8	1.6	59.3	11.6		60.9	45.2	13.2	88	3	4
85P03258	10-25	A2	S	0.1	0.1	0.1	0.7	1.0	45.1	5.1		46.1	28.9	6.1	84	2	3
85P03259	25-36	AB	S	tr	0.1	0.1	0.6	0.8	33.4	2.8		34.2	21.1	3.6	78	2	4
85P03260	36-59	Bw1	S	0.1	tr	0.1	0.6	0.8	15.3	1.3		16.1	11.7	2.1	62	5	7
85P03261	59-74	Bw2	S	0.1	--	tr	0.1	0.2	9.0	1.0		9.2	10.2	1.2	83	2	2
85P03262	74-117	C1	S	0.2	tr	tr	0.1	0.3	6.8	1.2		7.1	10.2	1.5	80	4	3
85P03263	117-152	C2	S	0.2	tr	tr	0.1	0.3	7.4	1.5		7.7	9.3	1.8	83	4	3

Salt

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
	Depth			Ca	Mg	Na	K	CO$_3$	HCO$_3$	F	Cl	PO$_4$	Br	OAC	SO$_4$	NO$_2$	NO$_3$	H$_2$O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
Layer	(cm)	Horz	Prep	(- - - - - mmol(+) L^{-1} - - - - -)				(- mmol(-) L^{-1} - - - - - - - - - - - - - - - - - - -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
85P03256	6-0	Oi	S																			tr	
85P03257	0-10	A1	S																			tr	
85P03258	10-25	A2	S																			tr	
85P03259	25-36	AB	S																			tr	
85P03260	36-59	Bw1	S																			1	
85P03261	59-74	Bw2	S																			--	
85P03262	74-117	C1	S																			--	
85P03263	117-152	C2	S																			--	

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pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl 8C1g	-2- $CaCl_2$ 0.01M 4C1a2a	-3- H_2O 1:2 4C1a2a	-4- Sat Paste	-5- Sulf	-6- NaF 8C1d	-7- Carbonate As $CaCO_3$ <2mm (%)	-8- Carbonate As $CaCO_3$ <20mm (%)	-9- Gypsum As $CaSO_4*2H_2O$ <2mm (%)	-10- Gypsum As $CaSO_4*2H_2O$ <20mm (%)	-11- Resist ohms cm^{-1}
85P03256	6-0	Oi	S	2.9	3.2	3.7			6.0					
85P03257	0-10	A1	S	3.4	3.4	3.5			7.7					
85P03258	10-25	A2	S	4.2	4.6	4.5			11.3					
85P03259	25-36	AB	S	4.4	4.6	4.8			11.5					
85P03260	36-59	Bw1	S	4.5	4.8	4.9			10.9					
85P03261	59-74	Bw2	S	4.4	4.7	4.9			10.1					
85P03262	74-117	C1	S	4.1	4.4	5.0			9.3					
85P03263	117-152	C2	S	4.1	4.8	4.9			9.6					

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ % 6S4	-3- Acid Oxal ($mg\ kg^{-1}$)	-4- Bray 1 ($mg\ kg^{-1}$)	-5- Bray 2 ($mg\ kg^{-1}$)	-6- Olsen ($mg\ kg^{-1}$)	-7- H_2O ($mg\ kg^{-1}$)	-8- Citric Acid ($mg\ kg^{-1}$)	-9- Mehlich III ($mg\ kg^{-1}$)	-10- Extr NO_3 ($mg\ kg^{-1}$)
85P03257	0-10	A1	S		72								
85P03258	10-25	A2	S		92								
85P03259	25-36	AB	S		91								
85P03260	36-59	Bw1	S		64								
85P03261	59-74	Bw2	S		3								
85P03262	74-117	C1	S		35								
85P03263	117-152	C2	S		37								

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Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray 7A2i peak size	-2-	-3-	-4-	-5-	-6- Thermal 7A3b %	-7-	-8-	-9-	-10- Elemental 7C3 % SiO_2	-11- Al_2O_3	-12- Fe_2O_3	-13- MgO	-14- CaO	-15- K_2O	-16- Na_2O	-17- EGME Retn mg g^{-1}	-18- Interpretation
85P03260	36-59	Bw1	tcly	GI 3	KK 1	CM 1			GI 13	KK 1					7.4			0.2			
85P03263	117-152	C2	tcly	GI 3	KK 2				GI 17	KK 2					4.6			0.2			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

CM - Chlorite-Mica GI - Gibbsite KK - Kaolinite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

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USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 85P0632

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray peak size	-2-	-3-	-4-	-5-	-6- Thermal %	-7-	-8-	-9-	-10- Optical Grain Count 7B1a % Tot Re	-11-	-12-	-13-	-14-	-15-	-16-	-17- EGME Retn mg g^{-1}	-18- Interpretation
85P03258	10-25	A2	fs										73	RA 42	QZ 25	HN 12	BT 8	GN 5	MS 4		
														OW 2	OP 1						
85P03260	36-59	Bw1	fs										15	BT 55	HN 13	QZ 12	MS 6	FP 6	AR 3		
														GN 2	FK 1	OW 1	OP 1				
85P03263	117-152	C2	fs										21	BT 51	QZ 21	HN 7	MS 7	AR 5	SR 5		
														FP 5	FK tr						

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

AR - Weatherable Aggregates BT - Biotite FK - Potassium Feldspar FP - Plagioclase Feldspar GN - Garnet

HN - Hornblende MS - Muscovite OP - Opaques OW - Other Weatherable Minerals QZ - Quartz

RA - Resistant Aggregates SR - Sericite

Utilizing Soil Surveys

Doug Thomas and Anthony Khiel
June 2007

Introduction:

Providing useful information for land use planning is the major function of the National Cooperative Soil Survey Program. However, soil survey information is only part of the total body of information needed for making wise land use decisions. Economic forces and quality of life issues often determine land use patterns on both public and private lands. Even so, the management information in Soil Surveys is useful in achieving land use pattern goals. It is important to understand the value as well as the limitations of the information in the Soil Surveys.

Soil Surveys provide land use interpretations based upon the needs of many user groups. While the early Soil Surveys were largely developed for agricultural use, later Surveys included interpretations for soils as a construction material. Today, land use interpretations in Soil Surveys commonly include: cropland management, forestland management, recreational development, building site development, sanitary facilities, construction materials, water management and in some cases suitability for wildlife habitat. The interpretations may be applied in regional or local planning. Individual sites in a county can be grouped by their common broad management properties. However, individual sites have additional properties which are site specific. Sites in a survey area with common management properties may be grouped together and given the same management unit name. However, individual sites mapped as the unit may have site specific properties. These properties include; differences in vegetative cover, differences in present management, differences in past management, differences in adjoining management units, differences in water management and/or differences in watersheds characteristics.

Soil Survey information is also limited by the level of homogeneity in the management units. The homogeneity of any of the management units used in a survey area is determined by such factors as the scale of the maps, the complexity of geology, landscape patterns and landscape features, and the precision at which the many different management units can be separated. As much as 20 percent of a management unit is something other than what is named as dominant. The values and the limitations of the information in the Soil Surveys are reviewed in this paper.

Defining Terms Used in Soil Surveys:

Map units have a soils component and other use and management properties. The soils in map units are defined by the many soil properties including soil texture, soil structure, soil color, organic matter content, bulk density, and mineralogy. Soils are also defined by the soil horizons (topsoil, subsoil, parent material, and bedrock). The soils impart certain management properties to the map units. These properties, in part, define the suitability of the map units for land uses. Map units are also defined by other management components such as: slope, flooding frequency, surface soil texture, surface stones, erosion class, and/or urban lands. These other components also dictate the suitability of map units for land uses. For example, the slope limits the use of heavy equipment in a given area. The Cheoah channery loam, 30 to 95 percent slopes map unit is defined by a soil type (Cheoah channery loam) and a slope range (30 to 95 percent slopes).

While map units are designed to reflect use and management consideration, they are named by the dominant soils. Map units have one or more dominant soils. The properties of dominant soils may vary, but the general use and management of the soils in the same map unit are similar. However, these similar soils may have different taxonomic classifications. Other non-dominant soils in a map unit may have differing management properties. These dissimilar soils are called minor components and occur in map units due the scales of the map base, the inaccurate nature of line placement between map units and complexity of soils in nature. Minor components represent the variability of use and management in the map units. Minor components comprise a small part of map units, usually less than 20 percent. The amount and type of variability within map units is dependent on factors such as, geologic formations, landscape patterns, landscape positions, soil creep and past management.

Map units, such as Cheoah channery loam, 30 to 95 percent slopes, are designed to be similar inside the individual units. However, each individual Cheoah channery loam, 30 to 95 percent slopes unit may have differences in vegetative cover, present management, past management, adjoining soils, water management and/or watersheds characteristics.

Phases

The use of phases must meet two conditions:

1. the use and management differences are significant,
2. the phases can be reliably separated.

Map Units Rated for Land Uses

Landscape Patterns

Landscape patterns refer to the arrangement of repeating topographic features across an area. Landscape patterns may be comprised of basins, rolling hills, low mountains, high mountains, gorges and/or domes with rock cliffs. Different landscape patterns can occur on the same geologic formations, and different geologic formations can have the same landscape pattern. Each geologic formation and landscape pattern combination is represented by a characteristic map unit pattern.

For example, a geologic formation composed of biotite gneiss weathers differently within each of the landscape patterns in which it occurs. Basins and low rolling hills commonly have weathered rock to a depth up to 30 feet that is easily dug with hand tools or a backhoe. Low and high mountains commonly have moderately weathered rock to a depth up to 10 feet that is difficult to dig with hand tools but can be dug with a backhoe. Gorges and rock outcrop domes commonly have hard rock at a depth < 3.5 feet that cannot be dug with backhoes or bulldozers and can only be moved by drilling and blasting with explosives.

Landscape patterns must be consistent and logical. For example, the identification of extremely stony map units in the colluvial parts of the landscape would indicate a likely source of coarse fragments in the surrounding upland map units. If the surrounding uplands are not the source, then map units at a greater distance must be examined to understand the landscape pattern.

Landscape Positions

Landscape positions refer to the relative location of features within a geographic area. For example, the landscape positions in mountain areas include floodplains, terraces, ridges, side slopes, coves or nearly vertical rock outcrops.

Transported Deposits

Transported deposits are layers of material moved by gravity, wind, ice and/or water. These deposits are thick enough to develop soils independent of the underlying geology. Transported deposits in the Southern Blue Ridge are commonly 10 to 30 feet deep, but many are over 100 feet deep.

Overland Flow

Overland flow is the intermittent flow of water in storm events. The intermittent flows of water can forms channels. However the intermittent flow of water may or may not form channels depending on the volume and flow velocity of the water and the type of ground cover.

Drainage Area or Watershed

A drainage area or watershed is the total land surface which funnels water to a point on the landscape. The volume and flow velocity of the water within and leaving a watershed is affected by many factors. The characteristics of the soils, the characteristics of the underlying geology, the characteristics of the surface cover, the slope of the landscape, the size of the watershed and the characteristics of the rainfall events are some of the factors affecting water movement in a watershed.

Understanding Limitations and Suitability of Map Unit Narratives and Tables for Land Uses

The national rating system used for map unit limitations incorporates the favorability of map units for common land uses. It is not intended to guide the land use of a region of the country. Many other factors, such as economics, commerce and recreational needs, may be the driving force in land use decisions. Dealing with poorly suited soils may be a small price for the other advantages offered by the location.

Limitations refer to the problems associated with map units being used for a given land use. These problems must be addressed to successfully use map units for a land use. The severity of ratings relates to the relative cost of overcoming the problems. That cost may or may not be at a level acceptable to the user. The decision to utilize a site for a land use is made based on the value received from the land use and the cost incurred in converting the land to that use. Soil Surveys only address the problems and difficulties of converting a site to a land use.

Understanding Limitations of Map Units Due to Map Unit Design

Map units are designed with the following principles:

1. map unit separations are base on the information needs of the users of the Soil Survey,
2. sites with the same map unit name have similar management properties,
3. the area within map units are at least 80 percent homogeneous,
4. the different map units can accurately separated, and
5. map unit patterns are constant with other data maps (geology, topography etc).

The design of map units is base on the management needs of the users. For example, the United Stated Forest Service needed a separation of management units where wheeled equipment is safe or unsafe to operate. That slope separation was determined to be at 50 percent slopes. Consequently, the traditional steep slope range of 30 to 95 percent slopes was split into two phases (30 to 50 percent slopes and 50 to 95 percent slopes).

Map units are designed to group management units which are similar under the same map unit name. For example, all the Saunook loam, 2 to 8 percent slopes map units are similar and can be reliably separated and mapped. However, separating soils is much more difficult because the natural pattern of soils and the associated landscape features are far too complex to separate at the scales commonly used in Soil Surveys.

Many factors must be constant when grouping sites into the same map unit. These factors include: geology, landscape position, micro-climate, productivity, slope, flooding frequency, drainage classes, surface soil texture, surface stones, and erosion class. Map units are fairly homogeneous in terms of use and management properties. Map units are not pure from a soils or landscape feature standpoint. There is variability within all map units because all map units contain minor components. Variability within map units is defined as the amount, kind, and location of minor components which could occur in that map unit. Generally, 10 to 20 percent of any map unit will be something other than the dominant type for which the unit was named. For example, a Saunook loam, 2 to 8 percent slopes map unit may have small amounts of Hayesville clay loam, 8 to 15 percent slopes, eroded in the unit. This variability is described in the minor components paragraph in the narrative of the map unit.

There is also variability between the individual map units. Any combination of the minor components listed in the narrative may be present and may vary in of the amount, kind, and location among sites. For example, one Saunook loam, 2 to 8 percent slopes map unit may have common minor components of Hayesville clay loam, 8 to 15 percent slopes, eroded, while another Saunook loam, 2 to 8 percent slopes map unit may have common minor components of Cullowhee-Nikwasi complex, 0 to 2 percent slopes, frequently flooded.

The accurate separation of the many different map units in a Soil Survey requires the careful design of map units and the use of supporting information. Information commonly used to separate map units includes; geology maps, topographic maps, and infrared photography.

There are other tools that can be used to improve the reliability of map unit separations, including, high-resolution photography, winter color (leaf-off) photography, spring color photography, fall color photography and late afternoon photography. Low altitude, high-resolution photography is used to check the vigor and productivity of the trees. Winter color photography is used to remote sense rock outcrops. Spring color photography is used to identify yellow-poplar vegetative cover because yellow-poplars leaf out before most other species. Fall color photography is used to identify oak-hickory-yellow pine vegetative cover. Late afternoon photography shows which parts of the landscape are shaded in the hottest part of the day (from 3:00 to 5:30 p.m.). In upland settings, oak-hickory-yellow

pine cover is in direct sunlight most of the day while yellow-poplar cover is in passive sunlight much of the day.

Other Factors Which Affect Map Units at Specific Sites:

A map unit is a set of interpretations linked to reoccurring map symbols on the soils maps. These sites have similar general properties related to the map unit design. The map unit design defines the properties inside a map unit. Examples of properties defined in a map unit are: the depth of the soils, the textures of the major layers of the soils, the slope, and the amount of stones on the surface. Map units are rated by their suitability for a management purpose. However, use and management is not determined by map unit properties alone. Specific sites are affected by local properties that occur beyond the resolution of the map units. Specific sites are also affected by properties of the surrounding map units. These local and adjacent properties are site dependent and do not relate to the map unit design. These properties include the:

1. location of map units to roads, railroads and/or dams,
2. location of map units to culverts and other man made diversions,
3. location of map units to rock outcrops,
4. characteristics of the overland flow,
5. drainage area of the overland flow,
6. makeup of the drainage area (woodland, grassland, bare ground or urban),
7. presence and characteristics of the streams,
8. drainage area of the streams,
9. makeup of the drainage area (woodland, grassland or urban),
10. makeup of the adjacent map units,
11. present management within and outside the map units,
12. past management within and outside the map units,
13. variability of map unit sites because of differences in the geologic formations, elevation, and latitude and longitude, and
14. variability of map unit sites because of differences in the amount of rainfall, wind, and passive and direct sunlight.

Road Systems

Road systems include the roadbed and all the cut and filled areas associated with the roadbed. Road systems can affect the use and management of individual map units. Roads alter the landscape through the creation of areas of cut and fill. Roads also alter the volume, velocity and location of water in natural flow and storm events. The cut areas of a road interrupt the natural slope and often create extremely steep slopes. Fill areas often increase water retention. Consequently, roads alter the runoff by adding hard surfaces to the watershed, altering overland flow and creating catchments. Roads also alter the volume, velocity and location of water in natural flow and storm events.

Culvert Systems

Culverts can affect the use and management of individual map units by altering water movement. Culverts alter the flow of water both by overland flow and in streams by changing the amounts, velocities and locations of water in the drainage system. The channels downstream can deteriorate because of the added volume and velocity of the water in the channel.

Overland Flow

Overland flow is the water that flows over the soil surface during storm events. This water flow is intermittent and dependent on water concentrated in channels during and shortly after rains. The surface cover in the watersheds or drainage areas can greatly affect the storm flow. Overland flow is often viewed based on the existing conditions of the watershed and the assumption that those conditions will not change. However, changes in the surface cover type in a watershed can alter the amounts, velocities and locations of water during overland flow.

Watershed or Drainage Area

The rate of water movement in watersheds is determined by slope characteristics including length, steepness, and shape. Length of slope influences the runoff and the infiltration of water. Increased slope length increases down slope movement of soil material. The longer the slope the greater force exerted on the soil material by gravity and the overland flow of water.

Steepness of slope influences the runoff and the infiltration of water. Increased slope steepness increases down slope movement of soil material. Steepness of slope is the distance of rise or fall vertically in feet per each 100 feet distance horizontally. For example, a 50 percent slope would rise or fall 50 feet vertically for each 100 feet horizontally.

Shape of slope also influences the runoff and the infiltration of water. A concave ground surface increases down slope movement of soil material and convex ground surface decrease down slope movement of soil material. Consequently, a concave ground surface concentrates water into smaller areas located downslope. This in turn increases the volume and velocity flowing overland. The influence slope shape is greater on longer, steeper slopes.

Watersheds or drainage areas can have varying types of surface cover. Surface cover types include woodlands, grasslands, croplands, bare ground, and hard surfaces such as, roads, roofs, parking lots, and rock outcrops. Vegetative cover slows water movement and increases water retention. Two sites in the same watersheds can have a vegetative cover of primarily woodland and have differing interpretations because factors other than cover type influences land use suitability. For example, downed trees can significantly reduce the down slope movement of soil material. The amount and orientation of downed trees influences the movement of soil material and water.

The amount, size and orientation of coarse fragments also affect the movement of soil material down slope. Sites with more fragments, larger fragments, and interlocking fragments experience less downslope movement of material.

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Present Management in Watershed or Drainage Area

Watersheds or drainage areas can vary in their present management. The present management may affect the composition of the surface cover and/or the soils. The present management may alter the condition in a positive or negative manner. Whether positive or negative results are achieved is dependent on the desired goals.

Management may favor or reduce the amount, the quality and the kind of canopy and/or ground cover. Management may favor or reduce the amount of organic matter in the soils. Management may favor or reduce the amount and size of the pore spaces in the soils. The results of present management greatly affect the hydrology of the watershed. The surface cover and the soils may be affected for many years after a management practices have ceased. For example, the use of heavy equipment on sites in a watershed greatly alters the surface cover and can compact the soils in that watershed. Wild fire can also alter the surface cover.

Past Management in Watershed or Drainage Area

Watersheds or drainage areas can vary in their past management. The past management may affect the composition of the surface cover and/or the soils. The past management may alter the condition in a positive or negative manner. Whether positive or negative results are achieved is dependent on the desired goals.

Management may favor or reduce the amount, the quality and the kind of canopy and/or ground cover. Management may favor or reduce the amount of organic matter in the soils. Management may favor or reduce the amount and size of the pore spaces in the soils. The results of past management greatly affect the hydrology of the watershed. The surface cover and the soils may be affected for many years after a management practices have ceased. For example, the heavy grazing of livestock can greatly alter the surface cover and compact the soils of a watershed. Wild fire can also alter the surface cover.

Variability of Map Unit Sites may occur because of differences in the Geologic Formations, Elevation, and Geographic Location

Map unit sites for a given map unit occur within ranges. For example, the range for the geologic formations may be limited to kinds of gneiss (hornblende gneiss, mica gneiss or garnet gneiss), and the range for the elevation may be may be limited to 1,200 to 4,500 feet.

Map unit sites, such as Evard-Cowee complex, 30 to 50 percent slopes, can vary somewhat in management properties due to variability in the geologic formations, elevation, and geographic location. Variability in the geologic formations may cause sites of Evard-Cowee complex, 30 to 50 percent slopes to vary somewhat in mica content or soil texture or the types of minor components. Variability in the elevation or in the geographic location may cause sites of Evard-Cowee complex, 30 to 50 percent slopes to vary somewhat in the organic content of the surface soil or the color of the subsoil or the types of vegetative cover. These variabilities may also cause the map units to vary somewhat in the types of minor components.

Variability of Map Unit Sites may occur because of differences in the Rainfall, Wind, and the Amount of Passive and Direct Sunlight

Map unit sites for a given map unit occur within ranges. For example, the range for the rainfall may be limited to 45 to 85 inches per year, and the range for the passive sunlight may be may be limited to 4 to 6 hours per day.

Map unit sites, such as Evard-Cowee complex, 30 to 50 percent slopes, can vary somewhat in management properties due to variability in the rainfall, wind, and the amount of passive and direct sunlight. Variability in the rainfall may cause sites of Evard-Cowee complex, 30 to 50 percent slopes to vary somewhat in the organic content of the surface soil or the rate of growth of the vegetative cover or the types of minor components. Variability in the wind may cause sites of Evard-Cowee complex, 30 to 50 percent slopes to vary in the amount of wind/ice damage to the vegetative cover. Variability in the amount of passive and direct sunlight may cause sites of Evard-Cowee complex, 30 to 50 percent slopes to vary somewhat in the organic content of the surface soil or the vegetative cover or the types of minor components.

Conclusions and Recommendations:

The goal of the National Cooperative Soil Survey Program is to provide useful information for long term planning. Interpretations in the soil survey can be used for countywide planning or specific sites. The interpretations are very reliable when used for general planning over an individual county. However, interpretations are less reliable when applied to a specific site within a county.

Interpretations are made by the use of management units called map units. Map units have a soils component, but are also defined by other management components such as slope, flooding frequency, surface soil texture, surface stones, and erosion class. Map units are not 100 % homogeneous because they contain minor components comprised of dissimilar soils. In addition, map units may contain other landscape features such as springs, wet spots, gullies, severely eroded spots, and gravelly or stony spots.

Map unit narratives provide interpretations for land uses. A map unit may be well, moderately, or poorly suited for a given land use. The potential of a map unit for given land use is limited by the level of management and the inherent capacity of the map unit. National standards are used to compare all the map units across the country. Individual counties commonly have no map units with slight limitations for a given land use.

Soil Surveys provide information which can aid in land use planning for specific sites. However, other factors must be evaluated for individual sites. Sites of the same map unit may differ in use and management due to the different properties of those specific sites

Every land use decision is an equation where the value received is weighed against the difficulty in converting the land to the desired use. Economic forces and quality of life issues often determine land use patterns. Soils survey information identifies problems associated with land uses and the level of difficulty in overcoming those problems. Soil Surveys only address the difficulty in the conversion side of the equation. Thus, Soil Surveys should not be used to dictate land use patterns. Wise land use decisions require solving the whole equation.

Coweeta Hydrologic Laboratory

History

Before the first white settlement in this area, the Cherokee Indian Nation inhabited the land. From 1848 to 1900, white settlers cultivated less than 200 acres of the basin, primarily along the main streams. Lumber companies purchased the Coweeta Valley in 1900, and subsequently the land was logged. In 1918, the Forest Service bought the tract and designated it part of the Nantahala National Forest in 1923. The site was set aside as the Coweeta Experimental Forest in 1934. Measurements of rainfall, streamflow, climate, and forest growth began almost immediately. The Civilian Conservation Corps built the original laboratory buildings, roads, climatic stations, and stream measurement devices. In 1948, the site was renamed Coweeta Hydrologic Laboratory, the only Forest Service outdoor site to carry the "Laboratory" title. The Laboratory's commitment to sharing its research with scientists worldwide has been recognized by its inclusion in the International Biological Program, the International Hydrologic Decade, and UNESCO's Man and the Biosphere project.

To support the growing Coweeta Research Program, Coweeta facilities have been expanded and upgraded considerably over the past few years. The newest building at Coweeta, The Coweeta Conference Center and Office Complex, was completed in 2003 and houses an 80-person capacity conference center, visitor reception area, and administrative and scientist office space. The Ecosystems Ecology Building, which contains additional offices for scientists and technicians, was constructed in 1980 by Job Corpsmen. The Data Processing and Hydrology Building is the focal point for data storage and processing at Coweeta. Built by the Job Corp in 1989, it contains data processing equipment, a vault for storing long-term data, and office space for technicians and scientists. The original part of the Coweeta Residence Building, built in 1937, served as Coweeta's headquarters. The residence was first expanded in 1987 to accommodate 14 researchers. Further renovations and expansions were initiated in 1999 and completed in 2003 to provide accommodations for 20 researchers. The Analytical Laboratory was expanded and renovated in 2001. It provides a state-of-the-art facility for chemical determinations of water, soil, and vegetation in support of the research activities at Coweeta.

The focal point of Coweeta is its outdoor living laboratory and you are invited to visit several of the accessible experimental sites. Because the roads are steep and narrow, please drive carefully and be prepared to share the right-of-way at all times.

Mission

The two problem statements below describe our contract with the U.S. public-- to use the best research methods available to resolve these problems and get the answers to the landowners, policy makers, and the public who need them.

Problem 1. Information, methods, and guidelines are lacking to implement and evaluate ecosystem management concepts, practices, and effects on water, soil and forest resources.

Research during the past 5 years has concentrated on quantifying the impacts of several alternative forest practices on soil and water resources. A body of knowledge, largely published, has emerged to assess practices such as cable logging, forest roads, herbicides, mechanical site preparation and cut/burn stand restoration. In many cases, results were translated into management guidelines and some studies were terminated. Remaining results will be published and appropriate guidelines and evaluation tools developed with an emphasis on responses of soil nutrients and site productivity. The RWU will continue to provide leadership in the Wine Spring Creek Ecosystem Management Project for both direction and conduct of research. New studies will address gaps in knowledge on the structure and function of ecosystems that must be filled to evaluate ecosystem sustainability.

Problem 2. Improved knowledge, baseline data, and predictive methods are required to evaluate effects of the atmospheric environment on forested watersheds in the southeastern U.S.

Research over the past five years has focused on developing a mechanistic understanding of the interactions among the atmospheric environment (chemical and physical) and watershed resources and biological processes at multiple scales. Particular emphasis has been placed on quantifying the atmospheric environment's regulation of carbon, water, and nutrient cycles, as well as potential climate change impacts on productivity and hydrology. Modeling has been a large component of these activities for integrating, synthesizing, and scaling processes across space and time. In the upcoming five years, past studies will be concluded and results published. New research to develop regional scale models of carbon, nitrogen, and sulfur cycles will be conducted along with synthesis of trends in atmospheric deposition and watershed level stream chemistry responses. Other new studies will focus on evapotranspiration and runoff processes as related to management and environmental issues

Major Areas of Research

Land Use and Water Quality

When the National Forest System was established in 1905, one of its first mandates was to restore the watershed function of forests. Today an estimated 80 percent of U.S. freshwater resources originate in forests, with much of the nation’s drinking water coming from the estimated 192 million acres of our national forests, which actually make up only 30 percent of U.S. forested land. According to the U.S. Environmental Protection Agency, more than 60 million people in 3,400 communities rely directly on national forests for their drinking water.

What is a watershed?

A watershed is a basin of sloping land surrounded by ridges and drained by a stream. The Coweeta basin, which contains dozens of separate watersheds, is ideal for hydrologic research. The site was strategically selected due to its topography and aspect and the unusually high rainfall (70 to 90 inches per year). The solid bedrock underlying the soils permits the hydrologist to account for most of the rainfall that enters the basin. Many of the watersheds in the basin are very similar in terms of size, climate, soils, and vegetation. The relationship between rainfall and streamflow before disturbance has been charted for many of the watersheds since 1934. To test a theory or evaluate a management practice, scientists can manipulate conditions on a watershed and then compare results with those from a similar undisturbed watershed that serves as a reference.

Since the 1930s, 32 weirs, or stream gauging stations, have been installed on streams in the Coweeta basin; 16 of these weirs are currently operational. Streamflow data has been collected from the weirs since the 1930s using automatic recorders that continuously monitor the height of the water in the weirs which is later translated into streamflow using a mathematical formula based on the dimensions of the weir blade. Because the weirs were precisely constructed, streamflow can be calculated day and night, through storm and sunshine, throughout the year. Sediment that accumulates in the ponding basin constructed behind each weir can also be measured and streamwater chemistry data has been monitored since 1972.

Water quality in the South has been shaped by three centuries of intensive land use, with clearing for agriculture, starting in the 1700s, and unregulated logging beginning shortly after the Civil War and lasting through the 1920s. The period between 1860 and 1920 was the most destructive known, with widespread clearing of southern forests without any few erosion control measures. Logging peaked in 1909 and stayed high until 1920, when only a few stands of virgin forest remained. Rivers were filled with sediment from mountain slopes; many still run muddy from those times.

Like most of the Southern Appalachians, the Coweeta basin was heavily harvested in the 1920s. At the time, very little scientific information was available about the impacts of unregulated logging on water quality, but it was clear to the naked eye that large amounts of sediment had reached the streams when mountain watersheds were logged.

How important are forests to maintaining high quality water in the southern Appalachians? Studies at Coweeta have shown studies show that forests produce the cleanest water among other land uses – forested watersheds have consistently been shown to have lower sediment and nutrients in streamwater. Healthy forests soak up nutrients from the soils as they grow. For example, the lowest levels of nitrogen are usually found in waters draining forested watersheds, while the highest levels are found in water from agricultural and urban uses. One study by Coweeta scientists showed that as the stream flows from a forest, water quality is high, but as the stream flows through a more urban setting water quality then declines from the inputs from non-forest landscapes. However, when intermixed with other land uses, undisturbed forests can improve streamwater quality draining agricultural and urban areas.

In a recent study, Coweeta scientists showed that the combination of dilution from clean water draining forested watersheds and in-stream processes, improved water quality in a stream draining an urbanized headwater watershed.

Sediment from Roads

Sediment is one of the most significant stream pollutants in the eastern United States. High sediment loads in streams have negative effects on aquatic insects, animals, and plants and can substantially increase the cost of water treatment. Non-point sediment from un-surfaced roads contributes to the majority of sediment present in southern Appalachian streams. One study estimated that unpaved roads, ditches, and road banks were responsible for 85% of the stream sediment load in a large watershed in the southern Appalachians.

Roads in the southern Appalachians vary from improved paved roads to poorly constructed and maintained dirt roads. Past research has generated a range of Best Management Practices (BMPs) designed to limit the production and movement of road sediment. Despite the development and implementation of these BMPs, road sediment continues to be a major challenge to private and public land managers. To address this challenge, land managers need information and tools to assess the relative differences in sediment generated from a range of existing road conditions, and to evaluate potential improvements after BMPs are put in place.

In one study, Coweeta researchers measured the particulate matter of total suspended solids (TSS) and total petroleum hydrocarbons (TPH) from an array of typical road conditions found on public and private land in the southern Appalachians. These included paved roads, gravel roads with routine maintenance, gravel roads with sediment control BMPs, and poorly constructed roads receiving minimal maintenance. Results showed the lowest amount of sediment production came from the paved roads and the most sediment production came from the poorly constructed roads receiving little or no maintenance. Properly installing and maintaining BMPs effectively reduced sediment delivery to streams. TPH was found to be in very low concentrations in paved road runoff, and was not found in nearby stream water or bottom sediments. These results held for both fresh and older paved surfaces. Paved surfaces generate less sediment, and that in combination with little or no TPH in runoff from these surfaces adds paving as an option to forest managers where critical aquatic habitat may be at risk to sedimentation from unpaved road surfaces. This information, combined with computer-based models that apply these values to the watershed scale, is currently being used by land managers to estimate current sediment yield and evaluate how improved road surfaces (either by paving or using BMPs) will impact future amounts of stream sediment.

Mountain Farming and Grazing

Scientists had never doubted that farming on steep slopes was destructive to soil and water, but they needed data to determine the nature and extent of the damage caused by practices that were commonplace on Appalachian hillsides. Watershed 3 was cleared in 1940. Corn was planted on 6 acres, and 7 acres were planted to pasture grasses that were grazed in alternate years, the remaining acreage stayed in forest. Expecting a significant increase in sediment runoff, researchers designed a large basin and deep-notch weir to measure erosion. During the 14 years of study, corn yields steadily declined even with the addition of commercial fertilizer because of the loss of top soil. Eventually crop yields were insufficient to pay for the seed. On the 7 acres planted in grasses and managed for grazing, cattle compacted the soil, reducing its ability to absorb water. By the end of the 13th year, erosion from Watershed 3 had resulted in a 215-ton increase in soil loss from the watershed. The stream channel had become wider and deeper, and overflowed from the streambanks, causing frequent flooding.

Control plots were established on Watershed 7 in 1941 for another grazing experiment. Half of the plots were fenced to prevent cattle from grazing; half were left open to unrestricted grazing. Due to compaction, the ability of the soil to absorb rain decreased significantly on the grazed plots, and by the end of the eighth grazing season, pasture forage had significantly decreased, and there was a sharp increase in the sediment runoff going into the stream. Cattle were forced to browse on hardwood foliage, causing the growth of, yellow-poplar (Liriodendron tulipifera) to decrease by 50 percent; the growth of other species also decreased.

Together, these experiments demonstrated the damaging effects of improperly managed hillside farming and grazing in the southern Appalachians.

Timber Practices

Watershed 10 was opened to local timber harvesting practices between 1941 and 1948, long before foresters were aware of Best Management Practices (BMPs) that allowed for responsible removal of logs from harvested areas. Logging roads were located and constructed by traditional methods, horses were used to drag the logs down slopes to loading decks, and trucks hauled the logs out of the forest. As expected, erosion from log trails and roads was extensive. In the undisturbed forest within the Coweeta basin, turbidity - a measure of the concentration of soil particles in the water - averages about 4 parts per million (ppm). During the logging operation, turbidity averaged 94 ppm and reached an alarming 5700 ppm during a storm event in 1947. Such erosion persisted long after the logging stopped. Soil erosion and impairment of water quality in streams during logging operations resulted from disturbance of the soil litter layer by dragging whole logs down trails and across streams, not from cutting trees. Studies at Coweeta on logging practices demonstrated several methods that minimize erosion and water quality effects.

A-frame winch and boom, crawler tractors, and cable logging were timber harvest methods developed to help reduce soil erosion and minimize stream turbidity. In the late 1950s, an A-frame winch and boom were used on two sites to skid logs to the log deck. The A-frame cable lifted the larger, butt end of the tree off the soil and skidded it uphill a maximum of 600 feet to the deck. Rarely was more than one tree winched over the same trail. During clearcutting operations on watershed 28 in 1963, crawler tractors were used to winch logs in much the same way. Skidding logs across watercourses was prohibited, and tractors were restricted to roads or ridges to reduce disturbance adjacent to the stream. Cable logging, a method that suspends logs on heavy wire high above the forest floor, was demonstrated in 1977 on Watershed 7. Cable logging virtually eliminates skid trails, and requires less road construction, therefore reducing erosion and sediment transport and deposition.

Key Findings from Coweeta Research

The Impacts of Forest Management on Water Quality and Quantity

- The amount of water flowing from a forest watershed increases after timber harvest, mainly because of reduced transpiration from trees.
- The volume of water from storms (stormflow) and maximum peak flows also tend to increase after harvest.
- Water yields and changes in stormflow lessen as vegetation grows back.
- Increases in the concentrations of nutrients such as nitrogen and phosphorus tend to be short lived.

- Leaving stream management zones—buffer strips of uncut trees and shrubs—protects stream temperatures by providing shade.
- Though erosion and sedimentation from forest management activities is small compared to other land uses, it can be significantly higher than that on undisturbed forest watersheds.
- Natural disturbances such as insect outbreaks can also temporarily increase nutrient losses from forest watersheds.
- Poorly designed or maintained roads are the main source for increased sediment levels associated with forest activities. Streamside management zones of sufficient width and extent are critical for reducing the delivery of pollutants to streams.

Prescribed Fire and its Effects on Forested Ecosystems

Since 1990, Coweeta scientists and collaborators have investigated the impacts of prescribed burning with long-term (ongoing), interdisciplinary, ecosystem approaches. Studies have been conducted on the effects of prescribed fire on ecosystem processes such as net primary production, nutrient and carbon cycling, and vegetation dynamics (regeneration, compositional changes, mortality, diversity) in a number of forest types.

Coweeta's research approach uses watershed-scale (water quality and quantity) and within watershed scale (plot level changes in nutrient and carbon cycling, vegetation dynamics) assessment of ecosystem responses to restoration burning. The watershed approach facilitates extrapolation of small-scale disturbances to larger landscape units. One unique aspect that is being addressed is the long- and short-term impacts of prescribed fire on ecosystem sustainability, using rates and pool sizes of carbon, nutrients, and water as key indicators of sustainability.

Prescribed burning in southern Appalachian ecosystems has many potential benefits: (1) reduction of fuel loads to minimize the risk and impacts of wildfire; (2) reduction of the evergreen understory to promote regeneration of desirable species such as oaks; (3) increased diversity of plants, small mammals, birds, amphibians, and insects; (4) stimulation of fast-growing new shoots to increase productivity; and (5) stimulation of nutrient cycling rates to increase site productivity. After nearly a century of exclusion, re-introduction of fire into the current forests of the southern Appalachians will have varying affects on ecosystem properties and vegetation structure and composition depending on fire type (intensity, severity, frequency, timing, and scale) and forest type (current species composition and structure, slope, soils, microclimate, and fuel load). Therefore, there is a need for more thorough investigation on the effects of prescribed fire on ecosystem processes in multiple forest types before widespread application. In addition, more knowledge is needed on the interactions between historical fire regimes, current ecosystem structure and function, and ecosystem responses to re-introduction of prescribed fire. Coweeta scientists are continuing their research efforts to understand the role of fire in forests of the Southern Appalachian Mountains.

Four large-scale prescribed burning projects in cooperation with the **Nantahala National Forest** of North Carolina, **Chattahoochee National Forest** of Georgia, and **Cherokee National Forest** of Tennessee are ongoing. Specific research questions to be addressed by prescribed and restoration burning are: 1) How does burning affect carbon and nutrient cycling and what are the short- and long-term effects on productivity and sustainability? 2) What are the effects of burning on regeneration patterns, biodiversity, and understory productivity? 3) How does burning affect wildlife habitat? and 4) How does burning affect stream water quality?

Wine Spring Creek restoration burn

The study area is located in the Nantahala National Forest of the southern Appalachian Mountains, western North Carolina (35°N latitude, 83°W longitude) and is part of the Wine Spring Creek Ecosystem Management Project. Wine Spring Creek watershed is within the Blue Ridge Mountain District of the Blue Ridge physiographic province. Three tributaries (Wine Spring Creek, Bearpen Creek, and Indian Camp Branch) converge into Wine Spring Creek that drains into Nantahala Lake at the western edge of the watershed boundary. The Wayah Ranger District, Nantahala National Forest, North Carolina prescribe burned the approximately 300 ha study area in April 1995. The fire was ignited by helicopter at the bottom of the south facing slope near the stream and created a mosaic of fire intensities, ranging from lightly burned (<80°C) at the low slope to heavily burned (>800°C) along upper slopes and ridges (Vose et al. 1999). On the ridge, the stand-replacing fire consumed understory vegetation and ignited the crowns in areas of highest fire intensity. Research demonstrated that prescribed stand restoration burning in mixed pine/hardwood ecosystems has positive benefits to pine regeneration, understory production and diversity, and habitat diversity (Elliott et al. 1999). Stream and soil chemistry showed no negative effects following burning (Vose et al. 1999). Small mammals and herpetofauna were unaffected (Ford et al. 1999) and groups of forest floor microarthropods responded differently to the burn treatment (Crossley et al. 1999).

Conasauga River Watershed restoration burn

Six sites were established in the Cherokee National Forest, TN (35° N latitude, 84° W longitude) and Chattahoochee National Forest, GA (34° N latitude, 84° W longitude). Sites were selected on the basis of similarity in overstory (Pinus virginiana, Pinus echinata, Quercus prinus, Q. coccinea, and Q. alba) and understory (Pinus strobus) composition, elevation, soils, topography, aspect, and presence of a perennial stream. The Ocoee Ranger District, Cherokee National Forest and the Cohutta Ranger District, Chattahoochee National Forest prescribed burned the four sites in March 2001. Fires were ignited with a drip torch using primarily backing-fire, lighting solid strips only along the ridge tops and allowing the fire to back down to the streams.

Before and after the prescribed fire, Coweeta scientists measured soil CO2 evolution; litterfall; large down wood; forest floor (small wood, litter, and fermentation+humus) mass, carbon and nitrogen pools; soil, soil solution, and stream chemistry; and vegetation (herbaceous, shrubs, and trees). Indices of soil nitrogen (N) availability showed no significant response to burning on any of the sites (Hubbard et al. 2004). Similarly, soil water NO3 - and NH4 +, and stream N did not increase after burning on any of the sites (Elliott and Vose 2005a). In the overstory, only a few small sized (5.0 cm< dbh<15.0 cm) trees were killed by the fire. However, significant mortality and subsequent

regeneration in the understory was found in the first growing season after the burn. Virginia pine and white pine decreased in the understory; while, yellow-poplar (Liriodendron tulipifera), red maple (Acer rubrum), scarlet oak (Quercus coccinea), and blueberries (Vaccinium spp.) increased in abundance (Elliott and Vose 2005b).

Joint Fire Science Program (JFSP)

In 2002, the JFSP provided funding for a combination of re-measurement of established studies and initiation of additional studies in mesic, mixed-hardwood forests in North Georgia (**Chattahoochee National Forest**) and western North Carolina (**Nantahala National Forest**). This forest type is the most extensive component in the southern Appalachians, yet there have been no systematic studies of ecosystem response to prescribed fire. In total, funding provided by the JFSP allowed detailed (following the same protocol) and long-term assessments of ecosystem responses to prescribed burning in major forest types in the southern Appalachian region.

The objectives of the research are twofold: (1) to document and synthesize information on the historical and contemporary fire regimes, and (2) to evaluate the effects of prescribed fire on ecosystem structure and function along a moisture/productivity gradient from xeric, pine-hardwood to mesic, mixed-hardwood ecosystems in the southern Appalachian region. The linkage between the two project objectives is based on the premise that significant improvements in the application of prescribed fire and in the understanding of fire effects are possible with an increased knowledge of historical fire regimes.

Objective 1: Document and synthesize information concerning pre- and post-settlement fire regimes in mixed-hardwood forests in the southern Appalachian region by using pollen/charcoal records, Cherokee Indian tribal records and archeological sites, and USFS and State Forest Service fire records.

Paleoecological data derived from charcoal and pollen in lakes and bog sediments provide reconstruction of environmental/fire history and a comparison with other documented accounts of vegetation patterns related to fire history (Clark, unpublished data). The synthesis of current information from the literature and other historical documents (Cherokee Indian Tribal records) established the historic locations of the Indian populations, the kinds of sites which were usually chosen for villages and agricultural fields (Gragson, in review), and how fire was used by Native Americans to modify their landscapes (Cooley 2004). A detailed analysis of USFS and State Forest Service fire records established the historical and contemporary fire regimes, both wildfire and prescribed fire, on state and federal lands in the southern Appalachians (Jurgelski and Gragson 2004, unpublished report).

Objective 2. Evaluate the effects of prescribed fire in mixed deciduous forests on fuel load reduction and ecosystem structure and function.

Most studies in the southern Appalachians have focused on pine/hardwood mixtures on xeric sites. Since these forest types occupy only a small portion of the landscape (about 5%), we know very little about the role of fire or its effects in most of the forested areas of the southern Appalachians. Strong topographic and edaphic variation creates gradients that determine vegetation composition, net primary productivity, and susceptibility and response to disturbance. To fully understand potential uses and effects of fire in the southern Appalachians, studies need to be conducted across vegetation and climatic gradients. To address this objective, Coweeta scientists are using a combination of ongoing and new research sites to assess short and long-term responses along these gradients. The ecosystems studied and compared are xeric, low productivity pitch pine (P. rigida)/hardwood forests; dry, moderate productivity shortleaf (P. echinata)/Virginia pine (P. virginiana)/oak forests; and mesic, high productivity, mixed/hardwood (L. tulipifera/Q. rubra) forests.

Ocoee Restoration Burn

In 2005, the JFSP provided funding to conduct watershed scale studies on the effects of fuel reduction and restoration treatments on pine/hardwood forests (**Ocoee Ranger District, Cherokee National Forest**) that have been severely impacted by the recent (1999-2003) southern pine beetle (*Dendroctonus frontalis* Zimmerman) outbreak. Federal, state, and private land managers are now challenged with large-scale implementation of management activities that: (1) reduce the

increased fire risk to widespread dead, fallen and dying trees, particularly in the wild land-urban interface, (2) restore forests destroyed by the SPB, and (3) reduce the potential for development of stand conditions that promote SPB outbreaks and other stand conditions and subsequent future wildfire risk.

This research approach uses within watershed scale (stand level changes in nutrient and carbon cycling, vegetation dynamics) assessment of ecosystem responses to restoration treatments. The objectives of the proposed research are: (1) to compare and quantify fuel load reduction methods (cutting dead pine and undesirable hardwoods, material left on site followed by prescribed fire; prescribed fire only; and no treatment) in pine/hardwood forests heavily impacted by southern pine beetle induced tree mortality, and (2) to evaluate the effects of further restoration treatments including planting shortleaf pine (*Pinus echinata*) and seeding native bluestem grasses on ecosystem structure and function in these pine-hardwood ecosystems in the southern Appalachian region. *We hypothesize that fuel reduction treatments (cutting and burning) followed by planting native pine and seeding native grasses will restore these ecosystems to a sustainable pine/hardwood ecosystem (i.e., more open savannas that are less susceptible to future SPB outbreaks and have lower wildfire risk).*

Modeling the effects of prescribed fire on nutrient loads in the southeastern US

Fire can play a significant role in altering runoff, sediment, and nutrient transport in aquatic and terrestrial ecosystems. The typical impact of fire is an immediate change in the physical properties of the soil and forest floor surface, alterations in nutrient uptake and processing, and changes in the amount and distribution of nutrient pools within the ecosystem. While there is potential for wildfire and prescribed burns to pose risks to water quality in the southeastern US, there has been little effort to specifically model the effects of prescribed burning on water quality at large spatial scales. This research addresses the needs of land managers to estimate the post-fire risks of flooding, erosion, and contamination of drinking water from sediment and nutrients.

Our approach is to use a combination of field studies and modeling to assess the impacts of varying fire regimes on water quality. For the modeling, we are applying and testing nutrient, sediment, and hydrologic cycling models across the mountains, piedmont and coastal plain physiographic regions in the southeastern US. Field study sites were located in the Nantahala National Forest in the southern Appalachians, the Uwharrie National Forest in the piedmont region and the Croatian National Forest in the coastal plain region. Portable automated samplers were installed to measure water quality and quantity, soil solution lysimeters and overland flow collectors were installed to determine surface vs. subsurface contributions of nutrients and sediment (Vose et al. 2005). We are focusing on nitrogen (NO-3, NH+4), phosphorous (PO-4) and sediment because they are key indicators of ecosystem response to disturbance and are important water quality parameters.

Summary

Prescribed fires in the southern Appalachians can be successful in reducing undesirable midstory species such as evergreen shrubs and invasive white pine (*Pinus strobus*), with little to no effect on sediment and nutrient transport to streams (Clinton et al. 2003, Elliott and Vose 2005a). Maintaining an intact forest floor and promoting rapid vegetation recovery is critical to minimizing the magnitude and duration of sediment transport (surface erosion), sediment delivery (suspended solids) and subsequent water quality responses (Elliott and Vose 2006, Clinton and Vose 2007). Fire managers can influence the effects of prescribed fire on water quality and other ecosystem properties (e.g., soil nutrient loss, vegetation recovery) by limiting fire severity and fire size. Understanding the effects of fire on southern Appalachian ecosystems is complex, because of the long period of fire exclusion and variation in and among ecosystems in terms of community composition and structure, fuel quality and quantity, climate, soil properties, and topography. Scientists are continuing their work on restoration of degraded ecosystems, evaluating a combination of treatments such as thinning overstory trees and midstory shrubs followed by fire and planting desirable species, using the watershed scale approach to evaluate the impacts on ecosystem resources.

Hemlock Woolly Adelgid Research in the Southern Appalachians

Hemlock woolly adelgid (HWA) is a non-native invasive pest that impacts eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga caroliniana*). HWA was first reported in the 1950's in the northeastern United States, and has now spread to the southern Appalachian region of northern Georgia, western North Carolina, and southern Virginia. Without control, hemlocks typically die within 5 to 7 years after infestation. Unfortunately, neither natural predators nor host resistance have been able to stop the spread of HWA. Hemlock trees serve important ecological roles in the southern Appalachians. They are a keystone species in near-stream areas, providing critical habitat for birds and other animals, and shading streams to maintain cool water temperatures required by trout and other aquatic organisms. Hemlocks are also prized for their visual beauty in both forest and urban settings.

A comprehensive research program is underway to address four key elements of the HWA problem:

1. Evaluating control strategies to reduce or eliminate the spread of HWA,
2. Understanding the impacts of hemlock mortality on ecosystem resources,
3. developing monitoring techniques that determine and predict HWA spread, and
4. Developing and evaluating restoration techniques to mitigate the impacts of hemlock mortality on ecosystem resources.

The research is being led by the USDA Forest Service's Southern Research Station and is being coordinated with the Northeastern Research Station, university cooperators throughout the Eastern U.S., and USDA Forest Service, State and Private Forestry's Forest Health Protection through participation in the HWA Research Coordinating Committee and the HWA Steering Committee. Most of the work will be centered at the Coweeta Hydrologic Laboratory in western North Carolina. The 5400 acre watershed has conducted watershed ecosystem research for 70 years and has strong supporting information on climate, soils, vegetation, and water quality. HWA was detected in the watershed in early 2003. Research was initiated in FY03 and will be continued and expanded in FY04 (see below). To fully understand HWA control, effects, monitoring, and restoration, a long-term approach will be required.

Research Activities

Evaluating Control Strategies

Biological control offers the best hope for long-term management of HWA in forests where chemical control is impractical. Thus far, three beetle predators of HWA have been brought into the Eastern U. S. and released, but evaluating their effectiveness has proven difficult in northern regions because harsh winters and declining host trees affect both the predators and their HWA prey. We plan to release and study these predators in or near the Coweeta Hydrologic Laboratory to evaluate their impact on HWA populations. These studies will provide insight into how the predators respond to low density populations at the leading edge of the infestation and how the milder winters in the South affect their ability to control HWA. A fundamental problem in evaluating predator impacts is

how to sample HWA and the predators to effectively characterize their abundance over time. Research on HWA biology and sampling protocols will address these problems.

Understanding Impacts

Research has been initiated to determine the impacts of HWA mortality on key ecosystem resources. In 2003, twenty study plots were located in areas with and without evidence of HWA infestation. These plots are being used to establish baseline measurements of nutrient, carbon, and water pools and cycling rates. Measures include: nitrogen mineralization, soil CO_2 flux, litterfall and coarse wood debris inputs, forest floor mass and decomposition, microenvironmental changes, overstory and understory species composition, and stream habitat and water quality. In FY04, HWA-related changes in microenvironment and transpiration will also be quantified. As the HWA infestation progresses, continuous monitoring of both terrestrial and aquatic ecosystems will quantify the impacts of hemlock mortality on ecosystem resources such as terrestrial and aquatic wildlife habitat, biodiversity, and water quality.

In addition, experimental plots have been located to simulate the impacts of hemlock loss on ecosystem processes. On a sub-set of these plots, all hemlock trees within the plots will be girdled to simulate HWA induced mortality. Detailed process-based measurements of carbon, water, and nutrient cycling will be used to predict potential impacts of actual HWA mortality.

Monitoring HWA Spread

In 2004, a network of monitoring plots will be established to determine rates and patterns of HWA spread. This network will utilize the approximately 800 long-term vegetation plots that were established at Coweeta in the 1930's. The long-term plots span gradients in soil, climate, slope, aspect and elevation comparable to those observed across the southern Appalachian region. A subset of plots will be surveyed on an annual basis to determine HWA infestation dynamics. These data will be combined with aerial photography, satellite imagery, and other remote sensing tools to examine the predictive ability of remote sensing tools for detecting HWA infestation. In addition, infestation patterns will be correlated with topographic, edaphic, and biological variables to determine controls on HWA infestation.

Restoration

The final phase of the HWA research program will be to develop techniques and strategies for restoring areas that have been impacted by HWA. This research component will not be initiated until further information is gained about the success of control strategies in the southern Appalachian region and the effects on HWA mortality on ecosystem resources.

Climate Change

Climate has been monitored at Coweeta Hydrologic Laboratory through a network of climate and rain gauging stations since 1934. Climate parameters such as temperature, rainfall, wind speed and direction, humidity, solar radiation, air quality, and evaporation continue to be measured at different elevations and aspects across the Coweeta basin.

The regions of the world are classified into climate regions; Coweeta is classified as having a maritime, humid, temperate climate. Coweeta weather is strongly influenced by the oceanic atmosphere (maritime); the basin receives high levels of rainfall throughout the year (humid), and daily and seasonal temperatures do not fluctuate widely (temperate). Long-term climatic monitoring is very important because it helps scientists explain current weather in terms of what has happened in the past and what can be expected to happen in the future

For example, long-term Coweeta climate data indicate that the frequency of significant droughts has increased since the mid-1980's and air temperature (especially during the winter) has been increasing since the 1970's.

Macon County, North Carolina

Map Symbol	Map unit name
ArA	Arkaqua loam, 0 to 2 percent slopes, frequently flooded
BeA	Biltmore sandy loam, 0 to 3 percent slopes, frequently flooded
BkB2	Braddock clay loam, 2 to 8 percent slopes, eroded
BkC2	Braddock clay loam, 8 to 15 percent slopes, eroded
BrC	Braddock-Urban land complex, 2 to 15 percent slopes
BrD	Braddock-Urban land complex, 15 to 30 percent slopes
BsC	Brasstown-Junaluska complex, 8 to 15 percent slopes
BsD	Brasstown-Junaluska complex, 15 to 30 percent slopes
BsE	Brasstown-Junaluska complex, 30 to 50 percent slopes
BsF	Brasstown-Junaluska complex, 50 to 95 percent slopes
BuD	Burton-Craggey-Rock outcrop complex, windswept, 15 to 30 percent slopes, stony
BuF	Burton-Craggey-Rock outcrop complex, windswept, 30 to 95 percent slopes, stony
CaE	Cashiers gravelly fine sandy loam, 30 to 50 percent slopes
CaF	Cashiers gravelly fine sandy loam, 50 to 95 percent slopes
CcF	Cataska-Sylco complex, 50 to 95 percent slopes
CdD	Chandler gravelly fine sandy loam, 15 to 30 percent slopes
CdE	Chandler gravelly fine sandy loam, 30 to 50 percent slopes
CdF	Chandler gravelly fine sandy loam, 50 to 95 percent slopes
ChE	Cheoah channery loam, 30 to 50 percent slopes
ChF	Cheoah channery loam, 50 to 95 percent slopes
CnC	Chestnut-Edneyville complex, windswept, 8 to 15 percent slopes, stony
CnD	Chestnut-Edneyville complex, windswept, 15 to 30 percent slopes, stony
CnE	Chestnut-Edneyville complex, windswept, 30 to 50 percent slopes, stony
CpD	Cleveland-Chestnut-Rock outcrop complex, windswept, 15 to 30 percent slopes
CpE	Cleveland-Chestnut-Rock outcrop complex, windswept, 30 to 50 percent slopes
CpF	Cleveland-Chestnut-Rock outcrop complex, windswept, 50 to 95 percent slopes
CsD	Cullasaja very cobbly fine sandy loam, 15 to 30 percent slopes, extremely bouldery
CsE	Cullasaja very cobbly fine sandy loam, 30 to 50 percent slopes, extremely bouldery
CuD	Cullasaja-Tuckasegee complex, 15 to 30 percent slopes, stony
CuE	Cullasaja-Tuckasegee complex, 30 to 50 percent slopes, stony
CuF	Cullasaja-Tuckasegee complex, 50 to 95 percent slopes, stony
DgB	Dellwood gravelly fine sandy loam, 0 to 5 percent slopes, frequently flooded
DrB	Dillard loam, 1 to 5 percent slopes, rarely flooded
DsB	Dillsboro loam, 2 to 8 percent slopes
DsC	Dillsboro loam, 8 to 15 percent slopes
EdB	Edneyville-Chestnut complex, 2 to 8 percent slopes, stony
EdC	Edneyville-Chestnut complex, 8 to 15 percent slopes, stony
EdD	Edneyville-Chestnut complex, 15 to 30 percent slopes, stony
EdE	Edneyville-Chestnut complex, 30 to 50 percent slopes, stony
EdF	Edneyville-Chestnut complex, 50 to 95 percent slopes, stony
EeC	Edneyville-Chestnut-Urban land complex, 2 to 15 percent slopes
EeD	Edneyville-Chestnut-Urban land complex, 15 to 30 percent slopes
EvB	Evard-Cowee complex, 2 to 8 percent slopes
EvC	Evard-Cowee complex, 8 to 15 percent slopes
EvD	Evard-Cowee complex, 15 to 30 percent slopes
EvE	Evard-Cowee complex, 30 to 50 percent slopes
EvF	Evard-Cowee complex, 50 to 95 percent slopes
ExC	Evard-Cowee-Urban land complex, 8 to 15 percent slopes
ExD	Evard-Cowee-Urban land complex, 15 to 30 percent slopes
FaC	Fannin fine sandy loam, 8 to 15 percent slopes
FaD	Fannin fine sandy loam, 15 to 30 percent slopes

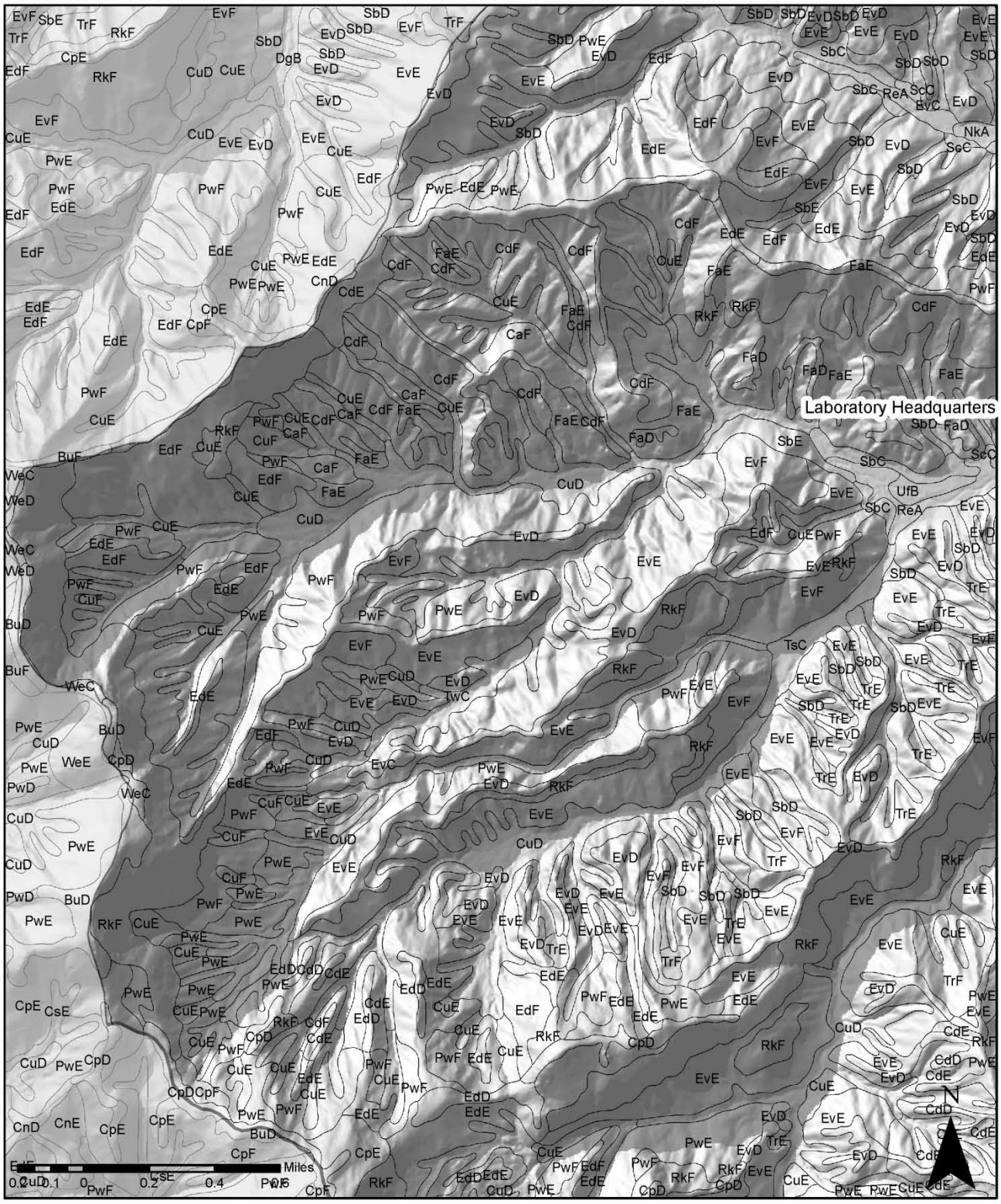
FaE	Fannin fine sandy loam, 30 to 50 percent slopes
FaF	Fannin fine sandy loam, 50 to 95 percent slopes

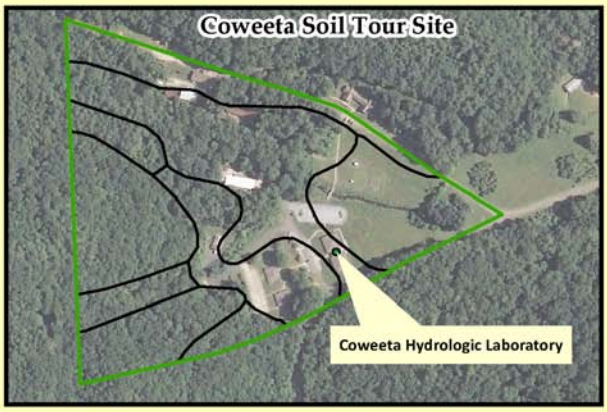
Map Symbol	Map unit name
HaB2	Hayesville clay loam, 2 to 8 percent slopes, eroded
HaC2	Hayesville clay loam, 8 to 15 percent slopes, eroded
HaD2	Hayesville clay loam, 15 to 30 percent slopes, eroded
HmA	Hemphill loam, 0 to 3 percent slopes, rarely flooded
NkA	Nikwasi fine sandy loam, 0 to 2 percent slopes, frequently flooded
OwE	Oconaluftee channery loam, windswept, 30 to 50 percent slopes
PwC	Plott fine sandy loam, 8 to 15 percent slopes, stony
PwD	Plott fine sandy loam, 15 to 30 percent slopes, stony
PwE	Plott fine sandy loam, 30 to 50 percent slopes, stony
PwF	Plott fine sandy loam, 50 to 95 percent slopes, stony
ReA	Reddies fine sandy loam, 0 to 3 percent slopes, frequently flooded
RhF	Rock outcrop-Cataska complex, 30 to 95 percent slopes
RkF	Rock outcrop-Cleveland complex, 30 to 95 percent slopes
RsA	Rosman fine sandy loam, 0 to 2 percent slopes, frequently flooded
SbC	Saunook gravelly loam, 8 to 15 percent slopes, stony
SbD	Saunook gravelly loam, 15 to 30 percent slopes, stony
SbE	Saunook gravelly loam, 30 to 50 percent slopes, stony
ScB	Saunook loam, 2 to 8 percent slopes
ScC	Saunook loam, 8 to 15 percent slopes
SoD	Soco-Stecoah complex, 15 to 30 percent slopes
SoE	Soco-Stecoah complex, 30 to 50 percent slopes
SoF	Soco-Stecoah complex, 50 to 95 percent slopes
SrC	Spivey-Santeetlah complex, 8 to 15 percent slopes, stony
SrD	Spivey-Santeetlah complex, 15 to 30 percent slopes, stony
SrE	Spivey-Santeetlah complex, 30 to 50 percent slopes, stony
StB	Statler fine sandy loam, 1 to 5 percent slopes, rarely flooded
SxE	Sylco-Cataska complex, 30 to 50 percent slopes
SyA	Sylva-Whiteside complex, 0 to 3 percent slopes
ToA	Toxaway loam, 0 to 2 percent slopes, frequently flooded
TrE	Trimont gravelly loam, 30 to 50 percent slopes, stony
TrF	Trimont gravelly loam, 50 to 95 percent slopes, stony
TsC	Tuckasegee-Cullasaja complex, 8 to 15 percent slopes, stony
TwB	Tuckasegee-Whiteside complex, 2 to 8 percent slopes
TwC	Tuckasegee-Whiteside complex, 8 to 15 percent slopes
Ud	Udorthents, loamy
UfB	Udorthents-urban land complex, 0 to 5 percent slopes, rarely flooded
W	Water
WeC	Wayah sandy loam, windswept, 8 to 15 percent slopes, stony
WeD	Wayah sandy loam, windswept, 15 to 30 percent slopes, stony
WeE	Wayah sandy loam, windswept, 30 to 50 percent slopes, stony
WeF	Wayah sandy loam, windswept, 50 to 95 percent slopes, stony

Taxonomic Classification of the Soils

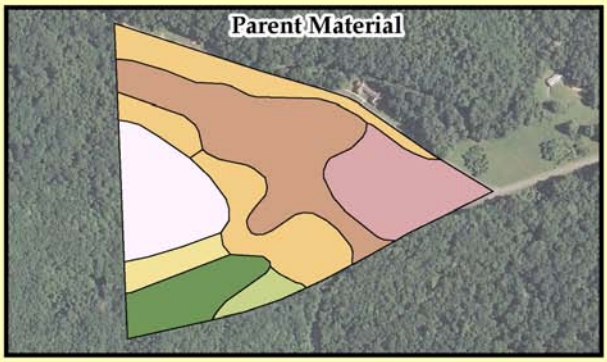
Soil name	Family or higher taxonomic classification
Arkaqua	Fine-loamy, mixed, active, mesic Fluvaquentic Dystrudepts
Biltmore	Mixed, mesic Typic Udipsamments
Braddock	Fine, mixed, semiactive, mesic Typic Hapludults
Brasstown	Fine-loamy, mixed, subactive, mesic Typic Hapludults
Burton	Fine-loamy, isotic, frigid Humic Dystrudepts
Cashiers	Fine-loamy, micaceous, mesic Typic Dystrudepts
Cataska	Loamy-skeletal, mixed, semiactive, mesic, shallow Typic Dystrudepts
Chandler	Coarse-loamy, micaceous, mesic Typic Dystrudepts
Cheoah	Fine-loamy, isotic, mesic Humic Dystrudepts
Chestnut	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Cleveland	Loamy, mixed, active, mesic Lithic Dystrudepts
Cowee	Fine-loamy, parasesquic, mesic Typic Hapludults
Craggey	Loamy, isotic, frigid Humic Lithic Dystrudepts
Cullasaja	Loamy-skeletal, isotic, mesic Humic Dystrudepts
Dellwood	Sandy-skeletal, mixed, mesic Oxyaquic Dystrudepts
Dillard	Fine-loamy, mixed, semiactive, mesic Aquic Hapludults
Dillsboro	Fine, mixed, active, mesic Humic Hapludults
Edneyville	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Evard	Fine-loamy, parasesquic, mesic Typic Hapludults
Fannin	Fine-loamy, paramicaceous, mesic Typic Hapludults
Hayesville	Fine, kaolinitic, mesic Typic Kanhapludults
Hemphill	Fine, mixed, active, mesic Umbric Endoaqualfs
Junaluska	Fine-loamy, mixed, subactive, mesic Typic Hapludults
Nikwasi	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, nonacid, mesic Cumulic Humaquepts
Oconaluftee	Fine-loamy, isotic, frigid Humic Dystrudepts
Plott	Fine-loamy, isotic, mesic Humic Dystrudepts
Reddies	Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Oxyaquic Dystrudepts
Rosman	Coarse-loamy, mixed, superactive, mesic Fluventic Humic Dystrudepts
Santeetlah	Fine-loamy, isotic, mesic Humic Dystrudepts
Saunook	Fine-loamy, mixed, superactive, mesic Humic Hapludults
Soco	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Spivey	Loamy-skeletal, isotic, mesic Humic Dystrudepts
Statler	Fine-loamy, mixed, active, mesic Humic Hapludults
Stecoah	Coarse-loamy, mixed, active, mesic Typic Dystrudepts
Sylco	Loamy-skeletal, mixed, active, mesic Typic Dystrudepts
Sylva	Coarse-loamy, mixed, semiactive, acid, mesic Humic Endoaquepts
Toxaway	Fine-loamy, mixed, superactive, nonacid, mesic Cumulic Humaquepts
Trimont	Fine-loamy, mixed, active, mesic Humic Hapludults
Tuckasegee	Fine-loamy, isotic, mesic Humic Dystrudepts
Udorthents	Udorthents
Wayah	Fine-loamy, isotic, frigid Humic Dystrudepts
Whiteside	Fine-loamy, mixed, active, mesic Aquic Hapludults

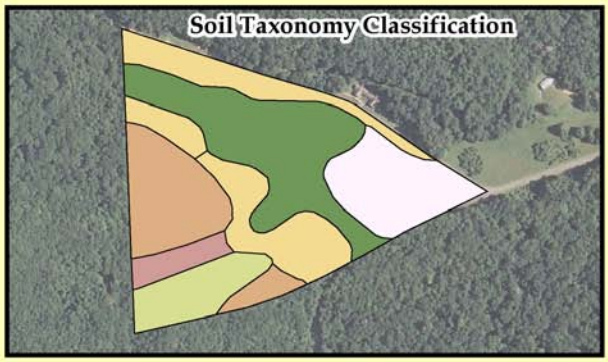
Soil Survey
of
Coweeta Hydrologic Laboratory Area





Map symbol	Map unit name
CuE	Cullasaja-Tuckasegee complex, 30 to 50 percent slopes, stony
EvE	Evard-Cowee complex, 30 to 50 percent slopes
EvF	Evard-Cowee complex, 50 to 95 percent slopes
PwF	Plott fine sandy loam, 50 to 95 percent slopes, stony
ReA	Reddies fine sandy loam, 0 to 3 percent slopes, frequently flooded
SbC	Saunook gravelly loam, 8 to 15 percent slopes, stony
SbE	Saunook gravelly loam, 30 to 50 percent slopes, stony
UfB	Udorthents-urban land complex, 0 to 5 percent slopes, rarely flooded





- Affected by Soil Creep in the Upper Solum Over Residuum Weathered from Igneous and Metamorphic Rock
- Affected by Soil Creep in the Upper Solum Over Residuum Weathered from Amphibolite or Hornblende Gneiss
- Cobbly and Stony Colluvium Derived from Igneous and Metamorphic Rock
- Colluvium Derived from Igneous and Metamorphic Rock
- Loamy Alluvium Over Cobbly and Gravelly Alluvium Derived from Igneous and Metamorphic Rock
- Loamy and Clayey Mine Spoil or Earthy Fill Derived from Igneous, Metamorphic and Sedimentary Rock
- Residuum Weathered from Amphibolite or Hornblende Gneiss

- Coarse-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Oxyaquic Dystrudepts
- Fine-loamy, isotic, mesic Humic Dystrudepts
- Fine-loamy, mixed, superactive, mesic Humic Hapludults
- Fine-loamy, parasesquic, mesic Typic Hapludults
- Loamy-skeletal, isotic, mesic Humic Dystrudepts
- Udorthents

NRCS

N

0 0.0375 0.075 0.15 0.225 0.3 Miles

Soil Models Developed for the Soil Survey of the Great Smoky Mountains National Park, North Carolina and Tennessee

Doug Thomas and Anthony Khiel, Soil Scientists, NRCS

The soil map layer of the Great Smoky Mountains National Park's geographic information system (GIS) was made by using remote sensing and model building techniques. The landscapes are rugged and access is limited. Historically, soils maps have been made with many onsite observations. In most cases, 70 to 75 percent of a survey area would have had onsite observation. Patterns of soils were often well understood. However, onsite observations were done to improve line placement between map units. To complete this project some remote sensing techniques were used. Soils models, or concepts involving patterns of soil distribution, have been developed using geomorphology, geology, landscape position, vegetative cover, microclimate, and the movement of soil material and rock fragments by gravity and/or water as guides. Onsite observations in accessible areas were used to verify the models. The models were then applied to similar remote landscapes.

Some of the land use concerns are the environmental hazard, the vigor and productivity of trees, the wildlife food source rating, and the relationship of soils to rare/ unique wildlife habitats. The environmental hazard is the potential of exposing fresh iron pyrite to weathering. This weathering releases sulfur into the environment and forms sulfuric acid. The sulfuric acid rapidly lowers the pH in streams, adversely affecting aquatic life. The vigor and productivity of trees is a measure of the ability of a landscape to produce food. The vigor and productivity are measured by taking the site index of the trees on each soil. Some soils have a wide range of productivity due local climatic conditions. These areas were phased into different map units. The wildlife populations of landscapes are limited by the amount of food, cover, shelter, or water. In this section only the ability of landscapes to produce food will be considered. The wildlife food source rating takes into account the vigor and productivity and also the quality and the diversity of food sources. Some trees are good sources of food, others are poor. Some landscapes have a high number of high food value trees, and some have few. Some trees have large well formed crowns and others have small crowns. None of the landscapes have reached their full potential to produce food. This is due to the large numbers of poor food source trees and/or poor crown development. Landscapes that have a high quantity, quality, and diversity of food sources have a high wildlife food source rating. If one food source fails, then there are others to replace it. In addition, the diversity of animals using the site for a food source is larger. Management that enhances the development of large healthy crowns in good food source trees can improve the wildlife food source rating on landscapes. Management that enhances the diversity of good food source trees can improve the wildlife food source rating. The best returns to management are on the higher vigor and productivity landscapes. The relationship of soils to rare/unique wildlife habitats occurs when soil properties cause an unusual habitat to form. This could include a rare/unique habitat for a single species or a group of species. Many of the rare/unique habitats have a low wildlife food source rating in general but are valuable for a limited number of species. A rare/unique habitat also includes a landscape or parts of a landscape that have high wildlife food source ratings. Landscapes with a high wildlife food source rating are very important because they provide the greatest potential for increasing food supplies. An example of a rare/unique habitat with a low wildlife food source rating is hanging coves where the soils form organic mats. The organic mats and mineral soil material cause a rare/unique water-enhanced habitat to form. This habitat is favorable for species such as salamanders. An example of rare/unique habitat with a high wildlife food source rating is the large basins and fans in watersheds draining north to east. This landscape has very high vigor and productivity. The food sources can be diverse due to many differing species that grow well on this landscape. However, there are too many yellow-poplars on this landscape to achieve maximum food production.

The models developed range from the relatively straightforward to the complex. The tools used to remote sense include U.S. Geological Survey topographic maps, geology maps, black-and-white stereoscopic photography, and infrared photography. The purity of the map units and the accuracy of the line placement between map units limit the reliability of a model. The purity of a map unit is the amount of dissimilar soils that are permitted in that map unit. Inaccurate line placement increases the amount of dissimilar soils and lowers the reliability. The reliability of the model cannot exceed the reliability of the map units in that model. If the line placement is in question, the reliability is decreased. Models that have parts of the landscape that are difficult to confirm with remote-sensing tools have lower reliability numbers. To achieve an acceptable level of reliability, onsite observations were done on similar landscapes with access. Models are difficult to apply where the geology maps do not separate differing rock types. Models that have a wide range in tree vigor and productivity are difficult to remote sense without high-resolution photography. Models that have both lithic and paralithic soils are difficult to remote sense. Shaded head

slopes and side slopes, rock outcrops, boulder trains, boulder fields, and hanging coves with organic mats are parts of the landscape which are difficult to remote sense.

There are other tools that can be used to improve the reliability of the models, such as high-resolution photography, winter color (leaf-off) photography, spring color photography, fall color photography, and late afternoon photography. Low altitude, high resolution photography can be used to check the vigor and productivity of the trees. Winter color photography can be used to remote sense rock outcrops. Spring color photography can be used to identify yellow-poplar vegetative cover. Yellow-poplars leaf out before most other species and can be used to identify colluvium and shaded head slopes and side slopes. Fall color photography can be used to identify oak-hickory-yellow pine vegetative cover. Late afternoon photography can show which parts of the landscape are in the shade in the hottest part of the day (from 3:00 to 5:30 p.m.). Oak-hickory- yellow pine cover is in direct sunlight most of the day. Yellow-poplar cover is in passive sunlight much of the day.

Landscapes with access were examined carefully. Onsite observations are used collectively to develop soil patterns and line placement patterns. What do the rock fragments look like on the landscape? Where are the rock fragments on the landscape? How many rock fragments are there? What is the size of the rock fragments? What is the shape of the rock fragments? Do the rock fragments show signs of chemical weathering? What do the rocks look like in the drainageways? What do the rock fragments look like in the streams? Is the water flowing over or around the rocks? Are rock fragments different or the same as the underlying geology? What is the slope? What is the aspect? What is the elevation? What is the shape of this part of the landscape? What is the vegetative cover? How well are the trees growing? How diverse are the trees? Are the trees good or poor food sources? Do the many observations support a single conclusion or are they conflicting? Does this onsite observation support a soil pattern and line placement pattern or is it conflicting? These questions are used to link a map unit identified in the field to a specific geology, vegetative cover, landscape position pattern, or a signature on one of the remote sensing tools. Trends allow more accurate predictions to be made. What is the likelihood that a certain soil will occur on a certain part of the landscape in a certain model? Confidence must be maintained in the accuracy of the models. In some cases onsite observations must be performed. The separation of hard metasandstone from soft metasandstone required observations. The geology maps did not show the separation. The separation of windswept parts of the landscape from non-windswept parts required observations. These observations were completed before the models were recommended to be used to map soils with only remote-sensing tools. The reliability of models can be improved by increasing the number of soils that can be predicted to occur on any given part of the landscape. However, to make a soil map that is useful to the user, the management concerns must be kept in mind. Soils of very different management concerns should not be combined. Each model was verified as being reliable before that model was used to remote sense with no additional onsite observations. This section outlines the different models that have been established in the soil resource inventory of the Great Smoky Mountains National Park.

Models are built based on geology, temperature regime, landscapes, the origin of the transported material, and the potential for mass wasting. First, models were developed based on geology and temperature regimes. Additional models were then developed by dividing these general models based on differences in landscapes, origin of transported material, and potential for mass wasting. For example, the black pyritic slates in the mesic temperature regime were divided into three models. The slates were first divided by the potential for mass wasting. Then, the slates, with little natural occurring mass wasting, were divided by landscapes.

The size of the rock fragments in the transported material affects the movement of that transported material. The force needed to move the rock fragments increases as the size of the rock fragments increases. Transported material with boulders tends to trip smaller transported material. Thus, boulders cause areas of transported material to be deeper and larger in size. The landscapes in the survey area in general have steep or very steep side slopes. The smaller streams tend to have stream gradients that are moderately steep or steep. Transported material, with gravel/channer-size rock fragments, tends to move easily down slope and down the watershed.

The weathering patterns of rock fragments are used to identify models. The weathering is chemical and physical. The weathering of rock fragments occurs in the soil and on the surface of the soil. If rock fragments are considered durable, they are resistant to weathering. For example, the Thunderhead Sandstone rock fragments are durable in the soil and on the surface of the soil. However, the Pigeon Siltstone rock fragments are durable in the soil and are not durable on the soil surface.

An understanding of soil formation is required to use these models. Most of the models are linked to the underlying geology. However, models are also linked to origin of the transported material in those models. Soils occur in reoccurring patterns. The upland in models is linked only to the underlying geology. The transported material in

models may or may not be related to the underlying geology. This material could be from an upslope part of the landscape with a different geology. Watersheds are use to determine the origin of the transported material. It is gravity and water that transports material. The transported material in models is linked to its origin. The origin of transported material is tracked by using watersheds. In the upper parts of watersheds, the transported material is often the same as the underlying geology. By the same token, the lower parts of watershed are most likely to be buried by material from a differing geology. A single model may have areas of transported material from the underlying geology and from other sources. Some models are all transported material.

Block diagram from the Soil Survey of Macon County, North Carolina

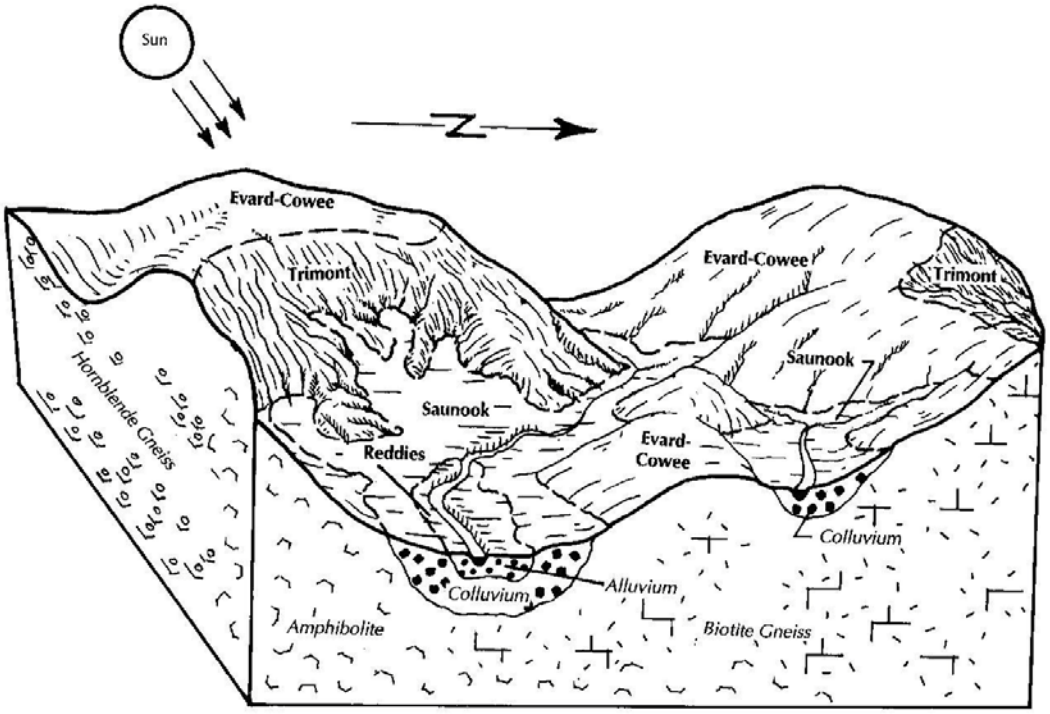


Figure 4.—Typical relationship of soils, landscape position, and parent material in the Evard-Cowee-Saunook general soil map unit.

Geology/Landscape/Vegetative Cover/Soils Models

Model 8: Mesic Gneiss

Geology

This model consists of gneiss (Biotite Granitic Gneiss) in a mesic temperature regime. It is in areas at elevations of less than 4,600 feet in watersheds draining south to west. It is associated with biotite granite gneiss. It is interlayered with biotite gneiss, amphibolite, and calc-silicate granofels.

The risk of exposing pyrite to the environment is none. The risk of stream acidification is none. The risk of landslides is low.

Rock fragments tend to weather very slowly physically when exposed on the surface. The fragments are durable even when transported long distances by gravity and/or water. Chemical weathering of gneiss is rapid when it is covered with soil material. In the park, gneiss is the best geology for the production of plant nutrients.

Landscape

This model is below 4,600 feet in elevation. It is only in North Carolina. This landscape has well rounded ridges and side slopes. This landscape has more well formed head slopes and colluvium than most other landscapes. Colluvium is relatively continuous, except where lithic soils occur on very steep side slopes. Lithic soils are largely confined to very steep side slopes with nearly vertical rock outcrops and boulder trains. Hanging coves commonly are upslope from these areas. Commonly there is little or no toeslope colluvium below the very steep side slopes. Cascades and waterfalls are common and occur on these very steep side slopes. Rock outcrops are not common, except in Raven Fork Gorge. Where rock outcrops occur, they are a source of rock fragments. Rock outcrops differ from slide faces in that the vegetative cover is not stripped away from large areas. Rock fragments of all sizes are produced.

Examples

The area around the Oconaluftee Visitor Center is a good example.

Vegetative Cover

This landscape is most commonly covered with oak-hickory-yellow pine on the ridges and side slopes. The main exception is on the east- to north-facing, very steep side slopes, where northern hardwoods and hemlock-white pine-rhododendron cover dominates. Various other species may occur or dominate at any given spot on the hot uplands, such as white pine, laurel, black locust, red maple, and sourwood. The colluvial and shaded side slope areas are most often covered in yellow-poplar. This is a rare/unique habitat for wildlife due to the high vigor and productivity. Various other species may occur or dominate at any given spot on the colluvium and shaded side slopes, such as northern red oak, sweet birch, black cherry, hemlock, basswood, black locust, fraser magnolia, beech, white pine, silverbell, and black walnut. Rhododendron and white pine or hemlock cover is found in some hanging coves. This is a rare/unique habitat for wildlife such as salamanders. The majority of this landscape has moderate vigor and productivity. The shaded side slopes and colluvium have some of the highest vigor and productivity measured in the park. This landscape has a moderate wildlife food source rating. Most parts of this landscape are less diverse in food sources than the frigid gneiss landscape. For example, the colluvial and shaded head slope areas of this landscape have far too many yellow-poplars as compared to other species. Yellow-poplar is of low value as wildlife food. Species of high value wildlife food are oak, hickory, black walnut, black cherry, maple, birch, beech, pine, and serviceberry. The lithic soil areas of the landscapes have low wildlife value.

Soils

Soils on this landscape have a moderate amount of plant nutrients. Hot upland soils comprise more than 70 percent of this landscape, and the shaded side slopes and colluvial soils less than 30 percent. Hot upland soils range from very deep to moderately deep for the most part. The hot, very deep and moderately deep soils comprise more than 80 percent of the upland, the shallow soils less than 5 percent, and the soils on shaded side slopes about 15 percent. Edneyville and Chestnut soils are mapped in a complex and are the dominant soils on the residual side slopes and ridges. Evard and Cowee soils are mapped in a complex and are on the residual side slopes and ridges at elevations of less than 3,600 feet. Chestnut and Cleveland soils are mapped in a complex and are most commonly on the very steep side slopes with rock outcrops. Leatherwood and Ravenfork soils are on shaded side slopes.

Leatherwood soils are on shaded head slopes. Ravenfork soils are on shaded nose slopes. Leatherwood and Ravenfork soils are limited to northwest- to east-facing aspects. At the extremes of the aspect range, Leatherwood and Ravenfork soils are only on the lower part of the side slopes. Commonly Leatherwood soils are on 60 to 75 percent of the lower head slope. Commonly Ravenfork soils are on 35 to 65 percent of the lower nose slope. The upper part of the head slopes and nose slopes is either Edneyville and Chestnut soils or Evard and Cowee soils. This depends on elevation and slope. Cullasaja and Tuckasegee soils are on colluvial portions of this landscape. A few small areas of Alarka, Wesser, and Whiteside soils are in hanging coves with rhododendron and white pine or hemlock canopy. Alarka and Wesser soils are on slopes of less than 8 percent. Alarka and Whiteside soils are on slopes of 8 to 15 percent. These soils are used in both frigid and mesic temperature regimes.

Mapping the Model

Many separations are needed to remote sense this landscape. The main tools needed for this model are infrared photography and black-and-white stereoscopic photography. Small windswept areas are separated from non-windswept areas. Side slopes with a yellow-poplar vegetative cover and the colluvial areas are identified. Lithic soils and rock outcrops are identified. Good reliability was achieved by finding ways to make these separations with the tools available. The vigor and productivity are not uniform over this landscape. This landscape is affected by aspect. Most of the landscape has moderate vigor and productivity. Almost all of this landscape is sheltered from the high winds. The entire mapping is completed on this landscape. Only about 100 acres were mapped as windswept. The side slopes with a yellow-poplar vegetative cover and colluvial areas are some of the most productive sites in the park. These areas are located using the black-and-white stereoscopic photography and some onsite observations. These observations are needed to determine how much of these areas are high in vigor and productivity. This landscape has both lithic and paralithic soils. The extent and location of lithic soils and rock outcrops are located using the black-and-white stereoscopic photography and some onsite observations. Areas of lithic soils and rock outcrops commonly have hanging coves upslope and little toeslope colluvium. Rock outcrops are difficult to remote sense with the tools available. While the total amount of rock surface on a side slope many be substantial, individual rock outcrops are generally small. They are commonly less than 200 feet across and less than 60 feet high. The rock outcrops generally line up across the very steep side slopes. Areas between the rock outcrops are in trees. Most rock outcrops are nearly vertical, making them more difficult to see on the photography. Hanging coves with organic mats are covered with rhododendron with white pine and/or hemlock. This is a rare/unique habitat for wildlife such as salamanders. It is important to try to identify these areas. The amount of the rhododendron to the white pine and/or hemlock is important. There must be enough of the rhododendron to dominate the leaf litter. However, this can be done under a white pine and/or hemlock canopy. As of now, there is no way to remote sense these areas. It is difficult to predict the reliability of this model with no onsite observations. However, the model has been applied to areas where onsite observations could be done. The amount of dissimilar soils in the map units is 10 to 15 percent. The line placement between map units is in question if there are no onsite observations made. The identification of the side slopes with a yellow-poplar vegetative cover and colluvial areas is likely be about 70 percent reliable using only remote sensing. The identification of the lithic soils and rock outcrops is likely to be about 70 percent reliable. For these reasons a reliability of 70 to 75 percent is the best that can be done using remote sensing alone. This model is difficult to remote sense. It is far from being a complete model. Ways to improve this model are still being considered. The amount of dissimilar soils probably cannot be reduced. If this model can be improved, it will be because of better line placement on the soils layer. More tools are needed to improve line placement.

Summary

Model 8 is characterized as being no risk to the environment and of moderate value as a wildlife food source. The wildlife food source rating of this model could be greatly improved if this landscape was managed.

REDDIES PEDON DESCRIPTION – FLOOD PLAIN

Print Date: 04/22/2011

Description Date: 6/1/1988

Describer: R.H. Ranson, B.P. Smith, J. Allison, R. Goodwin, F

Site ID: 88NC199003

Pedon ID: 88NC199003

Pedon Note: South side of rd. area has complex microrelief; braided intermit channels scoured to cobbles; mounded areas; short natural cutslopes 1 to 3 meters high.

Soil Name as Described/Sampled: Reddies

Soil Name as Correlated: Reddies

Classification: Coarse-loamy over sandy or sandy-skeletal, isotic, mesic Andic Haplumbrepts

Physiographic Section:

Geomorphic Setting: flood plain
mountains or deeply dissected plateaus

Particle Size Control Section: 25 to 102 cm.

Description origin: Converted from SSL-CMS data

Diagnostic Features: umbric epipedon 0 to 41 cm.
cambic horizon 41 to 66 cm.

Country:

State: North Carolina

County: Yancey

MLRA: 130 -- Blue Ridge

Map Unit:

Quad Name:

Latitude: 35 degrees 45 minutes 30.00 seconds north

Longitude: 82 degrees 12 minutes 30.00 seconds west

Datum:

Existing Vegetation: red maple, sweet birch, tulip tree

Bedrock Depth:

Surface Fragments: 0.1 percent

Description database: NSSL

Oe--3 to 0 centimeters; partially decomposed leaves, twigs, and moss with some humus; many very fine roots concentrated in thin humus mat at A1 contact. (Lab sample # 88P4703).

A1--0 to 13 centimeters; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 3/3), dry; moderate medium granular structure; very friable, nonsticky, nonplastic; many fine and very fine roots top of horizon; many fine tubular and many very fine tubular pores; 11 percent fine mica flakes, unspecified; extremely acid, pH 4.3, Hellige-Truog; clear wavy boundary. (Lab sample # 88P4699).

A2--13 to 41 centimeters; dark brown (10YR 3/3) loam, dark yellowish brown (10YR 4/4), dry; weak medium granular structure; very friable, nonsticky, nonplastic; many fine and common coarse roots throughout; many fine tubular and many very fine tubular pores; 11 percent fine mica flakes, unspecified; very strongly acid, pH 4.5, Hellige-Truog; clear wavy boundary. (Lab sample # 88P4700).

Bw--41 to 66 centimeters; dark yellowish brown (10YR 4/6) sandy loam; weak coarse subangular blocky structure; very friable, nonsticky, nonplastic; common fine and coarse roots throughout; common fine and very fine tubular pores; 11 percent fine mica flakes, unspecified; moderately acid, pH 6.0, Hellige-Truog; abrupt wavy boundary. (Lab sample # 88P4701).

C--66 to 201 centimeters; multicolored, stratified water rounded cobbles, gravels and sand; primary hues are 10YR and 7.5YR; extremely cobbly loamy coarse sand; single grain; loose, nonsticky, nonplastic; few medium and very fine roots top of horizon; few medium and very fine tubular pores; 30 percent fine mica flakes, unspecified and 11 percent medium mica flakes, unspecified; moderately acid, pH 6.0, Hellige-Truog. (Lab sample # 88P4702).

*** Primary Characterization Data ***

Pedon ID: 88NC199003 (Yancey, North Carolina) Print Date: May 1 2011 8:24AM

Sampled as on Jun 01, 1988 : Reddies ; Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haplumbrept
Revised to correlated on Dec 01, 1994 : Reddies ; Coarse-loamy over sandy or sandy-skeletal, isotic, mesic Andic Haplumbrept

SSL - Project CP88NC226 NORTH CAROLINA MOUNTAIN SOILS
- Site ID 88NC199003 Lat: 35° 45' 30.00" north Long: 82° 12' 30.00" west MLRA: 130
- Pedon No. 88P0870
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
88P04699	A1	A1	0-13				L	FSL
88P04700	A2	A2	13-41				L	FSL
88P04701	Bw	BW	41-66				SL	LS
88P04702	C	C	66-200				LCOS	COS
88P04703	Oe	OE	3-0					

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	1.67	(NA)
Clay, carbonate free, Weighted Average	5	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	78	% wt
Volume, >2mm, Weighted Average	38	% vol
Clay, total, Weighted Average	5	% wt

Weighted averages based on control section: 25-100 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay < .002	-2- Silt .002 -.05	-3- Sand .05 -2	-4- Fine < .0002	-5- CO_3 < .002	-6- Fine .002 -.02	-7- Coarse .02 -.05	-8- VF .05 -.10	-9- F .10 -.25	-10- M .25 -.50	-11- C .5 -1	-12- VC 1 -2	-13- (Rock Fragments (mm)) Weight 2 -5	-14- 5 -20	-15- 20 -75	-16- .1-75	-17- >2 mm wt % whole soil
				(Total)			(Clay)		(Silt)		(Sand)					(Rock Fragments (mm))				
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1			3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
88P04699	0-13	A1	S	9.9	14.2	75.9			6.8	7.4	21.3	37.5	14.1	2.5	0.5	tr	--	--	55	--
88P04700	13-41	A2	S	8.4	24.6	67.0			14.3	10.3	24.4	29.8	10.3	2.1	0.4	tr	tr	--	43	tr
88P04701	41-66	Bw	S	4.7	14.0	81.3			6.8	7.2	14.1	30.1	22.7	9.1	5.3	5	6	9	74	20
88P04702	66-200	C	S	4.0	4.9	91.1			1.1	3.8	8.1	19.3	22.2	21.8	19.7	8	16	61	97	85
88P04703	3-0	Oe	S													--	--	--		

*** Primary Characterization Data ***

Pedon ID: 88NC199003 (Yancey, North Carolina) Print Date: May 1 2011 8:24AM

Sampled As : Reddies Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 88P0870

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa (- - - g cm^{-3} - - -) 4A1d	-2- Oven Dry 4A1h	-3- Cole Whole Soil	-4- (- - - - - - - - - - Water Content - - - - - - - - - -) 6 kPa (- - - - - - - - - - - - % of < 2mm - - - - - - - - - -)	-5- 10 kPa	-6- 33 kPa 4B1c	-7- 1500 kPa 4B2a	-8- 1500 kPa Moist	-9- Ratio AD/OD 4B5	-10- WRD Whole Soil cm^3 cm^{-3} 4C1	-11- Aggst Stabl 2-0.5mm % 4G1	-12- (- - Ratio/Clay - -) CEC7 8D1	-13- 1500 kPa 8D1
88P04699	0-13	A1	S	0.65	0.77	0.058			51.1	10.3		1.015	0.27	98	2.19	1.04
88P04700	13-41	A2	S	0.92	0.92	--			25.1	9.8		1.017	0.14	96	2.27	1.17
88P04701	41-66	Bw	S	1.12	1.14	0.005			14.8	4.7		1.010	0.10		1.94	1.00
88P04702	66-200	C	S							2.4		1.005			1.20	0.60
88P04703	3-0	Oe	S							29.8		1.030				

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (- - - - - Total - - - - -) C (- - - - - - % of <2 mm - - - - -) 6A2d	-2- N 6B3a	-3- S	-4- Org C 6A1c	-5- C/N Ratio	-6- (- - - Dith-Cit Ext - - -) Fe (- % of < 2mm - - - - - - - - - - - - - - -) 6C2b	-7- Al 6G7a	-8- Mn 6D2a	-9- (- - - - - - Ammonium Oxalate Extraction - - - - -) Al+½Fe	-10- ODOE	-11- Fe 6C9a	-12- Al 6G12	-13- Si 6V2	-14- Mn mg kg^{-1} 6D5b	-15- (- - - Na Pyro-Phosphate - - -) C (- - - - - - % of < 2mm - - - - -)	-16- Fe	-17- Al	-18- Mn
88P04699	0-13	A1	S		0.261		4.85	19	1.6	0.6	tr	0.82	0.22	0.81	0.42	0.02	285.3				
88P04700	13-41	A2	S		0.215		4.65	22	2.1	0.8	tr	1.24	0.24	1.16	0.65	0.03	243.5				
88P04701	41-66	Bw	S				1.25		1.6	0.5	tr	0.83	0.12	0.80	0.43	0.05	313.6				
88P04702	66-200	C	S				0.43		1.5	0.4	tr	0.51	0.06	0.46	0.28	0.05	310.6				
88P04703	3-0	Oe	S	12.44	0.741		13.75	19					0.41	0.67	0.37	0.01	183.0				

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- (- - - - - - NH_4OAC Extractable Bases - - - - -) Ca (- cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - -) 6N2e	-2- Mg 6O2d	-3- Na 6P2b	-4- K 6Q2b	-5- Sum Bases	-6- Acid-ity 6H5a	-7- Extr Al 6G9b	-8- KCl Mn mg kg^{-1} 6D3	-9- CEC8 Sum Cats (- - - - cmol(+) kg^{-1} - - - -) 5A3a	-10- CEC7 NH_4 OAC 5A8b	-11- ECEC Bases +Al 5A3b	-12- Al Sat (- - - - - - - - % - - - - - - - -) 5G1	-13- (- - - - Base - - - -) (- Saturation -) Sum 5C3	-14- NH_4OAC 5C1
88P04699	0-13	A1	S	0.3	0.3	--	0.2	0.8	23.6	3.6	1.5	24.4	21.7	4.4	82	3	4
88P04700	13-41	A2	S	0.1	0.1	--	0.1	0.3	23.9	2.7	0.4	24.2	19.1	3.0	90	1	2
88P04701	41-66	Bw	S	0.1	0.1	tr	--	0.2	10.6	0.8	0.2	10.8	9.1	1.0	80	2	2
88P04702	66-200	C	S	0.1	0.1	0.1	--	0.3	5.2	0.1	0.1	5.5	4.8	0.4	25	5	6
88P04703	3-0	Oe	S	4.1	1.8	0.1	0.7		34.6	1.7	2.7		40.2				

*** Primary Characterization Data ***

Pedon ID: 88NC199003 (Yancey, North Carolina) Print Date: May 1 2011 8:24AM

Sampled As : Reddies Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 88P0870

Salt

(- - - Water Extracted From Saturated Paste - - -)

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- - mmol(+) L^{-1} - -)				(- - - mmol(-) L^{-1} - - -)										(- - % - -)		(- - dS m^{-1} - -)		%	
																						5D2	
88P04699	0-13	A1	S																			--	
88P04700	13-41	A2	S																			--	
88P04701	41-66	Bw	S																			--	
88P04702	66-200	C	S																			2	

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl	-2- $CaCl_2$ 0.01M 1:2	-3- H_2O 1:1	-4- Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4*2H_2O$ <2mm	-10- Gypsum As $CaSO_4*2H_2O$ <20mm	-11- Resist ohms
				(- - - pH - - -)						(- - - % - - -)				cm^{-1}
					4C1a2a	4C1a2a								
88P04699	0-13	A1	S		4.1	5.8								
88P04700	13-41	A2	S		4.5	5.2								
88P04701	41-66	Bw	S		4.8	4.9								
88P04702	66-200	C	S		5.0	5.2								
88P04703	3-0	Oe	S		3.9	5.8								

Organic

Layer	Depth (cm)	Horz	Prep	-1- Mineral Content	-2- OM TC*1.724	-3- OM+ Min	-4- Total C	-5- Total N	-6- C/N	-7- Fiber Content Unrub	-8- Fiber Content Rub	-9- NaPyro Color	-10- Decomp State	-11- Limnic Matter	-12- pH $CaCl_2$	-13- pH H_2O	-14- Bulk Density 33 kPa	-15- Bulk Density 33 kPa rewet	-16- Bulk Density OD	-17- Proj Subs
				(- - - % - - -)					ratio	% (by vol)								g cm^{-3}		cm cm^{-1}
				8F1			6A2d	6B3a								4C1a2a				
88P04699	0-13	A1	S					0.261	19							5.8				--
88P04700	13-41	A2	S					0.215	22							5.2				--
88P04701	41-66	Bw	S													4.9				10
88P04702	66-200	C	S													5.2				76
88P04703	3-0	Oe	S	73			12.44	0.741	19							5.8				

*** Primary Characterization Data ***

Pedon ID: 88NC199003 (Yancey, North Carolina) Print Date: May 1 2011 8:24AM

Sampled As : Reddies Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 88P0870

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ % 6S4	-3- Acid Oxal	-4- Bray 1	-5- Bray 2	-6- Olsen	-7- H_2O	-8- Citric Acid	-9- Mehlich III	-10- Extr NO_3 mg kg^{-1}
					(- - - Phosphorous - - -)								
						(- - - mg kg^{-1} - - -)							
88P04699	0-13	A1	S		49								
88P04700	13-41	A2	S		61								
88P04701	41-66	Bw	S		43								
88P04702	66-200	C	S		31								

*** Primary Characterization Data ***

Pedon ID: 88NC199003 (Yancey, North Carolina) Print Date: May 1 2011 8:24AM

Sampled As : Reddies Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 88P0870

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray					Thermal				Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	pretation
				7A2i									7C3								
				(- - - peak size - - -)					(- - - % - - -)				(- - - % - - -)							mg g^{-1}	
88P04699	0-13	A1	tcly	MI 2	VR 1	KK 1	GE 1							11	8.1			0.7			
88P04701	41-66	Bw	tcly	VR 1	KK 1	MI 1								8	6.0			0.6			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GE - Goethite KK - Kaolinite MI - Mica VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 88NC199003 (Yancey, North Carolina) Print Date: May 1 2011 8:24AM

Sampled As : Reddies Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Fluventic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 88P0870

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray					Thermal				Optical							EGME	Inter
													Tot Re	Grain Count						Retn	pretation
													7B1a								
				(- - - peak size - - -)					(- - - % - - -)				(- - - % - - -)							mg g^{-1}	
88P04699	0-13	A1	fs										53	QZ 50	MS 24	BT 17	OT 3	GN 2	OP 1		
														HN 1	RU tr	FP tr	TM tr	CL tr	ZR tr		
88P04701	41-66	Bw	fs										64	QZ 57	MS 20	BT 12	GN 5	OT 3	FK 2		
														OP 2	HN 1	RU tr	ZR tr				

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite CL - Chlorite FK - Potassium Feldspar FP - Plagioclase Feldspar GN - Garnet

HN - Hornblende MS - Muscovite OP - Opaques OT - Other QZ - Quartz

RU - Rutile TM - Tourmaline ZR - Zircon

SAUNOOK PEDON DESCRIPTION - COLLUVIUM

Description Date: 9/1/1987

Describer: Robert Ranson, Ernest Hayhurst, Benny Brasher

Site ID: 87NC199005

Pedon ID: 87NC199005

Pedon Note: Temp data from Celo, NC 1951 to 1981.

Soil Name as Described/Sampled: Saunook

Soil Name as Correlated: Saunook

Classification: Fine-loamy, mixed, active, mesic Humic Hapludults

Physiographic Division:

Geomorphic Setting: on footslope of head slope of terrace--outwash or marine
on footslope of head slope of intermontane basin

Upslope Shape: concave

Particle Size Control Section: 23 to 73 cm.

Description origin: Converted from SSL-CMS data

Diagnostic Features: ochric epipedon 0 to 23 cm.
argillic horizon 23 to 100 cm.

State: North Carolina

County: Yancey

MLRA: 130 -- Blue Ridge

Map Unit:

Quad Name:

Latitude: 35 degrees 53 minutes 34.00 seconds north

Longitude: 82 degrees 20 minutes 38.00 seconds west

Datum:

Primary Earth Cover: Grass/herbaceous cover

Bedrock Depth:

Bedrock Hardness:

Surface Fragments: 1.5 percent

Description database: NSSL

Ap--0 to 23 centimeters; dark brown (7.5YR 3/2) interior loam; moderate fine granular, and weak medium subangular blocky structure; very friable; many fine and very fine roots; many fine tubular and many medium tubular pores; common fine mica flakes; clear wavy boundary. (Lab sample # 87P4566).

Bt1--23 to 51 centimeters; brown (7.5YR 4/4) interior clay loam; weak fine granular, and moderate medium subangular blocky structure; friable; many fine and common very fine roots; many fine and many medium tubular pores; 15 percent discontinuous faint clay films on faces of peds; common fine mica flakes; slightly acid, pH 6.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4567).

Bt2--51 to 77 centimeters; strong brown (7.5YR 4/6) interior clay loam; moderate fine subangular blocky, and moderate medium subangular blocky structure; friable; common fine and very fine roots; common fine and medium tubular pores; 37 percent discontinuous faint clay films on faces of peds; common fine mica flakes; neutral, pH 7.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4568).

Bt3--77 to 100 centimeters; strong brown (7.5YR 4/6) interior clay loam; moderate medium subangular blocky, and moderate medium angular blocky structure; friable; common fine roots and common very fine roots; common fine tubular and common medium tubular pores; 37 percent discontinuous faint clay films on faces of peds and 37 percent discontinuous faint clay bridges between sand grains; common fine and medium mica flakes; slightly acid, pH 6.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4569).

BC1--100 to 124 centimeters; dark yellowish brown (10YR 4/6) interior loam; moderate medium subangular blocky, and moderate medium angular blocky structure; friable; common fine and very fine roots; common fine and medium tubular pores; 15 percent patchy faint clay films on faces of peds and 15 percent discontinuous faint, clay bridges between sand grains; common fine and medium and few coarse mica flakes; moderately acid, pH 5.7, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4570).

BC2--124 to 144 centimeters; dark yellowish brown (10YR 4/4) interior sandy loam; weak medium subangular blocky structure; friable; common fine and very fine roots; few fine and medium tubular pores; 15 percent

discontinuous faint clay bridges between sand grains; common fine, medium and coarse mica flakes; moderately acid, pH 6.0, Hellige-Truog; clear wavy boundary. (Lab sample # 87P4571).

C--144 to 200 centimeters; dark yellowish brown (10YR 3/6) interior very cobbly sandy loam; massive; friable; common fine and very fine roots; few fine and medium tubular pores; 5 percent 250- to 600-millimeter metamorphic rock fragments (stones) and 15 percent 75- to 250-millimeter metamorphic rock fragments (cobbles) and 30 percent 2- to 75-millimeter metamorphic rock fragments, by volume; many fine, medium and common coarse mica flakes; moderately acid, pH 6.0, Hellige-Truog. (Lab sample # 87P4572).

*** Primary Characterization Data ***

Pedon ID: 87NC199005

(Yancey, North Carolina)

Print Date: May 1 2011 8:28AM

Sampled as on Sep 01, 1987 : Saunook ; Fine-loamy, mixed, mesic Humic Hapludult
Revised to correlated on Dec 01, 1994 : Saunook ; Fine-loamy, mixed, active, mesic Humic Hapludult

SSL - Project CP87NC264 MOUNTIAN SOILS
- Site ID 87NC199005 Lat: 35° 53' 34.00" north Long: 82° 20' 38.00" west MLRA: 130
- Pedon No. 87P0828
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
87P04566	Ap	AP L	0-23					SCL
87P04567	Bt1	Bt1 CL	23-51					SCL
87P04568	Bt2	Bt2 CL	51-77					SCL
87P04569	Bt3	Bt3 CL	77-100					SCL
87P04570	BC1	BC1 L	100-124					SCL
87P04571	BC2	BC2 SL	124-144					COSL
87P04572	C	C SL	144-200					SL

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.41	(NA)
Clay, carbonate free, Weighted Average	26	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	47	% wt
Volume, >2mm, Weighted Average	3	% vol
Clay, total, Weighted Average	26	% wt
LE, Whole Soil, Summed to 1m	0	cm/m

Weighted averages based on control section: 23-73 cm

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
																(- - - - - - - - Weight - - - - - - - -)				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC					>2 mm
	Depth			< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	wt % whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - - -)				soil
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
87P04566	0-23	Ap	S	20.4	21.1	58.5	4.7		15.9	5.2	8.0	16.4	14.2	11.9	8.0	5	2	--	54	7
87P04567	23-51	Bt1	S	25.4	21.8	52.8	9.1		16.8	5.0	7.6	15.6	12.8	9.9	6.9	4	1	--	48	5
87P04568	51-77	Bt2	S	27.8	21.8	50.4	10.6		17.4	4.4	8.0	14.7	12.0	9.0	6.7	5	1	--	46	6
87P04569	77-100	Bt3	S	27.7	19.3	53.0	11.5		15.8	3.5	8.3	15.4	12.4	10.2	6.7	3	2	--	47	5
87P04570	100-124	BC1	S	20.9	16.4	62.7	8.1		13.1	3.3	7.7	17.2	14.2	12.3	11.3	6	5	--	60	11
87P04571	124-144	BC2	S	15.7	11.9	72.4	7.1		8.4	3.5	7.7	18.8	15.8	14.1	16.0	6	4	--	68	10
87P04572	144-200	C	S	16.0	18.5	65.5	5.5		14.0	4.5	7.3	18.0	16.6	13.3	10.3	--	--	131	113	126

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:28AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa (- - - g cm^{-3} - - -) 4A1d	-2- Oven Dry	-3- Cole Whole Soil	-4- (- - - - - - - - - - - - Water Content - - - - - - - - - - - -) 6 kPa (- - - - - - - - - - - - % of < 2mm - - - - - - - - - - - -)	-5- 10 kPa	-6- 33 kPa 4B1c	-7- 1500 kPa 4B2a	-8- 1500 kPa Moist	-9- Ratio AD/OD 4B5	-10- WRD Whole Soil cm^3 cm^{-3} 4C1	-11- Aggst Stabl 2-0.5mm % 4G1	-12- (- - Ratio/Clay - -) CEC7 8D1	-13- 1500 kPa 8D1
87P04566	0-23	Ap	S	1.39	1.46	0.016			23.5	12.1		1.020	0.15	62	0.74	0.59
87P04567	23-51	Bt1	S	1.55	1.63	0.016			21.1	13.7		1.017	0.11		0.43	0.54
87P04568	51-77	Bt2	S	1.50	1.58	0.017			22.3	14.5		1.016	0.11		0.39	0.52
87P04569	77-100	Bt3	S	1.42	1.50	0.018			24.1	15.0		1.022	0.12		0.39	0.54
87P04570	100-124	BC1	S	1.44	1.48	0.009			20.2	13.0		1.018	0.10		0.44	0.62
87P04571	124-144	BC2	S	1.48	1.51	0.006			17.1	10.5		1.017	0.09		0.50	0.67
87P04572	144-200	C	S							10.4		1.015			0.41	0.65

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (- - Atterberg - -) (- - - Limits - - -) LL pct <0.4mm 4F1	-2- PI 4F	-3- (- - - - - Bulk Density - - - -) Field (- - - - - - - - g cm^{-3} - - - - -)	-4- Recon 33 kPa	-5- Recon Oven Dry	-6- (- Water Content -) Field (- % of < 2mm -)	-7- Recon 33 kPa	-8- (- - - - - - - - - - - - - - Sieved Samples - - - - - - - - - - - -) 6 kPa	-9- 10 kPa	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa	-13- 500 kPa
87P04566	0-23	Ap	S	38	11											
87P04567	23-51	Bt1	S	41	15											
87P04570	100-124	BC1	S	45	15											
87P04572	144-200	C	S	36	12											

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:28AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- C	-2- N	-3- S	-4- Org C	-5- C/N Ratio	-6- Fe	-7- Al	-8- Mn	-9- Al+½Fe	-10- ODOE	-11- Fe	-12- Al	-13- Si	-14- Mn	-15- C	-16- Fe	-17- Al	-18- Mn
				(- - - - - Total - - - - -)					(- - - Dith-Cit Ext - - -)			(- - - - - - Ammonium Oxalate Extraction - - - - - -)						(- - - Na Pyro-Phosphate - - -)			
				(- - - - - - % of <2 mm - - - - - -)					(- % of < 2mm - - - - - - - - - - - - - - -)								mg kg^{-1}	(- - - - - - % of < 2mm - - - - -)			
					6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9a	6G12	6V2	6D5b				
87P04566	0-23	Ap	S		0.174		2.22	13	3.1	0.6	0.1	0.60	0.05	0.47	0.36	0.03	959.5				
87P04567	23-51	Bt1	S		0.042		0.38	9	3.9	0.6	0.1	0.48	0.06	0.47	0.24	0.04	565.5				
87P04568	51-77	Bt2	S		0.037		0.25	7	4.3	0.6	0.1	0.51	0.05	0.55	0.23	0.06	472.5				
87P04569	77-100	Bt3	S		0.034		0.22	6	4.5	0.6	0.1										
87P04570	100-124	BC1	S				0.14		3.9	0.6	tr	0.41	0.04	0.46	0.18	0.06	385.4				
87P04571	124-144	BC2	S				0.09		3.6	0.5	tr	0.42	0.04	0.49	0.17	0.05	426.3				
87P04572	144-200	C	S				0.15		2.7	0.4	tr	0.32	0.04	0.32	0.16	0.04	360.2				

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acidity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)												(- - - - Base - - - -)	
				(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9b		5A3a	5A8b	5A3b	5G1	5C3	5C1
87P04566	0-23	Ap	S	4.4	0.7	--	0.2	5.3	14.2	0.6		19.5	15.0	5.9	10	27	35
87P04567	23-51	Bt1	S	3.5	0.7	tr	tr	4.2	9.6			13.8	10.9			30	39
87P04568	51-77	Bt2	S	3.8	1.2	0.1	tr	5.1	7.6			12.7	10.8			40	47
87P04569	77-100	Bt3	S	3.0	1.7	tr	tr	4.7	7.7			12.4	10.7			38	44
87P04570	100-124	BC1	S	1.4	1.2	--	0.1	2.7	7.2	0.4		9.9	9.1	3.1	13	27	30
87P04571	124-144	BC2	S	1.1	1.0	--	0.1	2.2	5.9			8.1	7.8			27	28
87P04572	144-200	C	S	1.2	1.0	--	0.1	2.3	5.0			7.3	6.6			32	35

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:28AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Salt

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- - - Water Extracted From Saturated Paste - - -)																	Pred		
	Depth			Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
Layer	(cm)	Horz	Prep	(- - mmol(+) L^{-1} - -)				(- - - mmol(-) L^{-1} - - -)										(- - % - -)		(- - dS m^{-1} - -)		%	
																		8A			8I	5D2	
87P04566	0-23	Ap	S																			--	
87P04567	23-51	Bt1	S																			--	
87P04568	51-77	Bt2	S																			1	
87P04569	77-100	Bt3	S																			--	
87P04570	100-124	BC1	S															59.5			0.01	--	
87P04571	124-144	BC2	S																			--	
87P04572	144-200	C	S																			--	

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - pH - - -)						(- - Carbonate - -)		(- - Gypsum - -)		
					$CaCl_2$					As $CaCO_3$		As $CaSO_4*2H_2O$		Resist
	Depth				0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - % - - -)				cm^{-1}
				8C1g	4C1a2a	4C1a2a	8C1b							8E1
87P04566	0-23	Ap	S	4.3	4.8	5.2								
87P04567	23-51	Bt1	S	4.7	5.4	5.9								
87P04568	51-77	Bt2	S	4.7	5.5	6.0								
87P04569	77-100	Bt3	S	4.6	5.2	5.8								
87P04570	100-124	BC1	S	4.3	4.7	5.5	5.6							88000
87P04571	124-144	BC2	S	4.4	4.8	5.6								
87P04572	144-200	C	S	4.4	4.9	5.7								

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:28AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ % 6S4	-3- Acid Oxal	-4- Bray 1	-5- Bray 2	-6- Olsen	-7- H_2O	-8- Citric Acid	-9- Mehlich III	-10- Extr NO_3 mg kg^{-1}
					(- -)				Phosphorous - - - - - - - - - - -				
						(- -)				-mg kg^{-1}	- - - - - - - - - - -		
87P04566	0-23	Ap	S		43								
87P04567	23-51	Bt1	S		40								
87P04568	51-77	Bt2	S		43								
87P04570	100-124	BC1	S		45								
87P04571	124-144	BC2	S		33								
87P04572	144-200	C	S		33								

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:28AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray						Thermal			Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract	7A2i						7A4b			7C3								tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - -)						(- - - - - - - - - % - - - - - - - - - -)			(- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
87P04566	0-23	Ap	tcly	KK 3	VR 3	MI 1	GI 1	GE 1			KK 33	GI 4		22	12.9			0.9			
				HE 1																	
87P04567	23-51	Bt1	tcly	KK 3	VR 3	GE 2	HE 1	GI 1			KK 33	GI 3		25	14.3			0.9			
				MI 1	LE 1																
87P04570	100-124	BC1	tcly	KK 3	VR 2	GE 2	HE 1	GI 1			KK 36	GI 3		25	12.6			0.7			
				MI 1	LE 1																
87P04572	144-200	C	tcly	KK 3	VR 2	GE 2	GI 1	MI 1			KK 43	GI 3		26	10.0			0.8			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GE - Goethite GI - Gibbsite HE - Hematite KK - Kaolinite LE - Lepidocrocite

MI - Mica VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:28AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray						Thermal				Optical						EGME	Inter
													Tot Re	Grain Count						Retn	preta
	Depth		Fract											7B1a							tion
Layer	(cm)	Horz	ion	(- - - - - - - - peak size - - - - - - - - -)						(- - - - - - - - % - - - - - - - - - -)			(- % - - - - - - - - - - - - - - - - -)							mg g^{-1}	
87P04567	23-51	Bt1	vfs										37	BT 50	QZ 30	MS 10	GE 4	OT 3	OP 3		
														FK tr	PO tr	RU tr	HN tr	FP tr	HE tr		
														ZR tr	GN tr						
87P04572	144-200	C	vfs										30	BT 56	QZ 21	MS 9	GE 7	OT 4	OP 2		
														FK tr	ZR tr	CA tr	FP tr	RU tr	GN tr		

FRACTION INTERPRETATION:

vfs - Very Fine Sand, 0.05-0.1 mm

MINERAL INTERPRETATION:

BT - Biotite CA - Calcite FK - Potassium Feldspar FP - Plagioclase Feldspar GE - Goethite

GN - Garnet HE - Hematite HN - Hornblende MS - Muscovite OP - Opaques

OT - Other PO - Plant Opal QZ - Quartz RU - Rutile ZR - Zircon

BULADEAN PEDON DESCRIPTION – SIDE SLOPE

Description Date: 6/1/1988
Describer: John B. Allison, Fred Kaisaki, Andy Goodwin
Site ID: 88NC121007
Soil Name as Described/Sampled: Edneyville
Soil Name as Correlated: Buladean

Physiographic Division:
Geomorphic Setting: on shoulder of nose slope of hillside or mountainside
on shoulder of nose slope of mountains or deeply dissected plateaus

Particle Size Control Section: 25 to 102 cm.
Description origin: Converted from SSL-CMS data
Diagnostic Features: ochric epipedon 0 to 8 cm.
cambic horizon 8 to 64 cm.
paralithic contact 124 to 224 cm.

State: North Carolina
County: Mitchell
MLRA: 130 -- Blue Ridge
Latitude: 36 degrees 7 minutes 56.00 seconds north
Longitude: 82 degrees 14 minutes 18.00 seconds west
Primary Earth Cover: Crop cover

Bedrock Depth:

Surface Fragments: 0.1 percent
Description database: NSSL

Oi--2 to 0 centimeters.

A--0 to 8 centimeters; dark yellowish brown (10YR 3/4) fine sandy loam, loam; weak fine granular structure; very friable, nonsticky, nonplastic; common medium and few coarse roots; many very fine and fine tubular and few coarse tubular pores; 2 percent 2- to 75-millimeter igneous rock fragments; strongly acid, pH 5.5, Hellige-Truog; clear smooth boundary. (Lab sample # 88P4768).

Bw--8 to 51 centimeters; brown (7.5YR 4/4) loam; 21 percent clay; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine, fine, medium and coarse roots; common very fine and fine and few coarse tubular pores; 5 percent 2- to 75-millimeter igneous rock fragments; 1 percent fine platy mica flakes, unspecified; strongly acid, pH 5.5, Hellige-Truog; clear wavy boundary. (Lab sample # 88P4769).

BC--51 to 64 centimeters; brown (7.5YR 4/4) loamy sand; weak fine subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine, fine, medium and coarse roots; common very fine, fine and few coarse tubular pores; 5 percent 2- to 75-millimeter igneous rock fragments; 1 percent fine platy mica flakes, unspecified; strongly acid, pH 5.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 88P4770).

C--64 to 124 centimeters; multicolored sandy loam saprolite; massive; very friable, nonsticky, nonplastic; few very fine, fine and medium roots; few very fine, fine, medium and coarse tubular pores; 5 percent 2- to 75-millimeter igneous rock fragments; 1 percent fine platy mica flakes unspecified; strongly acid, pH 5.5, Hellige-Truog; abrupt smooth boundary. (Lab sample # 88P4771).

Cr1--124 to 196 centimeters; highly weathered, multicolored, biotite granitic gneiss; strongly acid, pH 5.5, Hellige-Truog; abrupt smooth boundary. (Lab sample # 88P4772).

Cr2--196 to 224 centimeters; highly weathered multicolored biotite granitic gneiss; strongly acid, pH 5.5, Hellige-Truog. (Lab sample # 88P4773).

*** Primary Characterization Data ***

Pedon ID: 88NC121007 (Mitchell, North Carolina) Print Date: May 1 2011 8:32AM

Sampled as : Edneyville ; Coarse-loamy, mixed, mesic Typic Dystrochrept
Revised to correlated: Buladean ; Coarse-loamy, mixed, active, mesic Typic Dystrochrept

SSL - Project CP88NC226 NORTH CAROLINA MOUNTAIN SOILS
- Site ID 88NC121007 Lat: 36° 7' 56.00" north Long: 82° 14' 18.00" west MLRA: 130
- Pedon No. 88P0881
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
88P04768	A	A	0-8				FSL	L
88P04769	Bw	BW	8-51				L	L
88P04770	BC	BC	51-66				L	COSL
88P04771	C	C	66-127				LS	COSL
88P04772	Cr1	CR1	127-198				SL	SL
88P04773	Cr2	CR2	198-218				SL	COSL

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.94	(NA)
Clay, carbonate free, Weighted Average	9	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	52	% wt
Volume, >2mm, Weighted Average	3	% vol
Clay, total, Weighted Average	9	% wt

Weighted averages based on control section: 25-100 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay < .002	-2- Total Silt .002-.05	-3- Total Sand .05-2	-4- Clay Fine < .0002	-5- Clay CO_3 < .002	-6- Silt Fine .002-.02	-7- Silt Coarse .02-.05	-8- Sand VF .05-.10	-9- Sand F .10-.25	-10- Sand M .25-.50	-11- Sand C .5-1	-12- Sand VC 1-2	-13- Rock Fragments Weight 2-5	-14- Rock Fragments Weight 5-20	-15- Rock Fragments Weight 20-75	-16- Rock Fragments Weight .1-75	-17- >2 mm wt % whole soil
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1			3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
88P04768	0-8	A	S	20.9	42.9	36.2			33.1	9.8	4.7	6.8	9.3	9.9	5.5	6	3	--	38	9
88P04769	8-51	Bw	S	16.0	35.3	48.7			25.5	9.8	6.2	9.1	11.9	14.3	7.2	3	4	2	48	9
88P04770	51-66	BC	S	9.3	32.8	57.9			21.9	10.9	8.0	10.6	13.3	16.8	9.2	4	1	--	52	5
88P04771	66-127	C	S	3.4	32.4	64.2			20.1	12.3	10.0	12.6	15.9	16.5	9.2	2	tr	--	55	2
88P04772	127-198	Cr1	GP	2.6	36.4	61.0			23.1	13.3	10.6	14.5	16.3	14.8	4.8					
88P04773	198-218	Cr2	GP	1.0	30.0	69.0			19.5	10.5	7.3	11.1	14.9	20.1	15.6					

*** Primary Characterization Data ***

Pedon ID: 88NC121007 (Mitchell, North Carolina) Print Date: May 1 2011 8:32AM

Sampled As : Edneyville Coarse-loamy, mixed, mesic Typic Dystrochrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 88P0881

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa (- - - g cm^{-3} - - -) 4A1d	-2- Oven Dry 4A1h	-3- Cole Whole Soil	-4- (- - - - - - - - - - - - Water Content - - - - - - - - - - - -) 6 kPa (- - - - - - - - - - - - % of < 2mm - - - - - - - - - - -)	-5- 10 kPa	-6- 33 kPa 4B1c	-7- 1500 kPa 4B2a	-8- 1500 kPa Moist	-9- Ratio AD/OD 4B5	-10- WRD Whole Soil cm^3 cm^{-3} 4C1	-11- Aggst Stabl 2-0.5mm % 4G1	-12- (- - Ratio/Clay - -) CEC7 8D1	-13- 1500 kPa 8D1
88P04768	0-8	A	S	0.78	0.92	0.055			42.5	13.6		1.017	0.22	87	1.04	0.65
88P04769	8-51	Bw	S							9.2		1.011			0.63	0.58
88P04770	51-66	BC	S							6.5		1.007			0.82	0.70
88P04771	66-127	C	S							3.4		1.004			1.24	1.00
88P04772	127-198	Cr1	S	1.51	1.54	0.007			21.1				0.25		2.23	1.65
88P04772	127-198	Cr1	GP							4.3		1.005				
88P04773	198-218	Cr2	S	1.73	1.77	0.008			13.0				0.19		3.20	2.30
88P04773	198-218	Cr2	GP							2.3		1.003				

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (- - - - - Total - - - - - -) C (- - - - - - % of <2 mm - - - - - -)	-2- N 6B3a	-3- S 6R3a	-4- Org C 6A1c	-5- C/N Ratio	-6- (- - - Dith-Cit Ext - - - -) Fe (- -) 6C2b	-7- Al 6G7a	-8- Mn 6D2a	-9- (- - - - - - Ammonium Oxalate Extraction - - - - - -) Al+½Fe	-10- ODOE % of < 2mm 8J	-11- Fe 6C9a	-12- Al 6G12	-13- Si 6V2	-14- Mn mg kg^{-1} 6D5b	-15- (- - - Na Pyro-Phosphate - - -) C (- - - - - - % of < 2mm - - - - - -)	-16- Fe	-17- Al	-18- Mn
88P04768	0-8	A	S		0.277	0.04	5.67	20	2.4	0.6	tr	0.66	0.16	0.59	0.37	0.03	89.6				
88P04769	8-51	Bw	S		0.053	0.01	0.77	14	2.3	0.5	tr	0.43	0.06	0.32	0.28	0.02	180.3				
88P04770	51-66	BC	S				0.31		1.8	0.3	tr	0.25	0.03	0.18	0.16	0.01	259.5				
88P04771	66-127	C	S			0.02	0.10		1.1	0.2	tr	0.11	0.02	0.08	0.07	0.01	256.4				
88P04772	127-198	Cr1	GP				0.03		1.7	0.2	0.1	0.14	0.02	0.08	0.10	0.01	496.7				
88P04773	198-218	Cr2	GP			0.02	0.02		0.8	0.1	tr	0.09	0.01	0.05	0.06	0.01	136.5				

*** Primary Characterization Data ***

Pedon ID: 88NC121007 (Mitchell, North Carolina) Print Date: May 1 2011 8:32AM

Sampled As : Edneyville Coarse-loamy, mixed, mesic Typic Dystrochrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 88P0881

CEC & Bases				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
	Depth			Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH_4 OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH_4OAC
Layer	(cm)	Horz	Prep	(- - - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9b	6D3	5A3a	5A8b	5A3b	5G1	5C3	5C1
88P04768	0-8	A	S	0.4	0.4	--	0.5	1.3	26.7	5.6	0.8	28.0	21.8	6.9	81	5	6
88P04769	8-51	Bw	S	0.2	0.2	--	0.2	0.6	10.5	2.8	0.6	11.1	10.1	3.4	82	5	6
88P04770	51-66	BC	S	0.2	0.3	--	0.4	0.9	6.9	1.7	0.6	7.8	7.6	2.6	65	12	12
88P04771	66-127	C	S	0.2	0.1	0.1	0.1	0.5	3.8	0.9	0.4	4.3	4.2	1.4	64	12	12
88P04772	127-198	Cr1	GP	0.1	0.1	0.1	tr	0.3	5.7	1.6	0.7	6.0	5.8	1.9	84	5	5
88P04773	198-218	Cr2	GP	0.2	--	0.1	tr	0.3	2.6	0.6	0.4	2.9	3.2	0.9	67	10	9

Salt				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
	Depth			Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
Layer	(cm)	Horz	Prep	(- - - - - mmol(+) L^{-1} - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
88P04768	0-8	A	S																			--	
88P04769	8-51	Bw	S																			--	
88P04770	51-66	BC	S																			--	
88P04771	66-127	C	S																			2	
88P04772	127-198	Cr1	GP																			2	
88P04773	198-218	Cr2	GP																			3	

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl	-2- CaCl$_2$ 0.01M 1:2	-3- H_2O 1:1	-4- Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4*2H_2O$ <2mm	-10- Gypsum As $CaSO_4*2H_2O$ <20mm	-11- Resist ohms cm^{-1}
				(- - - -	- pH -				- - - -)	(- - - - %			- - - -)	
					4C1a2a	4C1a2a								
88P04768	0-8	A	S		4.1	5.0								
88P04769	8-51	Bw	S		4.4	5.1								
88P04770	51-66	BC	S		4.4	5.2								
88P04771	66-127	C	S		4.4	5.1								
88P04772	127-198	Cr1	GP		4.3	5.2								
88P04773	198-218	Cr2	GP		4.5	5.3								

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ %	-3- Acid Oxal	-4- Bray 1	-5- Bray 2	-6- Olsen	-7- H_2O	-8- Citric Acid	-9- Mehlich III	-10- Extr NO_3 mg kg^{-1}
					(- - - -	- - Phosphorous -						- - - -)	
						(- - - -				mg kg^{-1}		- - - -)	
					6S4								
88P04768	0-8	A	S		46								
88P04769	8-51	Bw	S		43								
88P04770	51-66	BC	S		31								
88P04771	66-127	C	S		22								
88P04772	127-198	Cr1	GP		24								
88P04773	198-218	Cr2	GP		17								

COWEE SERIES – UPPER SIDE SLOPE, NOSE SLOPE

The Cowee series consists of moderately deep, well drained, moderately permeable soils on ridges and side slopes of the Blue Ridge (MLRA 130). They formed in residuum affected by soil creep in the upper part, and weathered from felsic to mafic, igneous and high-grade metamorphic rocks. Slope ranges from 2 to 95 percent. Near the type location, mean annual temperature is about 56 degrees F., and mean annual precipitation is about 49 inches.
TAXONOMIC CLASS: Fine-loamy, parasesquic, mesic Typic Hapludults

TYPICAL PEDON: Cowee gravelly sandy loam--forested. (Colors are for moist soil).

Oi--0 to 2 inch; slightly decomposed leaves, twigs, roots, and other organic matter.

A--2 to 7 inches; reddish brown (5YR 4/4) gravelly sandy loam; weak fine granular structure; very friable; many fine and medium roots; 20 percent by volume gneiss gravel; common fine and medium flakes of mica; strongly acid; clear wavy boundary. (1 to 10 inches thick)

Bt1--7 to 15 inches; red (2.5YR 4/8) gravelly sandy loam; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; common fine roots; common faint clay films on faces of peds; 20 percent by volume gneiss gravel; common fine and medium flakes of mica; strongly acid; gradual wavy boundary.

Bt2--15 to 29 inches; red (2.5YR 5/8) gravelly sandy clay loam; weak medium subangular blocky structure; friable, slightly sticky, slightly plastic; few fine roots; common faint clay films on faces of peds; 30 percent by volume gneiss gravel; common fine and medium flakes of mica; strongly acid; abrupt wavy boundary. (Combined thickness of the Bt horizons is 10 to 28 inches.)

Cr--29 to 62 inches; weathered, multicolored hornblende gneiss; that can be dug with difficulty with hand tools; rock structure; partly consolidated in place; few fine roots in cracks; cracks are more than 4 inches apart.

TYPE LOCATION: Jackson County, North Carolina; 1.1 miles northeast of Cullowhee from the Tuckasegee River on old N.C. Highway 107; 1.7 miles north of Black Mountain Baptist Church; 0.5 mile north on U.S. Forest Service access road and 500 feet east on U.S. Forest Service Trail, 25 feet north of trail.

REMARKS: The 12/97 revision places the Cowee series in a fine-loamy, parasesquic, mesic Typic Hapludults family. The series was formerly in a mixed mineralogy family. CEC activity class placement is based on sample pedon S85-NC-099-003 and on similar soils such as Brevard and Evard.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - the zone from 0 to 7 inches (Oi and A horizons).
Argillic horizon - the zone from 7 to 29 inches (Bt horizons).
Paralithic contact - the contact with weathered rock at 29 inches (upper boundary of the Cr horizon).
Parasesquic mineralogy class - total iron oxide, by weight (DCB Fe multiplied by 1.43) plus percent, by weight, gibbsite of more than 10 in the fine-earth fraction.

COWEE PEDON DESCRIPTION UPPER SIDE SLOPE, NOSE SLOPE

Lab Source ID: SSL

Lab Pedon #: 85P0634

Soil Name as Described/Sampled: Cowee

Classification: Fine-loamy, parasesquic, mesic Typic Hapludults

Pedon Type:

Pedon Purpose: full pedon description

Taxon Kind: series

Geomorphic Setting: on backslope of side slope of hillside or mountainside
on backslope of side slope of mountains or deeply dissected plateaus

Upslope Shape: linear

Cross Slope Shape:

Particle Size Control Section: 13 to 69 cm.

Description origin: Converted from SSL-CMS data

Diagnostic Features: ochric epipedon 0 to 18 cm.
argillic horizon 18 to 76 cm.
paralithic contact 76 to 90 cm.

Legal Description:

Latitude:

Datum: NAD83

UTM Zone: 17

UTM Easting: 595474 meters

UTM Northing: 4078721 meters

Bedrock Depth: 76 centimeters

Bedrock Hardness:

Bedrock Fracture Interval:

Surface Fragments: 0.1 percent

Description database: NSSC Data

Oi--0 to 5 centimeters; peat.

A--5 to 18 centimeters; reddish brown (5YR 4/4) interior gravelly loam; 50 percent sand; 18 percent clay; weak fine granular structure; very friable; many fine and medium roots throughout; 11 percent fine mica flakes, unspecified; 20 percent by volume, gneiss gravel; moderately acid, pH 5.6, Hellige-Truog; clear wavy boundary. (Lab sample # 85P3270).

Bt1--18 to 38 centimeters; red (2.5YR 4/8) interior gravelly sandy clay loam; 55 percent sand; 25 percent clay; weak medium subangular blocky structure; friable; common fine roots throughout; 11 percent fine mica flakes, unspecified; 20 percent by volume, gneiss gravel; moderately acid, pH 5.6, Hellige-Truog; gradual wavy boundary. (Lab sample # 85P3271).

Bt2--38 to 76 centimeters; red (2.5YR 5/8) interior gravelly clay loam; 43 percent sand; 30 percent clay; weak medium subangular blocky structure; friable; few fine roots throughout; 11 percent fine mica flakes, unspecified; 30 percent by volume, gneiss gravel; strongly acid, pH 5.2, Hellige-Truog; abrupt wavy boundary. (Lab sample # 85P3272).

Cr--76 to 89 centimeters; weathered bedrock. (Lab sample # 85P3274).

Sampled as on Apr 01, 1985 : Cowee ; Fine-loamy, mixed, mesic Typic Hapludult
Revised to correlated on Aug 01, 1996 : Cowee ; Fine-loamy, parasesquic, mesic Typic Hapludult

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

SSL - Project CP85NC171 NORTH CAROLINA MOUNTAIN SOILS
- Site ID 85NC099003 Lat: 35° 21' 21.00" north Long: 83° 8' 4.00" west NAD83 MLRA: 130
- Pedon No. 85P0634
- General Methods 1B1A, 2A1, 2B

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
85P03270	A	A	0-13				L	SL
85P03271	Bt1	BT1	13-33				SCL	SL
85P03272	Bt2	BT2	33-69				CL	SCL
85P03273	Bt / Cr	BTCR	33-69					LCOS
85P03274	Cr	CR	69-89					COS

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.23	(NA)
Clay, carbonate free, Weighted Average	22	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	22	% wt

Weighted averages based on control section: 13-63 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
																(- - - - - - - - Weight - - - - - - - -)				>2 mm
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC					
				< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	wt % whole soil
				(- % of <2mm Mineral Soil -)												(- - - - - - - - % of <75mm - - - - -)				
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
85P03270	0-13	A	S													13	7	--	--	20
85P03270	0-13	A	GP	12.2	20.6	67.2	1.8		14.3	6.3	10.2	21.6	15.9	10.5	9.0					
85P03271	13-33	Bt1	S													16	1	--	--	17
85P03271	13-33	Bt1	GP	18.6	18.6	62.8	5.4		13.2	5.4	8.1	17.5	14.4	11.9	10.9					
85P03272	33-69	Bt2	S													2	--	53	--	55
85P03272	33-69	Bt2	GP	23.5	10.3	66.2	11.3		6.7	3.6	7.7	17.1	16.4	14.0	11.0					
85P03273	33-69	Bt / Cr	GP	7.2	10.4	82.4	3.3		6.2	4.2	10.3	23.5	19.7	14.5	14.4					
85P03274	69-89	Cr	GP	3.6	8.1	88.3	1.3		4.9	3.2	8.6	19.6	18.1	17.1	24.9					

*** Primary Characterization Data ***

Pedon ID: 85NC099003 (Jackson, North Carolina) Print Date: May 1 2011 8:36AM

Sampled As : Cowee Fine-loamy, mixed, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 85P0634

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa (- - - g cm^{-3} - - -) 4A1d	-2- Oven Dry 4A1h	-3- Cole Whole Soil	-4- (- - - - - - - - - - - - Water Content - - - - - - - - - - - -) 6 kPa (- - - - - - - - - - - - % of < 2mm - - - - - - - - - - - -)	-5- 10 kPa	-6- 33 kPa 4B1c	-7- 1500 kPa 4B2a	-8- 1500 kPa Moist	-9- Ratio AD/OD 4B5	-10- WRD Whole Soil cm^3 cm^{-3} 4C1	-11- Aggst Stabl 2-0.5mm %	-12- (- - Ratio/Clay - -) CEC7 8D1	-13- 1500 kPa 8D1
85P03270	0-13	A	S	1.26	1.33	0.018			26.9				0.24		0.67	0.45
85P03270	0-13	A	GP							5.5		1.010				
85P03271	13-33	Bt1	S	1.59	1.64	0.010			15.9				0.11		0.23	0.44
85P03271	13-33	Bt1	GP							8.1		1.011				
85P03272	33-69	Bt2	S	1.48	1.55	0.016			22.2				0.11		0.23	0.42
85P03272	33-69	Bt2	GP							9.9		1.013				
85P03273	33-69	Bt / Cr	S												0.49	1.86
85P03273	33-69	Bt / Cr	GP							13.4		1.010				
85P03274	69-89	Cr	S	2.10	2.11	0.002			10.6				0.11		0.86	1.56
85P03274	69-89	Cr	GP							5.6		1.010				

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (- - Atterberg - -) (- - - Limits - - -) LL pct <0.4mm 4F1	-2- PI 4F	-3- (- - - - - Bulk Density - - - - -) Field (- - - - - - - - g cm^{-3} - - - - -)	-4- Recon 33 kPa	-5- Recon Oven Dry	-6- (- -) Field (- -)	-7- Recon 33 kPa	-8- (- - - - - - - - - - - - - - Water Content -) 6 kPa (- - - - - - - - - - - - - - Sieved Samples -)	-9- 10 kPa (- - - - - - - - - - - - % of < 2mm -)	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa	-13- 500 kPa
85P03272	33-69	Bt2	GP	42	8											
85P03274	69-89	Cr	GP		NP											

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				(- - - - - Total - - - - -)			Org	C/N	(- - - Dith-Cit Ext - - -)			(- - - - - - Ammonium Oxalate Extraction - - - - - -)						(- - - Na Pyro-Phosphate - - -)			
				C	N	S	C	Ratio	Fe	Al	Mn	Al+½Fe	ODOE	Fe	Al	Si	Mn	C	Fe	Al	Mn
				(- - - - - - % of <2 mm - - - - - -)					(- % of < 2mm - - - - - - - - - - - - - - - - - -)								mg kg^{-1}	(- - - - - - % of < 2mm - - - - -)			
				6A2d	6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9a	6G12	6V2	6D5b				
85P03270	0-13	A	GP	2.21	0.088		2.43	28	5.5	0.9	tr	0.87	0.11	0.86	0.44	0.04	278.6				
85P03271	13-33	Bt1	GP	0.55	0.017		0.27	16	5.7	0.7	tr	0.38	0.04	0.43	0.16	0.03	68.5				
85P03272	33-69	Bt2	GP	0.35	0.014		0.30	21	6.6	0.8	0.1										
85P03273	33-69	Bt / Cr	GP	0.14			0.11		5.6	0.6	0.1	0.25	0.03	0.32	0.09	0.04	634.2				
85P03274	69-89	Cr	GP	0.11			0.07		5.1	0.6	0.1	0.20	0.03	0.24	0.07	0.04	836.1				

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
				Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH_4 OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH_4OAC
				(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9a		5A3a	5A8b	5A3b	5G1	5C3	5C1
85P03270	0-13	A	GP	0.1	0.2	0.1	0.1	0.5	11.2	1.1		11.7	8.2	1.6	69	4	6
85P03271	13-33	Bt1	GP	0.1	0.8	tr	tr	0.9	5.3	0.1		6.2	4.2	1.0	10	15	21
85P03272	33-69	Bt2	GP	0.2	1.0	0.1	tr	1.3	6.0	--		7.3	5.4			18	24
85P03273	33-69	Bt / Cr	GP	0.1	0.6	tr	--	0.7	4.2			4.9	3.5			14	20
85P03274	69-89	Cr	GP	tr	0.4	0.1	tr	0.5	3.0			3.5	3.1			14	16

Salt

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
				Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
				(- - - - - mmol(+) L^{-1} - - - -)				(- mmol(-) L^{-1} - - - - - - - - - - - - - - - - - - -)										(- - - - % - - - -)		(- - dS m^{-1} - - -)		%	
																						5D2	
85P03270	0-13	A	GP																			1	
85P03271	13-33	Bt1	GP																			--	
85P03272	33-69	Bt2	GP																			2	
85P03273	33-69	Bt / Cr	GP																			--	
85P03274	69-89	Cr	GP																			3	

*** Primary Characterization Data ***

Pedon ID: 85NC099003 (Jackson, North Carolina) Print Date: May 1 2011 8:36AM

Sampled As : Cowee Fine-loamy, mixed, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 85P0634

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - pH - - - -)						(- - Carbonate - -)		(- - Gypsum - - -)		
					$CaCl_2$					As $CaCO_3$		As $CaSO_4*2H_2O$		Resist
	Depth				0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - % - - -)				cm^{-1}
				8C1g	4C1a2a	4C1a2a								
85P03270	0-13	A	GP	4.4	4.6	5.0								
85P03271	13-33	Bt1	GP	4.8	5.2	5.3								
85P03272	33-69	Bt2	GP	5.1	5.3	5.4								
85P03273	33-69	Bt / Cr	GP	5.6	5.3	5.5								
85P03274	69-89	Cr	GP	5.6	5.6	5.6								

Phosphorous

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-
					(- - - Phosphorous - - -)								
				Melanic	NZ	Acid	Bray	Bray	Olsen	H_2O	Citric	Mehlich	Extr
	Depth			Index		Oxal	1	2			Acid	III	NO_3
Layer	(cm)	Horz	Prep		%	(- - - mg kg^{-1} - - -)							mg kg^{-1}
					6S4								
85P03270	0-13	A	GP		42								
85P03271	13-33	Bt1	GP		35								
85P03273	33-69	Bt / Cr	GP		35								
85P03274	69-89	Cr	GP		29								

*** Primary Characterization Data ***

Pedon ID: 85NC099003 (Jackson, North Carolina) Print Date: May 1 2011 8:36AM

Sampled As : Cowee Fine-loamy, mixed, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 85P0634

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray 7A2i peak size				-6- Thermal 7A3b %		-10- Elemental 7C3 % SiO_2	-11- Al_2O_3	-12- Fe_2O_3	-13- MgO	-14- CaO	-15- K_2O	-16- Na_2O	-17- EGME Retn mg g^{-1}	-18- Interpretation
85P03270	0-13	A	tcly	KK 3	GI 1	CL 1		KK tr	GI tr			13.6						
85P03272	33-69	Bt2	tcly	KK 3	GI 2	GE 1	CL 1	KK 22	GI 7			15.7			0.2			
85P03273	33-69	Bt / Cr	tcly	KK 3	GI 2	GE 1	CL 1	KK 14	GI tr			14.3						
85P03274	69-89	Cr	tcly	KK 3	GI 2	GE 1		KK 9	GI 2			10.4						

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

CL - Chlorite GE - Goethite GI - Gibbsite KK - Kaolinite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 85NC099003 (Jackson, North Carolina) Print Date: May 1 2011 8:36AM

Sampled As : Cowee Fine-loamy, mixed, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 85P0634

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray peak size				-6- Thermal %		-10- Tot Re	-11- Optical Grain Count 7B1a %						-17- EGME Retn mg g^{-1}	-18- Interpretation
85P03272	33-69	Bt2	fs							61	QZ 37	MS 34	RA 18	FE 6	BT 5	GN tr		
85P03273	33-69	Bt / Cr	fs							47	MS 48	QZ 29	RA 12	BT 5	FE 5	GN 1		
85P03274	69-89	Cr	fs							48	MS 43	QZ 30	RA 11	BT 8	FE 6	GN 1		
											OW tr							

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite FE - Iron Oxides (Goethite GN - Garnet MS - Muscovite OW - Other Weatherable Minerals

QZ - Quartz RA - Resistant Aggregates

CULLASAJA SERIES – COLLUVIUM IN UPPER WATERSHED

The Cullasaja series consists of very deep, well drained soils on benches, toe slopes, foot slopes, drainageways, and fans in coves in the Southern Blue Ridge, MLRA 130B. They formed in colluvium derived from materials weathered from felsic to mafic high-grade metamorphic and igneous rocks such as granite, mica gneiss, hornblende gneiss, and schist. Near the type location, mean annual air temperature is about 52 degrees F., and mean annual precipitation is about 70 inches. Slope ranges from 8 to 95 percent.

TAXONOMIC CLASS: Loamy-skeletal, isotic, mesic Typic Humudepts

TYPICAL PEDON: Typical pedon of Cullasaja cobbly sandy clay loam, on a 30 percent southeast facing toe slope at 3220 feet elevation - Forested. (Colors are for moist soil unless otherwise stated.)

Oi--0 to 2 inches; partially decomposed leaves, twigs, and roots.

A1--2 to 12 inches; very dark grayish brown (10YR 3/2) cobbly sandy clay loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium granular structure; very friable; many fine and medium, and common coarse roots; 5 percent gravel, 10 percent cobbles, 5 percent stones by volume; few fine flakes of mica; very strongly acid; clear wavy boundary.

A2--12 to 19 inches; dark brown (10YR 3/3) cobbly sandy clay loam, dark yellowish brown (10YR 4/4) dry; moderate fine and medium granular structure; very friable; common fine to coarse roots; 5 percent gravel, 10 percent cobbles, 5 percent stones by volume; few fine flakes of mica; strongly acid; clear wavy boundary. (Combined thickness of the A horizon is 10 to 20 inches.)

Bw--19 to 34 inches; strong brown (7.5YR 4/6) cobbly fine sandy loam; weak fine and medium subangular blocky structure; very friable; common medium to coarse roots; 10 percent gravel, 10 percent cobbles, 20 percent stones; few fine flakes of mica; strongly acid; clear wavy boundary. (10 to 40 inches thick)

BC--34 to 67 inches; strong brown (7.5YR 4/6) cobbly loamy sand; weak fine and medium subangular blocky structure; very friable; few medium to coarse roots; 10 percent gravel, 15 percent cobbles, 30 percent stones; few fine to medium flakes of mica; moderately acid.

TYPE LOCATION: Macon County, North Carolina; approximately 3.0 miles west of Coweeta Hydrologic Station Office on the Shope Creek road; 40 feet upslope from hairpin curve; 500 feet east of weir on Watershed No. 36. USGS Prentis topographic quadrangle; lat. 35 degrees 3 minutes 28 seconds N. and long. 83 degrees 27 minutes 53 seconds W., NAD 27. State plane coordinates are: 505,700N; 664,600E.

Diagnostic horizons and other features recognized in this pedon:

Umbric Epipedon - the zone from the mineral soil surface to a depth of 19 inches (A1 and A2 horizons).
Cambic Horizon - 19 to 67 inches (Bw and BC horizons).
Isotic mineralogy class - within the PSCS the soil generally has high amorphous materials (high pH-dependent charge) and a high moisture retention (at 1500 kPa) to clay ratio.

*** Primary Characterization Data ***

Pedon ID: 86NC113023 (Macon, North Carolina) Print Date: May 1 2011 8:45AM

Sampled as on Jul 01, 1986 : Cullasaja ; Loamy-skeletal, mixed, mesic Typic Haplumbrept
Revised to correlated on Aug 01, 1996 : Cullasaja ; Loamy-skeletal, isotic, mesic Andic Haplumbrept

SSL - Project CP86NC207 MOUNTAIN SOILS
- Site ID 86NC113023 Lat: 35° 3' 28.00" north Long: 83° 27' 51.00" west MLRA: 130
- Pedon No. 86P0743
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
86P04495	Oe	OE	0-5				L	
86P04496	A	A	5-30				L	SCL
86P04497	AB	AB	30-48				L	FSL
86P04498	Bw	BW	48-86				L	SL
86P04499	BC	BC	86-139				SL	LS

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.9	(NA)
Clay, carbonate free, Weighted Average	13	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	75	% wt
Volume, >2mm, Weighted Average	47	% vol
Clay, total, Weighted Average	13	% wt

Weighted averages based on control section: 25-100 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay (Total) < .002	-2- Silt (Total) .002 -.05	-3- Sand (Total) .05 -2	-4- Fine Clay < .0002	-5- CO_3 Clay < .002	-6- Fine Silt .002 -.02	-7- Coarse Silt .02 -.05	-8- VF Sand .05 -.10	-9- F Sand .10 -.25	-10- M Sand .25 -.50	-11- C Sand .5 -1	-12- VC Sand 1 -2	-13- (Rock Fragments) Weight 2 -5	-14- (Rock Fragments) Weight 5 -20	-15- (Rock Fragments) Weight 20 -75	-16- (Rock Fragments) Weight .1-75	-17- >2 mm wt % whole soil
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1			3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
86P04495	0-5	Oe	S													4	4	6		
86P04496	5-30	A	S	21.0	23.7	55.3			17.3	6.4	11.3	20.1	13.7	7.6	2.6	1	2	24	59	51
86P04497	30-48	AB	S	17.9	21.4	60.7			15.7	5.7	13.1	25.3	14.1	5.4	2.8	5	8	11	60	43
86P04498	48-86	Bw	S	11.8	13.6	74.6			9.4	4.2	13.0	25.3	16.8	10.8	8.7	7	19	21	80	67
86P04499	86-139	BC	S	4.8	9.7	85.5			6.3	3.4	12.9	28.9	20.9	13.4	9.4	9	25	25	89	81

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(Bulk Density)		Cole	(- - - - - - - - - - - - Water Content - - - - - - - - - - -)						WRD	Aggst		
				33	Oven	Whole	6	10	33	1500	1500 kPa	Ratio	Whole	Stabl	(- - Ratio/Clay - -)	
				kPa	Dry	Soil	kPa	kPa	kPa	kPa	Moist	AD/OD	Soil	2-0.5mm	CEC7	1500 kPa
				(- - - g cm^{-3} - - -)			(- - - - - - - - - - - - % of < 2mm - - - - - - - - - - -)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a	4B2b	4B5	4C1		8D1	8D1
86P04495	0-5	Oe	S	0.36	0.52				136.6	26.6		1.035				
86P04495	0-5	Oe	M								46.7					
86P04496	5-30	A	S	0.76	0.84	0.026			36.8	20.6		1.034	0.09		1.64	0.98
86P04497	30-48	AB	S	1.18	1.20	0.004			22.2	12.5		1.017	0.08		0.72	0.70
86P04498	48-86	Bw	S							9.0		1.013			0.76	0.76
86P04499	86-139	BC	S							5.0		1.010			1.23	1.04

Water Content

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(- - Atterberg - -)		(- - - - - Bulk Density - - - - -)			(- Water Content -)							
				(- - - Limits - - -)		Field	Recon	Recon	Field	Recon	(- - - - - - - - - - - - - - - Sieved Samples - - - - - - - - - - - - -)					
				LL	PI		33 kPa	Oven Dry		33 kPa	6 kPa	10 kPa	33 kPa	100 kPa	200 kPa	500 kPa
				pct <0.4mm		(- - - - - - - - g cm^{-3} - - - - - - -)			(- % of < 2mm -)							
				4F1	4F											
86P04496	5-30	A	S	69	4											
86P04498	48-86	Bw	S	35	2											

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				(- - - - - Total - - - - -)			Org	C/N	(- - - Dith-Cit Ext - - -)			(- - - - - - Ammonium Oxalate Extraction - - - - - - -)						(- - - Na Pyro-Phosphate - - -)			
				C	N	S	C	Ratio	Fe	Al	Mn	Al+½Fe	ODOE	Fe	Al	Si	Mn	C	Fe	Al	Mn
				(- - - - - - % of <2 mm - - - - - -)					(- % of < 2mm - - - - - - - - - - - - - - - - - -)								mg kg^{-1}	(- - - - - - % of < 2mm - - - - -)			
					6B3a		6A1c		6C2b	6G7a			8J	6C9a	6G12	6V2	6D5b		6C8a	6G10	
86P04495	0-5	Oe	S		0.911		13.84		2.2	1.2											
86P04496	5-30	A	S		0.618		8.10	13	2.3	1.2		1.78	0.41	0.96	1.30	0.04	1262.2		0.9	1.3	
86P04497	30-48	AB	S		0.121		1.59	13	2.6	0.7		1.21	0.17	0.90	0.76	0.05	583.2		0.8	1.0	
86P04498	48-86	Bw	S		0.057		0.67	12	2.6	0.6		0.84	0.10	0.88	0.40	0.04	517.6		0.4	0.5	
86P04499	86-139	BC	S				0.31		2.1	0.5											

*** Primary Characterization Data ***

Pedon ID: 86NC113023 (Macon, North Carolina) Print Date: May 1 2011 8:45AM

Sampled As : Cullasaja Loamy-skeletal, mixed, mesic Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0743

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - -)												(- - - - Base - - -) (- Saturation -)	
				(- - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - - % - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9b		5A3a	5A8b	5A3b	5G1	5C3	5C1
86P04495	0-5	Oe	S	11.9	2.4	0.5	1.0		57.2				49.6				
86P04496	5-30	A	S	4.0	0.7	0.3	0.4	5.4	42.5	4.2		47.9	34.5	9.6	44	11	16
86P04497	30-48	AB	S	0.4	0.1	0.1	0.1	0.7	14.4	1.8		15.1	12.9	2.5	72	5	5
86P04498	48-86	Bw	S	0.4	0.1	tr	--	0.5	8.1	0.4		8.6	9.0	0.9	44	6	6
86P04499	86-139	BC	S	0.2	0.1	tr	--	0.3	5.5			5.8	5.9			5	5

Salt

(- Water Extracted From Saturated Paste -)

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- - - - - mmol(+) L^{-1} - - -)				(- mmol(-) L^{-1} - - - - - - - - - - - - - - - - - -)										(- - - - % - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
86P04496	5-30	A	S																			1	
86P04497	30-48	AB	S																			1	
86P04498	48-86	Bw	S																			--	
86P04499	86-139	BC	S																			--	

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl	-2- $CaCl_2$ 0.01M 1:2	-3- H_2O 1:1	-4- Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4*2H_2O$ <2mm	-10- Gypsum As $CaSO_4*2H_2O$ <20mm	-11- Resist ohms cm^{-1}
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - - -)						(- - - - - - - - - - - - % - - - - - - - - - - - -)				
				8C1g	4C1a2a	4C1a2a			8C1d					
86P04495	0-5	Oe	S	4.4	4.7	5.3								
86P04496	5-30	A	S	4.1	4.4	4.6			9.7					
86P04497	30-48	AB	S	4.4	4.5	5.0			9.8					
86P04498	48-86	Bw	S	4.6	4.8	5.2			8.8					
86P04499	86-139	BC	S	4.9	5.1	5.6			7.6					

*** Primary Characterization Data ***

Pedon ID: 86NC113023 (Macon, North Carolina) Print Date: May 1 2011 8:45AM

Sampled As : Cullasaja Loamy-skeletal, mixed, mesic Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0743

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ	-3- Acid Oxal	-4- Bray 1	-5- Bray 2	-6- Olsen	-7- H_2O	-8- Citric Acid	-9- Mehlich III	-10- Extr NO_3
					(- Phosphorous - - - - - - - - - - - - - - - - - -)								
					%	(- mg kg^{-1} - - - - - - - - - - - - - - - - -)							mg kg^{-1}
					6S4								
86P04496	5-30	A	S		79								
86P04497	30-48	AB	S		56								
86P04498	48-86	Bw	S		46								

*** Primary Characterization Data ***

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Sampled As : Cullasaja Loamy-skeletal, mixed, mesic Typic Haplumbrept
USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0743

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- to -5- X-Ray 7A2i (peak size)	-6- to -9- Thermal 7A6 (%)	-10- SiO_2	-11- Al_2O_3	-12- Fe_2O_3	-13- MgO	-14- CaO	-15- K_2O	-16- Na_2O	-17- EGME Retn mg g^{-1}	-18- Interpretation
86P04498	48-86	Bw	tcly	GI 3 VR 2 KK 1	GI 11 KK tr			11.0			0.4			

Elemental columns -10- to -16-: 7C3, (%)

FRACTION INTERPRETATION:
tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:
GI - Gibbsite KK - Kaolinite VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 86NC113023 (Macon, North Carolina) Print Date: May 1 2011 8:45AM
Sampled As : Cullasaja Loamy-skeletal, mixed, mesic Typic Haplumbrept
USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0743

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- to -5- X-Ray (peak size)	-6- to -9- Thermal (%)	-10- Tot Re	-11-	-12-	-13-	-14-	-15-	-16-	-17- EGME Retn mg g^{-1}	-18- Interpretation
86P04498	48-86	Bw	fs			18	BT 40	MS 31	QZ 15	FP 7	RA 1	PR 1		
							FK 1	HN 1	OP 1	TM 1	ZR tr			

Optical columns -10- to -16-: Grain Count 7B1a (%)

FRACTION INTERPRETATION:
fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite FK - Potassium Feldspar FP - Plagioclase Feldspar HN - Hornblende MS - Muscovite
OP - Opaques PR - Pyroxene QZ - Quartz RA - Resistant Aggregates TM - Tourmaline
ZR - Zircon

TUCKASEGEE SERIES – COLLUVIUM IN UPPER WATERSHED

The Tuckasegee series consists of very deep, well drained soils on gently sloping to very steep benches, foot slopes, toe slopes, drainageways, and fans in coves in the Southern Blue Ridge, MLRA 130B. These soils formed in colluvium derived from materials weathered from igneous and high-grade metamorphic rocks such as granite, mica gneiss, hornblende gneiss, and schist. Slopes range from 2 to 95 percent.

TAXONOMIC CLASS: Fine-loamy, isotic, mesic Typic Humudepts

TYPICAL PEDON: Tuckasegee fine sandy loam on a 30 percent southeast facing foot slope at an elevation of 3320 feet -- Forested. (Colors are for moist soil unless otherwise stated.)

Oi--2 to 0 inches; partially decomposed deciduous leaves, twigs and roots.

A1--0 to 9 inches; black (10YR 2/1) fine sandy loam; dark brown (10YR 3/3) dry; moderate fine and medium granular structure; very friable; many fine, common medium, and few coarse roots; 5 percent gravel by volume; few fine flakes of mica; strongly acid; clear smooth boundary.

A2--9 to 13 inches; dark brown (7.5YR 3/2) fine sandy loam; brown (7.5YR 4/2) dry; moderate coarse granular and weak fine and medium granular structure; very friable; common fine to coarse roots; 5 percent gravel by volume; few fine flakes of mica; very strongly acid; gradual wavy boundary. (Combined thickness of the A horizon is 10 to 20 inches.)

Bw1--13 to 26 inches; dark brown (7.5YR 3/4) fine sandy loam; weak medium subangular blocky structure; friable; common medium to coarse roots; 5 percent gravel, 5 percent cobbles by volume; few fine flakes of mica; strongly acid; gradual wavy boundary.

Bw2--26 to 47 inches; brown (7.5YR 4/4) stony sandy clay loam; weak medium subangular blocky structure; friable; few medium to coarse roots; 5 percent gravel, 5 percent cobbles, 15 percent stones by volume; few fine flakes of mica; strongly acid; gradual wavy boundary. (Combined thickness of the Bw horizons is 30 to 51 inches.)

BC--47 to 65 inches; strong brown (7.5YR 4/6) very stony sandy clay loam; weak medium subangular blocky structure; friable; few medium roots; 10 percent gravel, 15 percent cobbles, 30 percent stones by volume; few fine flakes of mica; strongly acid.

TYPE LOCATION: Macon County, North Carolina; 3.0 miles west of Coweeta Hydrologic Station Office on Shope Creek road; 150 feet upslope from hairpin curve; in the woods, 400 feet east of weir on Watershed No. 36.

REMARKS: This series was previously included with the Tusquitee series. However, Tusquitee soils have umbric colored A horizons 7 to 10 inches thick and are Coarse-loamy, mixed, mesic Umbric Dystrochrepts. National Soil Survey Lab data (NSSL #86P0742) is available for the typical pedon. That data and other data indicate that these soils are generally marginal to the coarse-loamy family. The 6/90 revision of the series changes the classification from coarse-loamy to fine-loamy, mixed, mesic Typic Haplumbrepts. The 9/07(HCD) revisions add a texture modifier to the Bw2 horizon where none existed and corrects the texture modifier in the BC horizon

Diagnostic horizons and features in this pedon are:

Umbric epipedon - 0 to 13 inches (A1 and A2 horizons)
Cambic horizon - 13 to 47 inches (Bw1, Bw2, Bw3 horizons)

*** Primary Characterization Data ***

Pedon ID: 86NC113022 (Macon, North Carolina) Print Date: May 1 2011 8:48AM

Sampled as on Jul 01, 1986 : Tuckasegee ; Coarse-loamy, mixed, mesic Typic Haplumbrept
Revised to correlated on Aug 01, 1996 : Tuckasegee ; Fine-loamy, mixed, superactive, mesic Andic Haplumbrept

SSL - Project CP86NC207 MOUNTAIN SOILS
- Site ID 86NC113022 Lat: 35° 3' 29.00" north Long: 83° 27' 54.00" west MLRA: 130
- Pedon No. 86P0742
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
86P04487	A1	A1	0-5				FSL	
86P04488	A2	A2	5-27				FSL	FSL
86P04489	A3	A3	27-39				FSL	FSL
86P04490	Bw1	BW1	39-60				L	FSL
86P04491	Bw2	BW2	60-71				L	SCL
86P04492	Bw3	BW3	71-105				L	SCL
86P04493	Bw4	BW4	105-125				SCL	SCL
86P04494	Bw5	BW5	125-155				FSL	SCL

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.87	(NA)
Clay, carbonate free, Weighted Average	19	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	56	% wt
Volume, >2mm, Weighted Average	14	% vol
Clay, total, Weighted Average	19	% wt

Weighted averages based on control section: 25-100 cm

*** Primary Characterization Data ***

Pedon ID: 86NC113022 (Macon, North Carolina) Print Date: May 1 2011 8:48AM

Sampled As : Tuckasegee Coarse-loamy, mixed, mesic Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0742

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay < .002	-2- Total Silt .002 -.05	-3- Total Sand .05 -2	-4- Clay Fine < .0002	-5- Clay CO_3 < .002	-6- Silt Fine .002 -.02	-7- Silt Coarse .02 -.05	-8- Sand VF .05 -.10	-9- Sand F .10 -.25	-10- Sand M .25 -.50	-11- Sand C .5 -1	-12- Sand VC 1 -2	-13- Rock Fragments (mm) Weight 2 -5	-14- 5 -20	-15- 20 -75	-16- .1-75	-17- >2 mm wt % whole soil
				(% of <2mm Mineral Soil)												(% of <75mm)				
				3A1	3A1	3A1			3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
86P04487	0-5	A1	S													3	7	1		
86P04488	5-27	A2	S	15.5	28.1	56.4			21.1	7.0	11.6	21.2	14.6	6.6	2.4	1	3	12	54	16
86P04489	27-39	A3	S	10.4	31.1	58.5			21.9	9.2	15.9	20.7	13.5	5.4	3.0	1	2	13	52	16
86P04490	39-60	Bw1	S	18.6	25.0	56.4			19.0	6.0	11.2	22.1	13.7	6.3	3.1	2	3	12	55	26
86P04491	60-71	Bw2	S	21.0	21.1	57.9			15.6	5.5	12.1	23.8	14.1	5.2	2.7	3	4	11	56	26
86P04492	71-105	Bw3	S	21.1	20.6	58.3			15.8	4.8	11.3	25.0	14.6	5.3	2.1	4	5	11	58	34
86P04493	105-125	Bw4	S	21.8	23.4	54.8			18.4	5.0	11.5	22.7	13.0	5.4	2.2	2	3	12	54	48
86P04494	125-155	Bw5	S	20.4	21.6	58.0			17.4	4.2	10.9	24.5	14.1	6.0	2.5	2	1	30	65	71

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa	-2- Oven Dry	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- Ratio/Clay CEC7	-13- 1500 kPa
				(g cm^{-3})			(% of < 2mm)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a	4B2b	4B5	4C1		8D1	8D1
86P04487	0-5	A1	S	0.60	0.77				97.4	22.3		1.041				
86P04487	0-5	A1	M								43.5					
86P04488	5-27	A2	S	1.01	1.11	0.030			37.5	16.3		1.034	0.20		1.82	1.05
86P04489	27-39	A3	S	0.92	0.97	0.017			31.9	15.6		1.026	0.14		1.88	1.50
86P04490	39-60	Bw1	S	1.02	1.08	0.017			34.4	12.4		1.019	0.20		0.74	0.67
86P04491	60-71	Bw2	S	1.14	1.17	0.008			27.6	11.4		1.014	0.16		0.59	0.54
86P04492	71-105	Bw3	S	1.21	1.26	0.011			26.3	10.9		1.016	0.15		0.58	0.52
86P04493	105-125	Bw4	S	1.35	1.39	0.007			22.1	12.2		1.017	0.09		0.61	0.56
86P04494	125-155	Bw5	S	1.35	1.39	0.004			22.4	11.3		1.016	0.07		0.66	0.55

*** Primary Characterization Data ***

Pedon ID: 86NC113022 (Macon, North Carolina) Print Date: May 1 2011 8:48AM

Sampled As : Tuckasegee Coarse-loamy, mixed, mesic Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0742

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (Atterberg Limits) LL	-2- (Atterberg Limits) PI	-3- (Bulk Density) Field	-4- (Bulk Density) Recon 33 kPa	-5- (Bulk Density) Recon Oven Dry	-6- (Water Content) Field	-7- (Water Content) Recon 33 kPa	-8- (Water Content, Sieved Samples) 6 kPa	-9- 10 kPa	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa	-13- 500 kPa
				pct <0.4mm		g cm^{-3}			% of < 2mm							
				4F1	4F											
86P04488	5-27	A2	S	19	9											
86P04492	71-105	Bw3	S	35	9											

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (Total) C	-2- (Total) N	-3- (Total) S	-4- Org C	-5- C/N Ratio	-6- (Dith-Cit Ext) Fe	-7- (Dith-Cit Ext) Al	-8- (Dith-Cit Ext) Mn	-9- (Ammonium Oxalate Extraction) Al+½Fe	-10- ODOE	-11- Fe	-12- Al	-13- Si	-14- Mn	-15- (Na Pyro-Phosphate) C	-16- Fe	-17- Al	-18- Mn
				% of <2 mm					% of < 2mm								mg kg^{-1}	% of < 2mm			
					6B3a		6A1c		6C2b	6G7a			8J	6C9a	6G12	6V2	6D5b		6C8a	6G10	
86P04487	0-5	A1	S		0.878		12.49		2.5	1.3											
86P04488	5-27	A2	S		0.426		6.36	15	2.4	1.3		1.92	0.42	1.02	1.41	0.05	1235.0		0.9	1.4	
86P04489	27-39	A3	S		0.206		3.40	17	2.6	1.1		1.92	0.29	1.18	1.32	0.05	1119.9		0.9	1.1	
86P04490	39-60	Bw1	S		0.099		1.55	16	2.7	0.7		1.30	0.19	1.15	0.72	0.05	860.0		0.8	0.8	
86P04491	60-71	Bw2	S				0.96		2.6	0.7		1.07	0.16	1.03	0.55	0.04	618.2		0.5	0.4	
86P04492	71-105	Bw3	S				0.44		2.5	0.5											
86P04493	105-125	Bw4	S				0.25		2.5	0.4											
86P04494	125-155	Bw5	S				0.23		2.3	0.4											

*** Primary Characterization Data ***

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Sampled As : Tuckasegee Coarse-loamy, mixed, mesic Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0742

CEC & Bases

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
	Depth			Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH_4 OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH_4OAC
Layer	(cm)	Horz	Prep	(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9b		5A3a	5A8b	5A3b	5G1	5C3	5C1
86P04487	0-5	A1	S	12.9	2.5	0.1	0.9		60.2				46.7				
86P04488	5-27	A2	S	1.2	0.3	0.2	0.3	2.0	36.9	4.2		38.9	28.2	6.2	68	5	7
86P04489	27-39	A3	S	0.3	0.1	0.1	0.1	0.6	25.9	2.6		26.5	19.5	3.2	81	2	3
86P04490	39-60	Bw1	S	0.4	0.1	0.1	0.1	0.7	15.1	2.2		15.8	13.8	2.9	76	4	5
86P04491	60-71	Bw2	S	0.6	0.2	0.1	0.1	1.0	12.6	1.7		13.6	12.3	2.7	63	7	8
86P04492	71-105	Bw3	S	1.0	0.5	tr	0.1	1.6	9.9	1.6		11.5	12.3	3.2	50	14	13
86P04493	105-125	Bw4	S	0.7	1.3	tr	0.1	2.1	10.1	2.4		12.2	13.3	4.5	53	17	16
86P04494	125-155	Bw5	S	0.6	0.8	tr	0.1	1.5	9.6	2.4		11.1	13.5	3.9	62	14	11

Salt

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
	Depth			Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
Layer	(cm)	Horz	Prep	(- - - - - mmol(+) L^{-1} - - - -)				(- mmol(-) L^{-1} - - - - - - - - - - - - - - - - -)										(- - - - % - - - -)		(- - dS m^{-1} - - -)		%	
																						5D2	
86P04488	5-27	A2	S																			1	
86P04489	27-39	A3	S																			1	
86P04490	39-60	Bw1	S																			1	
86P04491	60-71	Bw2	S																			1	
86P04492	71-105	Bw3	S																			--	
86P04493	105-125	Bw4	S																			--	
86P04494	125-155	Bw5	S																			--	

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- pH KCl	-2- pH $CaCl_2$ 0.01M 1:2	-3- pH H_2O 1:1	-4- pH Sat Paste	-5- pH Sulf	-6- pH NaF	-7- Carbonate As $CaCO_3$ <2mm %	-8- Carbonate As $CaCO_3$ <20mm %	-9- Gypsum As $CaSO_4*2H_2O$ <2mm %	-10- Gypsum As $CaSO_4*2H_2O$ <20mm %	-11- Resist ohms cm^{-1}
				8C1g	4C1a2a	4C1a2a			8C1d					
86P04487	0-5	A1	S	4.5	4.8	5.2			8.9					
86P04488	5-27	A2	S	4.3	4.4	4.7			10.6					
86P04489	27-39	A3	S	4.4	4.6	5.0			10.7					
86P04490	39-60	Bw1	S	4.3	4.5	5.1			9.4					
86P04491	60-71	Bw2	S	4.2	4.5	5.3			9.2					
86P04492	71-105	Bw3	S	4.2	4.4	5.4			8.8					
86P04493	105-125	Bw4	S	4.1	4.4	5.3								
86P04494	125-155	Bw5	S	4.0	4.3	5.2								

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- Phosphorous NZ %	-3- Acid Oxal mg kg^{-1}	-4- Bray 1 mg kg^{-1}	-5- Bray 2 mg kg^{-1}	-6- Olsen mg kg^{-1}	-7- H_2O mg kg^{-1}	-8- Citric Acid mg kg^{-1}	-9- Mehlich III mg kg^{-1}	-10- Extr NO_3 mg kg^{-1}
					6S4								
86P04488	5-27	A2	S		81								
86P04489	27-39	A3	S		78								
86P04490	39-60	Bw1	S		59								
86P04491	60-71	Bw2	S		56								

*** Primary Characterization Data ***

Pedon ID: 86NC113022 (Macon, North Carolina) Print Date: May 1 2011 8:48AM

Sampled As : Tuckasegee Coarse-loamy, mixed, mesic Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0742

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray 7A2i peak size	-2-	-3-	-4-	-5-	-6- Thermal 7A6 %	-7-	-8-	-9- 7A4b	-10- Elemental 7C3 % SiO_2	-11- Al_2O_3	-12- Fe_2O_3	-13- MgO	-14- CaO	-15- K_2O	-16- Na_2O	-17- EGME Retn mg g^{-1}	-18- Interpretation
86P04491	60-71	Bw2	tcly	VR 2	GI 2	KK 2	MI 1		KK 10	GI 7	KK 26	GI 13			12.4			0.8			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GI - Gibbsite KK - Kaolinite MI - Mica VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 86NC113022 (Macon, North Carolina) Print Date: May 1 2011 8:48AM

Sampled As : Tuckasegee Coarse-loamy, mixed, mesic Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0742

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray peak size	-2-	-3-	-4-	-5-	-6- Thermal %	-7-	-8-	-9-	-10- Optical Grain Count 7B1a Tot Re %	-11-	-12-	-13-	-14-	-15-	-16-	-17- EGME Retn mg g^{-1}	-18- Interpretation
86P04491	60-71	Bw2	fs										32	BT 34	QZ 28	MS 16	FP 12	HN 4	OP 4		
														FK 1	OW 1	HY 1	GN tr	ZR tr			

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite FK - Potassium Feldspar FP - Plagioclase Feldspar GN - Garnet HN - Hornblende

HY - Hypersthene MS - Muscovite OP - Opaques OW - Other Weatherable Minerals QZ - Quartz

ZR - Zircon

FANNIN PEDON DESCRIPTION – RESIDUUM FROM MICACEOUS BEDROCK

Print Date: 04/22/2011
Description Date: 1/1/1990
Describer:
Site ID: 90NC099001
Pedon Note: Vegetation: mixed hardwood and pine. Parent material: mica schist.
Lab Source ID: SSL
Lab Pedon #: 90P0391
Soil Name as Described/Sampled: Fannin
Description origin: Converted from SSL-CMS data
Cont. Site ID: 90NC099001

Country:
State: North Carolina
County: Jackson
MLRA:
Quad Name:
Legal Description:
Latitude: north
Description database: NSSL
Pedon ID: 90NC099001

Oi--5 to 0 centimeters; partially decomposed leaves and needles of deciduous and coniferous plants

A--0 to 13 centimeters; reddish brown (5YR 4/4) loam; moderate medium granular structure; friable; many fine and medium roots; 30 percent fine mica flakes, unspecified; strongly acid, pH 5.5, Hellige-Truog; clear wavy boundary. (Lab sample # 90P2186).

Bt--13 to 64 centimeters; red (2.5YR 4/6) clay loam; moderate medium subangular blocky structure; friable; common fine and medium roots; continuous faint clay films on faces of peds; 30 percent fine mica flakes, unspecified; very strongly acid, pH 5.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 90P2187).

BC--64 to 97 centimeters; 20 percent reddish brown (5YR 4/4) and 80 percent red (2.5YR 4/8) loam; weak medium subangular blocky structure; friable; few medium and coarse roots; 30 percent fine mica flakes, unspecified; very strongly acid, pH 5.0, Hellige-Truog. (Lab sample # 90P2188).

C1--97 to 168 centimeters; reddish brown (5YR 4/4) fine sandy loam; friable; few medium and coarse roots; 2.5YR8), moist, coats in root channels and/or pores; 30 percent fine mica flakes, unspecified; very strongly acid, pH 4.8, Hellige-Truog. (Lab sample # 90P2189).

C2--168 to 198 centimeters; fine sandy loam; friable; few medium and coarse roots; 30 percent fine mica flakes, unspecified; very strongly acid, pH 4.8, Hellige-Truog. (Lab sample # 90P2190).

Cr--198 to 224 centimeters; slightly acid, pH 6.5, Hellige-Truog. (Lab sample # 90P2191).

*** Primary Characterization Data ***

Pedon ID: 90NC099001 | (Jackson, North Carolina) | Print Date: May 1 2011 8:50AM

Sampled as on Jan 01, 1990 : Fannin ; Fine-loamy, micaceous, mesic Typic Hapludult
Revised to correlated on Aug 01, 1996 : Fannin ; Fine-loamy, parasesquic, mesic Typic Hapludept

SSL - Project CP90NC090 JACKSON COUNTY
- Site ID 90NC099001 MLRA: 130
- Pedon No. 90P0391
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
90P02186	A	A	3-13				L	SCL
90P02187	Bt	BT	13-64				CL	SCL
90P02188	BC	BC	64-97				L	FSL
90P02189	C1	C1	97-168				FSL	FSL
90P02190	C2	C2	168-198				FSL	LS
90P02191	Cr	CR	198-224					S

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.28	(NA)
Clay, carbonate free, Weighted Average	28	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	35	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	28	% wt

Weighted averages based on control section: 13-64 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay < .002	-2- Total Silt .002 -.05	-3- Total Sand .05 -2	-4- Clay Fine < .0002	-5- Clay CO_3 < .002	-6- Silt Fine .002 -.02	-7- Silt Coarse .02 -.05	-8- Sand VF .05 -.10	-9- Sand F .10 -.25	-10- Sand M .25 -.50	-11- Sand C .5 -1	-12- Sand VC 1 -2	-13- Rock Fragments (mm) Weight 2 -5	-14- Rock Fragments (mm) Weight 5 -20	-15- Rock Fragments (mm) Weight 20 -75	-16- Rock Fragments (mm) Weight .1-75	-17- >2 mm wt % whole soil
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
90P02186	3-13	A	S	23.6	26.5	49.9	11.8		18.7	7.8	13.7	18.3	9.1	6.0	2.8	--	--	--	36	--
90P02187	13-64	Bt	S	28.2	23.5	48.3	13.0		16.5	7.0	13.7	17.6	9.3	5.1	2.6	--	--	--	35	--
90P02188	64-97	BC	S	12.7	18.3	69.0	6.6		11.1	7.2	19.1	25.9	13.5	6.8	3.7	1	--	--	50	1
90P02189	97-168	C1	S	5.5	22.6	71.9	2.5		11.9	10.7	23.7	25.0	13.2	6.9	3.1	1	--	--	49	1
90P02190	168-198	C2	S	2.9	20.3	76.8	1.7		8.5	11.8	16.8	24.5	16.3	12.8	6.4	3	tr	--	61	3
90P02191	198-224	Cr	S	1.0	12.8	86.2	0.8		4.5	8.3	17.2	25.8	20.8	14.6	7.8	10	2	--	73	12

*** Primary Characterization Data ***

Pedon ID: 90NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:50AM

Sampled As : Fannin Fine-loamy, micaceous, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 90P0391

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa (- - - g cm^{-3} - - -)	-2- Oven Dry	-3- Cole Whole Soil	-4- (- - - - - - - - - - - Water Content - - - - - - - - - - -) 6 kPa (- - - - - - - - - - - - % of < 2mm - - - - - - - - - - -)	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa 4B2a	-8- 1500 kPa Moist	-9- Ratio AD/OD 4B5	-10- WRD Whole Soil cm^3 cm^{-3}	-11- Aggst Stabl 2-0.5mm %	-12- (- - Ratio/Clay - -) CEC7 8D1	-13- 1500 kPa 8D1
90P02186	3-13	A	S							15.7		1.012			0.58	0.67
90P02187	13-64	Bt	S							15.0		1.009			0.28	0.53
90P02188	64-97	BC	S							11.2		1.006			0.43	0.88
90P02189	97-168	C1	S							6.1		1.003			0.80	1.11
90P02190	168-198	C2	S							5.2		1.006			1.83	1.79
90P02191	198-224	Cr	S							3.9		1.008			5.10	3.90

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (- - - - - Total - - - - -) C (- - - - - - % of <2 mm - - - - -)	-2- N 6B3a	-3- S	-4- Org C 6A1c	-5- C/N Ratio	-6- (- - - Dith-Cit Ext - - -) Fe (- % of < 2mm - - - - - - - - - - - - - - -) 6C2b	-7- Al 6G7a	-8- Mn 6D2a	-9- (- - - - - - Ammonium Oxalate Extraction - - - - -) Al+½Fe	-10- ODOE 8J	-11- Fe 6C9a	-12- Al 6G12	-13- Si 6V2	-14- Mn mg kg^{-1} 6D5b	-15- (- - - Na Pyro-Phosphate - - -) C (- - - - - - % of < 2mm - - - - -)	-16- Fe	-17- Al	-18- Mn
90P02186	3-13	A	S		0.202		2.99	15	2.7	0.3	tr	0.39	0.08	0.31	0.23	0.03	236.3				
90P02187	13-64	Bt	S		0.041		0.38	9	2.8	0.3	tr	0.35	0.05	0.31	0.20	0.03	147.9				
90P02188	64-97	BC	S		0.009		0.09	10	1.9	0.2	--	0.17	0.04	0.16	0.09	0.02	18.5				
90P02189	97-168	C1	S		0.004		0.06	14	1.1	0.1	--	0.11	0.02	0.08	0.07	tr	--				
90P02190	168-198	C2	S				0.04		1.2	0.1	tr	0.33	0.04	0.26	0.20	0.04	110.6				
90P02191	198-224	Cr	S				0.01		1.0	0.2	tr	0.79	0.06	0.13	0.73	0.21	172.7				

*** Primary Characterization Data ***

Pedon ID: 90NC099001 — (Jackson, North Carolina) — Print Date: May 1 2011 8:50AM

Sampled As : Fannin — Fine-loamy, micaceous, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 90P0391

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)													
				(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9b	6D3	5A3a	5A8b	5A3b	5G1	5C3	5C1
90P02186	3-13	A	S	5.7	1.6	0.1	0.8	8.2	12.5			20.7	13.8			40	59
90P02187	13-64	Bt	S	1.4	0.8	0.1	0.2	2.5	8.6	1.4	0.9	11.1	8.0	3.9	36	23	31
90P02188	64-97	BC	S	0.7	0.8	0.1	0.2	1.8	5.5	0.8	--	7.3	5.4	2.6	31	25	33
90P02189	97-168	C1	S	0.3	0.5	0.1	0.1	1.0	4.4	1.2	0.1	5.4	4.4	2.2	55	19	23
90P02190	168-198	C2	S	0.3	0.5	0.1	0.1	1.0	5.5	1.3	0.2	6.5	5.3	2.3	57	15	19
90P02191	198-224	Cr	S	0.1	--	0.1	tr	0.2	7.0			7.2	5.1			3	4

Salt

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- Water Extracted From Saturated Paste -)																			
				(- - - - - mmol(+) L^{-1} - - - -)				(- mmol(-) L^{-1} - - - - - - - - - - - - - - - -)										(- - - - % - - - -)		(- - dS m^{-1} - - -)		%	
																						5D2	
90P02186	3-13	A	S																			1	
90P02187	13-64	Bt	S																			1	
90P02188	64-97	BC	S																			2	
90P02189	97-168	C1	S																			2	
90P02190	168-198	C2	S																			2	
90P02191	198-224	Cr	S																			2	

*** Primary Characterization Data ***

Pedon ID: 90NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:50AM

Sampled As : Fannin Fine-loamy, micaceous, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 90P0391

pH & Carbonates				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - pH	- - - - - - - - - - - - - - - - -)					(- - Carbonate - -) As $CaCO_3$		(- - Gypsum - - -) As $CaSO_4*2H_2O$		
Layer	Depth (cm)	Horz	Prep	KCl 8C1g	$CaCl_2$ 0.01M 1:2 4C1a2a	H_2O 1:1 4C1a2a	Sat Paste	Sulf	NaF	<2mm (- - - - - -	<20mm - - - - - - %	<2mm - - - - - -	<20mm - - - - - -)	Resist ohms cm^{-1}
90P02186	3-13	A	S	4.8	5.1	5.7								
90P02187	13-64	Bt	S	4.0	4.3	4.9								
90P02188	64-97	BC	S	3.8	4.3	4.8								
90P02189	97-168	C1	S	4.1	4.3	4.8								
90P02190	168-198	C2	S	4.4	4.3	5.0								
90P02191	198-224	Cr	S	5.0	5.2	5.5								

*** Primary Characterization Data ***

Pedon ID: 90NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:50AM

Sampled As : Fannin Fine-loamy, micaceous, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 90P0391

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray				Thermal					Elemental					EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract			7A2i									7C3						tion
Layer	(cm)	Horz	ion	(- - - - - - - - -	peak size	- - - - - -	- - - -)		(- - - - - - - - -	%	- - - - - - - -)		(- - - - - - - - -	- - - - - - - - -	- - - %	- - - - - - - -	- - - - - -)			mg g^{-1}	
90P02186	3-13	A	tcly	KK 5	GI 3	MI 1	VM 1	GE 1						26	11.4			0.5			
				HE 1																	
90P02187	13-64	Bt	tcly	KK 5	GI 3	VM 1	GE 1	MI 1						30	12.4			0.6			
				HE 1																	
90P02188	64-97	BC	tcly	KK 4	GI 3	GE 1	HE 1	MI 1						30	12.6			0.3			
90P02189	97-168	C1	tcly	GI 3	KK 3	MI 1								28	7.7			0.4			
90P02190	168-198	C2	tcly	GI 3	KK 2	MI 1								20	5.7			0.4			
90P02191	198-224	Cr	tcly	KK 2	MI 1	GI 1								19	7.6			1.0			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GE - Goethite GI - Gibbsite HE - Hematite KK - Kaolinite MI - Mica

VM - Vermiculite-Mica

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 90NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:50AM

Sampled As : Fannin Fine-loamy, micaceous, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 90P0391

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a					tion
Layer	(cm)	Horz	ion	(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
90P02186	3-13	A	fs										28	BT 70	QZ 23	OP 4	FD 2	OT 1	ZR 1		
														MS 1							
90P02187	13-64	Bt	fs										32	BT 60	QZ 28	FD 4	OP 2	ZR 2	OT 1		
														MS 1	PR 1						
90P02188	64-97	BC	fs										18	BT 80	QZ 17	FD 2	ZR 1	OT 1	PR tr		
														OP tr	MS tr						
90P02189	97-168	C1	vfs										12	BT 79	QZ 11	FD 8	OT 1	ZR 1	FP tr		
														MS tr	OP tr	AP tr					
90P02190	168-198	C2	fs										26	BT 65	QZ 20	OP 4	FD 3	MS 3	OT 2		
														ZR 2	HN tr						
90P02191	198-224	Cr	fs										30	BT 64	QZ 25	OP 4	FD 3	OT 3	ZR 1		
														MS tr							

FRACTION INTERPRETATION:

vfs - Very Fine Sand, 0.05-0.1 mm fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

AP - Apatite BT - Biotite FD - Feldspar FP - Plagioclase Feldspar HN - Hornblende

MS - Muscovite OP - Opaques OT - Other PR - Pyroxene QZ - Quartz

ZR - Zircon

*** Primary Characterization Data ***

Pedon ID: 90NC099001 (Jackson, North Carolina) Print Date: May 1 2011 8:50AM

Sampled As : Fannin Fine-loamy, micaceous, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 90P0391

Fine Earth Mineralogy (<2.0 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract			7A2i										7C3					tion
Layer	(cm)	Horz	ion	(- - - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
90P02186	3-13	A	feth	QZ	KK	MI	FD							9	6.1			2.1			
90P02187	13-64	Bt	feth	QZ	FD	KK	MI	GI						11	5.9			2.4			
90P02188	64-97	BC	feth	QZ	MI	KK	FD	GI						16	8.6			2.9			
90P02189	97-168	C1	feth	QZ	KK	FD	MI	GI						17	8.6			3.6			
90P02190	168-198	C2	feth	QZ	KK	FD	MI	GI						16	7.9			3.1			
90P02191	198-224	Cr	feth	QZ	FD	MI	KK							18	8.3			2.4			

FRACTION INTERPRETATION:

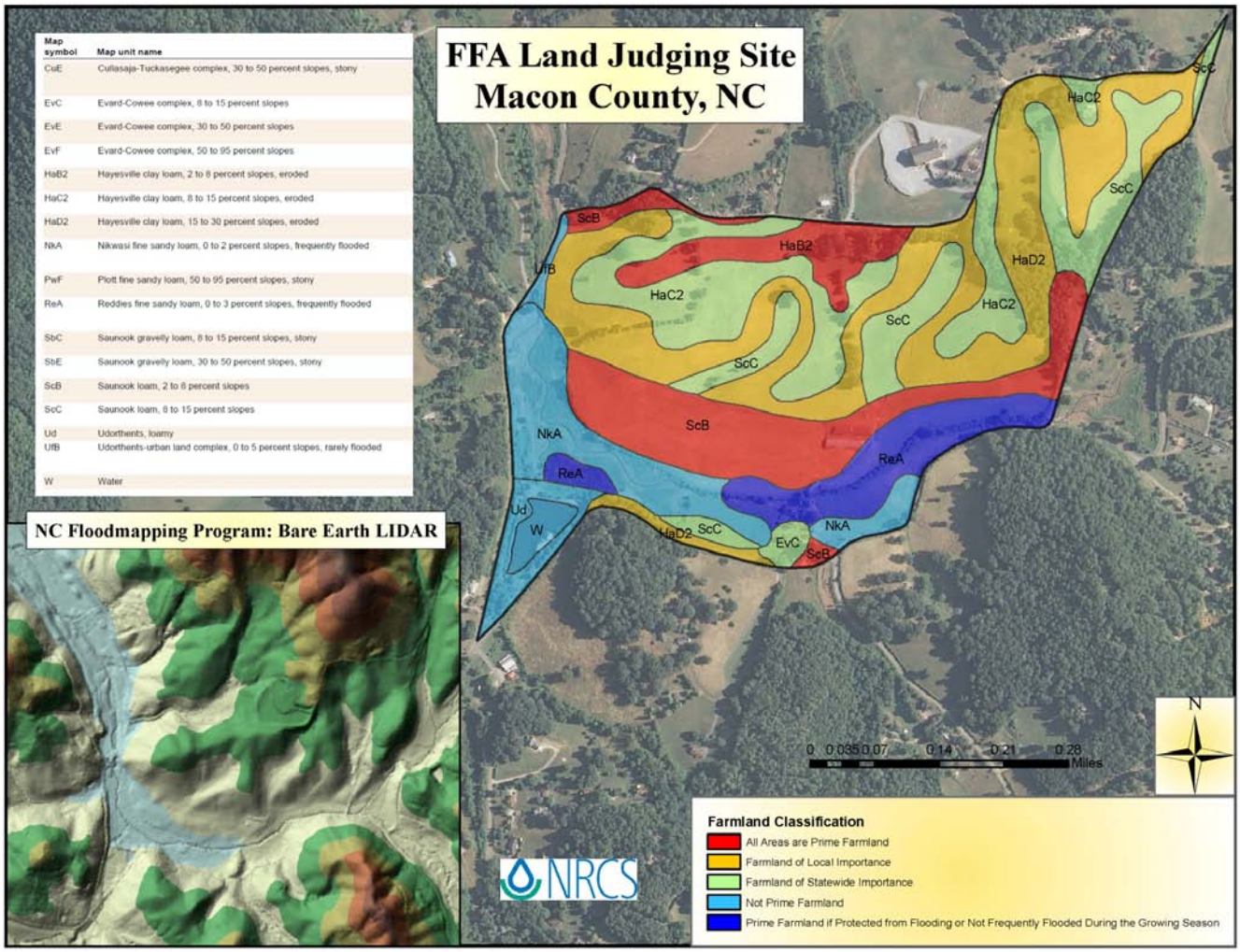
feth - Fine Earth, <2 mm

MINERAL INTERPRETATION:

FD - Feldspar GI - Gibbsite KK - Kaolinite MI - Mica QZ - Quartz

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

Waldroop Farm



Map symbol	Map unit name
CuE	Cullasaja-Tuckasegee complex, 30 to 50 percent slopes, stony
EvC	Evard-Cowee complex, 8 to 15 percent slopes
EvE	Evard-Cowee complex, 30 to 50 percent slopes
EvF	Evard-Cowee complex, 50 to 95 percent slopes
HaB2	Hayesville clay loam, 2 to 8 percent slopes, eroded
HaC2	Hayesville clay loam, 8 to 15 percent slopes, eroded
HaD2	Hayesville clay loam, 15 to 30 percent slopes, eroded
NkA	Nikwasi fine sandy loam, 0 to 2 percent slopes, frequently flooded
PwF	Plott fine sandy loam, 50 to 95 percent slopes, stony
ReA	Reddies fine sandy loam, 0 to 3 percent slopes, frequently flooded
SbC	Saunook gravelly loam, 8 to 15 percent slopes, stony
SbE	Saunook gravelly loam, 30 to 50 percent slopes, stony
ScB	Saunook loam, 2 to 8 percent slopes
ScC	Saunook loam, 8 to 15 percent slopes
Ud	Udorthents, loamy
UfB	Udorthents-urban land complex, 0 to 5 percent slopes, rarely flooded
W	Water

Important Farmlands of North Carolina

Three categories of important farmlands are recognized in North Carolina-prime, unique, statewide, and local importance. Criteria used for prime and unique farmlands were published January 31, 1978 in the Federal Register and amended in June 17, 1994. These criteria are also in General Manual, Title 310-Land Use, section 403.3 and Section 622 of the Natural Resources Conservation Service (NRCS) National Soil Survey Handbook (Title 430). Criteria for farmland of statewide importance were developed in 1988 by the North Carolina NRCS State Soils Staff in consultation with soil survey cooperators, resource conservationists, and key soil survey customers. Criteria for farmland of local importance were developed in 2009 by the North Carolina NRCS Area 1 Soils Staff in consultation with soil survey cooperators, resource conservationists, and key soil survey customers.

Farmland of Statewide Importance

In general, soils that do not quite meet the requirements for prime farmland fall into this category. This could be due to steepness of slope, permeability, susceptibility to erosion, low available water capacity, or some other soil property.

The following criteria were selected to help define farmland of statewide importance in North Carolina:

1. Slopes shall not exceed 15 percent.
2. Stony, very stony, extremely stony, very cobbly, and bouldery phases are excluded.
3. Severely eroded phases are excluded.
4. Wet soils that have very slow permeability (< 0.06 in/hr) are excluded.
5. Somewhat poorly drained, poorly drained, and very poorly drained soils that are not drained are excluded.
6. Soils that are frequently flooded during the growing season are excluded.
7. Soils that are droughty, 3 inches or less available water capacity to a limiting layer or 40 inch depth, are excluded from this category.
8. Rocky phases or soils that have rock outcrop in the map unit name are excluded from this category.

Farmland of Local Importance

In areas where the extent of prime and statewide important farmlands is limited, there may be a need to identify certain additional farmlands of local importance. These lands are to be identified by local Soil and Water Conservation Districts with input from other local units of government and interested groups where appropriate. In general, soils that do not quite meet the requirements for farmland of statewide importance fall into this category. This could be due to steepness of slope, stoniness, flooding, cobbly surface texture, or some other soil property.

The following criteria were selected to help define farmland of statewide importance in North Carolina:

1. Slopes shall not exceed 30 percent.
2. Very stony, extremely stony, very cobbly, and very bouldery phases are excluded.
3. Severely eroded phases are excluded.
4. Wet soils that have very slow permeability (< 0.06 in/hr) are excluded.
5. Somewhat poorly drained, poorly drained, and very poorly drained soils that are not drained are excluded.
6. Soils that are frequently flooded during the growing season are excluded.
7. Soils that are very droughty, 2.5 inches or less available water capacity to a limiting layer or 40 inch depth, are excluded from this category.
8. Rocky phases or soils that have rock outcrop in the map unit name are excluded from this category.

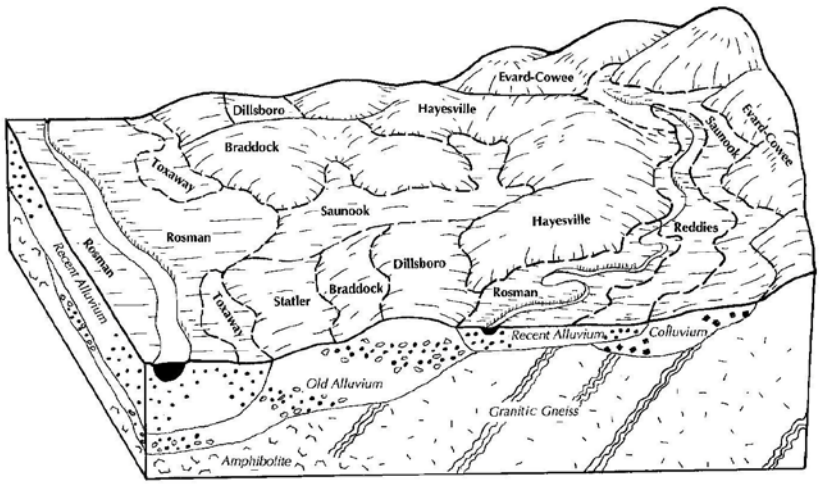


Figure 2.—Typical relationship of soils, landscape position, and parent material in the Rosman-Reddies-Toxaway and Hayesville-Braddock general soil map units.

HAYESVILLE PEDON DESCRIPTION – RESIDUAL UPLANDS

Description Date: 10/1/1991
Describer: Milton Martinez, John Allison, Mark Hudson
Site ID: 91NC021001
Pedon Note: 92P0589 (114-185 cm) was sampled
Soil Name as Described/Sampled: Hayesville
Soil Name as Correlated:
Physiographic Division:
Geomorphic Setting: on interfluve of None Assigned
Upslope Shape: convex
Cross Slope Shape:
Particle Size Control Section: 30 to 81 cm.
Description origin: Converted from SSL-CMS data
Diagnostic Features: ochric epipedon 0 to 20 cm.
argillic horizon 30 to 51 cm.
paralithic contact 203 to 254 cm.
Cont. Site ID: 91NC021001

State: North Carolina
County: Buncombe
MLRA: 130 -- Blue Ridge
Quad Name:
Latitude: 35 degrees 31 minutes 45.00 seconds north
Longitude: 82 degrees 34 minutes 12.00 seconds west
Primary Earth Cover: Crop cover
Bedrock Depth:
Bedrock Hardness:
Bedrock Fracture Interval:
Surface Fragments: 0.0 percent
Description database: NSSL
Pedon ID: 91NC021001

Ap--0 to 20 centimeters; reddish brown (5YR 4/4) fine sandy loam; weak medium granular structure; very friable, nonsticky, nonplastic; common very fine and fine roots between peds; common very fine and fine tubular pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; abrupt smooth boundary. (Lab sample # 92P0580).

BA--20 to 30 centimeters; red (2.5YR 4/8) clay loam; 11 percent medium distinct dark yellowish brown (10YR 4/6) and 11 percent fine faint yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine and fine roots between peds; many very fine and fine vesicular and common medium and coarse tubular pores; 15 percent discontinuous faint clay films on faces of peds and in pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0581).

Bt1--30 to 43 centimeters; red (2.5YR 4/6) clay; 1 percent fine faint yellowish red (5YR 4/6) mottles; moderate medium and coarse subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine and fine roots between peds; many very fine and fine vesicular and few medium and coarse tubular pores; 55 percent continuous faint clay films on faces of peds and in pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0582).

Bt2--43 to 71 centimeters; red (2.5YR 4/6) clay; 11 percent medium and coarse faint yellowish red (5YR 4/6) mottles; moderate medium and coarse subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine and fine roots between peds; many very fine and fine vesicular and few medium and coarse tubular pores; 55 percent continuous faint clay films on faces of peds and in pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0583).

BC--71 to 91 centimeters; red (2.5YR 4/6) clay loam; 1 percent medium faint dark reddish gray (2.5YR 3/1) and 1 percent medium distinct reddish yellow (7.5YR 6/8) mottles; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; few very fine and fine roots between peds; few very fine and fine tubular pores; 37 percent patchy faint clay films on faces of peds; 1 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0584). Quartz vein running through BC 1-4".

C1--91 to 114 centimeters; red (2.5YR 4/6) sandy loam saprolite; 11 percent medium and coarse prominent dark reddish gray (2.5YR 3/1) and 11 percent medium and coarse prominent olive yellow (2.5Y 6/8) mottles; massive;

very friable, nonsticky, nonplastic; few very fine and fine roots between peds; few very fine and fine tubular pores; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0585). Quartz vein running through C 1-4".

C2--114 to 185 centimeters; red (2.5YR 4/6) sandy loam saprolite; 11 percent medium and coarse prominent dark reddish gray (2.5YR 3/1) and 11 percent medium and coarse prominent olive yellow (2.5Y 6/8) mottles; massive; very friable, nonsticky, nonplastic; few very fine and fine roots between peds; few very fine and fine tubular pores; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0586). Quartz vein running through C 1-4".

C3--185 to 203 centimeters; multicolored sandy loam saprolite; massive; very friable, nonsticky, nonplastic; very fine and fine roots between peds; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog; clear irregular boundary. (Lab sample # 92P0587). Quartz vein running through C 1-4".

Cr--203 to 254 centimeters; multicolored weathered bedrock; very fine and fine roots between peds; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog. (Lab sample # 92P0588).

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled as : Hayesville ; Clayey, kaolinitic, mesic Typic Kanhapludult
Revised to correlated: Hayesville ; Fine, allitic, mesic Typic Kanhapludult

SSL - Project CP92NC019 MOUNTAIN SOILS - BUNCOMBE COUNTY
- Site ID 91NC021001 Lat: 35° 31' 45.00" north Long: 82° 34' 12.00" west MLRA: 130
- Pedon No. 92P0081
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
92P00580	Ap	AP	0-17				FSL	FSL
92P00581	BA	BA	17-30				CL	CL
92P00582	Bt1	BT1	30-44				C	C
92P00583	Bt2	BT2	44-72				C	C
92P00584	BC	BC	72-90				CL	SCL
92P00585	C1	C1	90-114				SL	FSL
92P00586	C2	C2	114-185				SL	LFS
92P00587	C3	C3	185-203				SL	LS
92P00588	Cr	CR	203-254					FSL
92P00589			114-185					

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.14	(NA)
Clay, carbonate free, Weighted Average	43	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	32	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	43	% wt
LE, Whole Soil, Summed to 1m	1	cm/m

Weighted averages based on control section: 17-67 cm

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay (Total) < .002	-2- Silt (Total) .002 -.05	-3- Sand (Total) .05 -2	-4- Fine Clay (Clay) < .0002	-5- CO_3 (Clay) < .002	-6- Fine Silt (Silt) .002 -.02	-7- Coarse Silt (Silt) .02 -.05	-8- VF Sand (Sand) .05 -.10	-9- F Sand (Sand) .10 -.25	-10- M Sand (Sand) .25 -.50	-11- C Sand (Sand) .5 -1	-12- VC Sand (Sand) 1 -2	-13- Rock Fragments (mm) Weight 2 -5	-14- Rock Fragments (mm) Weight 5 -20	-15- Rock Fragments (mm) Weight 20 -75	-16- Rock Fragments (mm) Weight .1-75	-17- >2 mm wt % whole soil
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
92P00580	0-17	Ap	S	19.2	25.1	55.7	7.3		16.4	8.7	16.1	28.2	8.5	1.8	1.1	3	6	--	45	9
92P00581	17-30	BA	S	39.0	17.9	43.1	17.7		12.9	5.0	10.6	23.0	7.8	1.2	0.5	tr	tr	--	33	
92P00582	30-44	Bt1	S	44.5	15.7	39.8	21.7		10.1	5.6	10.0	21.7	6.8	1.0	0.3	tr	tr	--	30	
92P00583	44-72	Bt2	S	43.4	13.5	43.1	22.1		7.9	5.6	9.8	21.8	8.4	2.1	1.0	tr	tr	--	33	
92P00584	72-90	BC	S	23.3	13.9	62.8	13.5		6.9	7.0	17.0	32.6	12.0	1.1	0.1	tr	tr	--	46	
92P00585	90-114	C1	S	15.7	16.9	67.4	8.8		8.0	8.9	17.6	36.7	10.7	1.4	1.0	2	8	--	55	10
92P00586	114-185	C2	S	3.9	14.9	81.2	2.5		7.3	7.6	19.9	38.5	15.9	4.8	2.1	1	tr	--	62	1
92P00587	185-203	C3	S	7.7	13.7	78.6	3.5		6.5	7.2	14.5	32.9	18.3	9.2	3.7	9	14	--	73	23
92P00588	203-254	Cr	S	6.7	20.8	72.5	3.6		10.7	10.1	18.9	24.2	13.7	9.7	6.0	3	3	17	64	23
92P00589	114-185		S													--	--	--		

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa	-2- (Bulk Density) Oven Dry	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- Water Content 10 kPa	-6- Water Content 33 kPa	-7- Water Content 1500 kPa	-8- Water Content 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- Ratio/Clay CEC7	-13- Ratio/Clay 1500 kPa
				(- - - g cm^{-3} - - -)			(- - - - - - - - - - - - % of < 2mm - - - - - - - - - - -)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a		4B5	4C1		8D1	8D1
92P00580	0-17	Ap	S	1.54	1.58	0.008			16.4	8.3		1.008	0.12		0.31	0.43
92P00581	17-30	BA	S	1.51	1.55	0.009			20.2	14.2		1.011	0.09		0.14	0.36
92P00582	30-44	Bt1	S	1.31	1.38	0.017			27.9	18.0		1.014	0.13		0.14	0.40
92P00583	44-72	Bt2	S	1.27	1.35	0.021			29.1	18.7		1.014	0.13		0.14	0.43
92P00584	72-90	BC	S	1.50	1.52	0.004			22.9	13.3		1.010	0.14		0.21	0.57
92P00585	90-114	C1	S	1.52	1.52	--			17.8	10.6		1.009	0.10		0.29	0.68
92P00586	114-185	C2	S	1.62	1.62	--			11.4	4.8		1.009	0.11		1.64	1.23
92P00587	185-203	C3	S	1.80	1.80	--			7.1	5.4		1.010	0.03		0.71	0.70
92P00588	203-254	Cr	S	1.40	1.40	--			16.0	7.2		1.011	0.11		0.97	1.07
92P00589	114-185		S							6.3						

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (Atterberg Limits) LL pct <0.4mm	-2- (Atterberg Limits) PI	-3- (Bulk Density) Field (g cm^{-3})	-4- (Bulk Density) Recon 33 kPa (g cm^{-3})	-5- (Bulk Density) Recon Oven Dry (g cm^{-3})	-6- (Water Content) Field (% of < 2mm)	-7- (Water Content) Recon 33 kPa (% of < 2mm)	-8- (Water Content) Sieved Samples 6 kPa (% of < 2mm)	-9- (Water Content) Sieved Samples 10 kPa (% of < 2mm)	-10- (Water Content) Sieved Samples 33 kPa (% of < 2mm)	-11- (Water Content) Sieved Samples 100 kPa (% of < 2mm)	-12- (Water Content) Sieved Samples 200 kPa (% of < 2mm)	-13- (Water Content) Sieved Samples 500 kPa (% of < 2mm)
															4B1a	
92P00580	0-17	Ap	S												11.7	
92P00581	17-30	BA	S												17.4	
92P00582	30-44	Bt1	S												19.2	
92P00583	44-72	Bt2	S												21.3	
92P00584	72-90	BC	S												15.6	
92P00585	90-114	C1	S												12.4	
92P00586	114-185	C2	S												7.3	
92P00587	185-203	C3	S												6.8	
92P00588	203-254	Cr	S												10.6	

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (Total) C (% of <2 mm)	-2- (Total) N (% of <2 mm)	-3- (Total) S (% of <2 mm)	-4- Org C (% of <2 mm)	-5- C/N Ratio	-6- (Dith-Cit Ext) Fe (% of < 2mm)	-7- (Dith-Cit Ext) Al (% of < 2mm)	-8- (Dith-Cit Ext) Mn (% of < 2mm)	-9- (Ammonium Oxalate Extraction) Al+½Fe (% of < 2mm)	-10- (Ammonium Oxalate Extraction) ODOE (% of < 2mm)	-11- (Ammonium Oxalate Extraction) Fe (% of < 2mm)	-12- (Ammonium Oxalate Extraction) Al (% of < 2mm)	-13- (Ammonium Oxalate Extraction) Si (% of < 2mm)	-14- (Ammonium Oxalate Extraction) Mn (mg kg^{-1})	-15- (Na Pyro-Phosphate) C (% of < 2mm)	-16- (Na Pyro-Phosphate) Fe (% of < 2mm)	-17- (Na Pyro-Phosphate) Al (% of < 2mm)	-18- (Na Pyro-Phosphate) Mn (% of < 2mm)
					6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9b	6G12b	6V2b	6D5b				
92P00580	0-17	Ap	S		0.091		1.13		2.7	0.4	tr	0.24	0.04	0.15	0.16	0.04	240.0				
92P00581	17-30	BA	S		0.035		0.37		5.8	0.6	tr	0.32	0.04	0.26	0.19	0.06	28.4				
92P00582	30-44	Bt1	S		0.030		0.29		5.2	0.7	--	0.40	0.05	0.36	0.22	0.07	--				
92P00583	44-72	Bt2	S		0.026		0.26		5.1	0.7	tr	0.37	0.04	0.36	0.19	0.06	--				
92P00584	72-90	BC	S				0.08		4.5	0.4	tr	0.25	0.04	0.28	0.11	0.06	17.8				
92P00585	90-114	C1	S				0.03		4.0	0.3	tr	0.19	0.03	0.22	0.08	0.05	65.7				
92P00586	114-185	C2	S				0.02		2.7	0.2	tr	0.10	0.03	0.14	0.03	0.04	198.3				
92P00587	185-203	C3	S				0.05		2.1	0.2	tr	0.12	0.03	0.14	0.06	0.05	317.7				
92P00588	203-254	Cr	S				0.02		3.2	0.3	0.1	0.20	0.05	0.22	0.09	0.06	723.8				
92P00589	114-185		S						1.9	0.2	0.2										

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)													
				(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	6D3b	5A3a	5A8b	5A3b	5G1	5C3	5C1
92P00580	0-17	Ap	S	2.1	0.6	0.1	--	2.8	3.7	0.1	1.0	6.5	5.9	2.9	3	43	47
92P00581	17-30	BA	S	2.4	0.9	0.1	--	3.4	2.2			5.6	5.4			61	63
92P00582	30-44	Bt1	S	3.0	0.9	0.1	--	4.0	3.5			7.5	6.3			53	63
92P00583	44-72	Bt2	S	2.7	0.9	0.1	--	3.7	4.7			8.4	6.2			44	60
92P00584	72-90	BC	S	1.2	0.5	0.1	--	1.8	5.2			7.0	4.8			26	38
92P00585	90-114	C1	S	0.5	0.4	tr	1.2	2.1	0.9			3.0	4.6			70	46
92P00586	114-185	C2	S	tr	0.1	tr	0.7	0.8	2.6			3.4	6.4			24	13
92P00587	185-203	C3	S	tr	0.1	tr	tr	0.1	3.8			3.9	5.5			3	2
92P00588	203-254	Cr	S	tr	0.2	tr	tr	0.2	2.4			2.6	6.5			8	3

Salt

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- Water Extracted From Saturated Paste -)																			
				(- - - - - mmol(+) L^{-1} - - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
92P00580	0-17	Ap	S																			2	
92P00581	17-30	BA	S																			2	
92P00582	30-44	Bt1	S																			2	
92P00583	44-72	Bt2	S																			2	
92P00584	72-90	BC	S																			2	
92P00585	90-114	C1	S																			--	
92P00586	114-185	C2	S																			--	
92P00587	185-203	C3	S																			--	
92P00588	203-254	Cr	S																			--	

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

pH & Carbonates				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - -)						(- - Carbonate - -) As $CaCO_3$		(- - Gypsum - - -) As $CaSO_4*2H_2O$		Resist
	Depth				$CaCl_2$ 0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl 8C1g	1:2 4C1a2a	1:1 4C1a2a	Paste	Sulf	NaF	(- - - - - - - - - - - - % - - - - - - - - - - - -)				cm^{-1}
92P00580	0-17	Ap	S	4.5	4.9	5.5								
92P00581	17-30	BA	S	5.3	5.6	6.1								
92P00582	30-44	Bt1	S	5.6	6.7	7.6								
92P00583	44-72	Bt2	S	5.5	6.2	7.1								
92P00584	72-90	BC	S	5.3	5.6	5.9								
92P00585	90-114	C1	S	5.2	5.6	6.1								
92P00586	114-185	C2	S	4.4	5.4	5.6								
92P00587	185-203	C3	S	4.6	5.2	5.4								
92P00588	203-254	Cr	S	4.6	5.4	6.0								

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray					Thermal				Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract	7A2i					7A4b				7C3								tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- % -)							mg g^{-1}	
92P00580	0-17	Ap	tcly	GI 4	KK 3	VR 2	GE 2	HE 1			KK 33	GI 24		27	11.2			0.3			
92P00581	17-30	BA	tcly	GI 5	KK 3	VR 2	GE 2	HE 2						34	14.3			0.3			
92P00582	30-44	Bt1	tcly	GI 4	KK 3	VR 2	GE 2	HE 2			KK 32	GI 30		34	14.3			0.2			
92P00583	44-72	Bt2	tcly	GI 4	KK 3	VR 2	GE 2	HE 2			GI 29	KK 27		35	15.7			0.2			
92P00584	72-90	BC	tcly	GI 3	KK 2	GE 2	VR 1	HE 1			GI 29	KK 28		35	17.2			0.4			
92P00587	185-203	C3	tcly	GI 2	KK 1						GI 21	KK 19		24	14.3			0.2			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GE - Goethite GI - Gibbsite HE - Hematite KK - Kaolinite VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray				Thermal						Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a					tion
Layer	(cm)	Horz	ion	(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00587	185-203	C3	fs										51	QZ 50	BT 36	OT 9	MS 4	OP 1	CA tr		

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite CA - Calcite MS - Muscovite OP - Opaques OT - Other

QZ - Quartz

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

Fine Earth Mineralogy (<2.0 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray				Thermal						Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract																	7D2	tion
Layer	(cm)	Horz	ion	(- - - - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00580	0-17	Ap	feth																	9.0	
92P00581	17-30	BA	feth																	18.0	
92P00582	30-44	Bt1	feth																	22.0	
92P00583	44-72	Bt2	feth																	22.0	
92P00584	72-90	BC	feth																	14.0	
92P00585	90-114	C1	feth																	11.0	
92P00586	114-185	C2	feth																	9.0	
92P00587	185-203	C3	feth																	7.0	
92P00588	203-254	Cr	feth																	9.0	

FRACTION INTERPRETATION:

feth - Fine Earth, <2 mm

MINERAL INTERPRETATION:

eg - Surface Area

BRADDOCK - PEDON DESCRIPTION – HIGH TERACE

Description Date: 8/4/2004
Describer: Robert H. Ranson, Jr. and Roger J. Leab
Site ID: 04NC097024-Braddock, TYP
Site Note:

Pedon ID: 04NC097024

Soil Name as Described/Sampled: Braddock
Soil Name as Correlated:

Classification: Fine, mixed, semiactive, mesic Typic Hapludults
Pedon Type: modal pedon for series
Pedon Purpose: full pedon description
Taxon Kind: series
Physiographic Division: Undesignated
Physiographic Province: Piedmont Province
Physiographic Section: Piedmont upland
State Physiographic Area:
Local Physiographic Area: Redmond Mountain
Geomorphic Setting: micro-high on toeslope of base slope of fan remnant
Upslope Shape: linear
Cross Slope Shape: linear
Particle Size Control Section: 24 to 74 cm.
Description origin: NASIS
Cont. Site ID: 04NC097024-Braddock, TYP

State: North Carolina
County: Iredell
MLRA:
Soil Survey Area: NC097 -- Iredell County, North Carolina
Map Unit: 234B -- Braddock and Clifford soils, 2 to 8 percent slopes
Latitude: 36 degrees 2 minutes 11.00 seconds north
Longitude: 80 degrees 58 minutes 12.80 seconds west
Datum: NAD83
UTM Zone: 17
UTM Easting:
UTM Northing:
Primary Earth Cover: Crop cover
Secondary Earth Cover: Close-grown crop
Existing Vegetation:
Parent Material: colluvium and slope alluvium
Bedrock Kind:
Bedrock Depth:
Bedrock Hardness:
Bedrock Fracture Interval:
Surface Fragments:
Description database: MLRA14_Office
Pedon ID: 04NC097024

Ap--0 to 24 centimeters; 95 percent dark yellowish brown (10YR 4/4) broken face sandy loam; 15 percent clay; 5 percent fine prominent irregular red (2.5YR 5/8) mottles; moderate medium and coarse granular structure; friable, nonsticky, nonplastic; low excavation difficulty; many very fine and fine roots throughout and many medium and coarse roots throughout; many fine high-continuity dendritic tubular and many very fine high-continuity dendritic tubular pores; 1 percent nonflat subangular indurated 2- to 75-millimeter metaquartzite fragments and 3 percent nonflat subrounded indurated 2- to 75-millimeter metaquartzite fragments; abrupt wavy boundary.

A/Btp--24 to 41 centimeters; 80 percent brown (7.5YR 5/4) broken face and 25 percent strong brown (7.5YR 5/8) broken face clay; 25 percent clay; 5 percent medium distinct irregular light yellowish brown (10YR 6/4) mottles; moderate medium granular, and weak coarse subangular blocky structure; friable, slightly sticky, nonplastic; low excavation difficulty; common very fine and fine roots throughout and common medium and coarse roots throughout; common very fine and fine moderate-continuity dendritic tubular and common medium moderate-continuity dendritic tubular and common coarse dendritic tubular pores; 40 percent discontinuous distinct clay films on all faces of peds; fine clay depletions and 5 percent medium and coarse prominent irregular strong brown (7.5YR 5/8), moist, iron depletions; 2 percent nonflat subrounded indurated 2- to 75-millimeter metaquartzite fragments; 5 to 30 percent krotovinas (volume percent); 10 to 60 percent krotovinas (lateral area percent); This horizon was originally called BA horizon, but after reviewing the photography it appears to be more of an A2 or AB horizon with a horizontally oriented tube or large krotovina with higher clay content with higher chroma and redder hue than the surrounding matrix. These may be old mole or vole burrows, old horizontal tree root channels, or may be related to some type of deep cultivation or land clearing activity. NASIS does not allow the option of naming a horizon AB/Bt at the time of this data input. It may be more correct to just call this an AB and let the Pedon Feature Table Krotovina suffice. This feature may not fit the accepted definition for "Krotovina". The 10YR 6/4 mottles

appear to be small remnants of an E horizon. They do not have enough continuity or thickness across the face of this pedon to consider a separate horizon. They might be enough to consider as a /E, but there is already a /Bt component which is more significant; clear wavy boundary.

Bt1--41 to 70 centimeters; 99 percent red (2.5YR 4/6) interior clay; 45 percent clay; moderate medium subangular blocky, and moderate fine subangular blocky structure; firm, moderately sticky, moderately plastic; low excavation difficulty; common very fine and fine roots between peds and common medium and coarse roots throughout; many very fine and fine high-continuity dendritic tubular and common medium high-continuity dendritic tubular pores; 80 percent continuous distinct clay films on all faces of peds; 10 percent medium and coarse prominent platy strong brown (7.5YR 5/8), moist, iron depletions; 2 percent nonflat subrounded indurated 2- to 50-millimeter metaquartzite fragments; gradual wavy boundary.

Bt2--70 to 102 centimeters; 98 percent red (2.5YR 4/8) interior clay; 50 percent clay; strong medium subangular blocky, and strong fine subangular blocky structure; firm, moderately sticky, moderately plastic; low excavation difficulty; common very fine and fine roots between peds and common medium roots between peds and few coarse roots between peds; many fine dendritic tubular and many medium dendritic tubular and many coarse dendritic tubular pores; 85 percent continuous distinct clay films on all faces of peds; prominent platy brownish yellow (10YR 6/8), moist, and pale yellow (2.5Y 7/4), moist, iron depletions and 1 percent fine distinct threadlike clay depletions with sharp boundaries on horizontal faces of peds; 1 percent nonflat subrounded indurated 2- to 50-millimeter metaquartzite fragments; clear wavy boundary.

Bt3--102 to 145 centimeters; 70 percent red (2.5YR 4/6) interior clay; 40 percent clay; moderate very thick platy parting to strong medium subangular blocky parting to strong fine subangular blocky structure; firm, moderately sticky, slightly plastic; low excavation difficulty; common fine and medium roots throughout and few coarse roots throughout; many fine and medium dendritic tubular and common coarse dendritic tubular pores; 90 percent continuous distinct clay films on all faces of peds; 2 percent fine prominent reticulate pinkish gray (7.5YR 7/2), moist, masses of reduced iron with sharp boundaries on surfaces along root channels and 5 percent fine and medium prominent reticulate pink (7.5YR 7/3), moist, iron depletions with clear boundaries on surfaces along root channels and 5 percent fine and medium distinct reticulate dark red (10R 3/6), moist, masses of oxidized iron with clear boundaries in matrix surrounding redox depletions and 15 percent fine and medium distinct reticulate pale yellow (2.5Y 7/4), moist, and brownish yellow (10YR 6/6), moist, and yellowish red (5YR 4/6), moist, clay depletions with clear boundaries in matrix; 1 percent flat well rounded indurated 2- to 50-millimeter metamorphic rock fragments and 2 percent nonflat angular indurated 2- to 75-millimeter metaquartzite fragments and 2 percent nonflat subrounded indurated 2- to 75-millimeter metaquartzite fragments and 3 percent nonflat well rounded indurated 2- to 75-millimeter metaquartzite fragments; 1 to 10 percent stone line (volume percent); 5 to 20 percent stone line (lateral area percent); clear wavy boundary.

2BCt1--145 to 185 centimeters; 60 percent red (2.5YR 5/8) interior sandy clay loam; 25 percent clay; 5 percent fine and medium distinct reticulate red (10R 4/6) and 10 percent medium and coarse prominent reticulate strong brown (7.5YR 5/6) and 25 percent fine and medium prominent irregular pinkish white (2.5YR 8/2) mottles; moderate very coarse subangular blocky parting to moderate coarse subangular blocky parting to moderate medium subangular blocky structure; friable, slightly sticky, nonplastic; low excavation difficulty; few very fine and fine roots throughout; common fine vesicular and common very fine vesicular pores; 70 percent continuous prominent clay films on all faces of peds; 3 percent fine platy mica flakes, unspecified with clear boundaries in matrix; 2 percent flat angular indurated 2- to 5-millimeter metamorphic rock fragments, (fragments in this horizon appear to be small blades of kyanite. The small mountains or foot hills in the immediate area are primarily gneiss and schist many of which contain kyanite crystals in addition to sillimanite. Local nearby geology maps refer to sillimanite quite often. Of course, the more common quartz, feldspar, and mica minerals are present in nearly all of these country rocks); gradual smooth boundary.

2BCt2--185 to 243 centimeters; 50 percent red (2.5YR 5/8) interior loam; 20 percent clay; 5 percent fine and medium distinct irregular yellowish red (5YR 5/6) and 10 percent fine and medium distinct irregular red (10R 4/6) and 20 percent fine and medium prominent irregular pinkish white (2.5YR 8/2) mottles; moderate very coarse subangular blocky parting to moderate coarse subangular blocky structure; friable, slightly sticky, nonplastic; low excavation difficulty; few very fine and fine roots throughout; common fine dendritic tubular and common very fine and fine vesicular pores; 30 percent discontinuous prominent clay films; 10 percent fine platy mica flakes, unspecified with clear boundaries in matrix; clear wavy boundary.

2CBt--243 to 260 centimeters; 60 percent red (10R 4/8) interior sandy clay loam saprolite; 20 percent clay; 5 percent medium and coarse prominent platy pink (5YR 7/4) and 15 percent medium and coarse distinct platy red (2.5YR 5/8) mottles; weak very coarse subangular blocky structure; friable, slightly sticky, nonplastic; low excavation difficulty; very few very fine roots top of horizon; few very fine and fine vesicular pores; 10 percent discontinuous distinct clay films on vertical faces of peds; 20 percent fine platy mica flakes, unspecified with clear boundaries in matrix.

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled as on Aug 02, 2004 : Braddock ; Fine, mixed, semiactive, mesic Typic Hapludult
Revised to :

SSL - Project C2004USNC189 Iredell Co.
- Site ID S04NC-097-024 Lat: 36° 2' 12.40" north Long: 80° 58' 12.90" west NAD83
- Pedon No. 04N1090
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
04N06082	A		0-24	S04NC-097-024-1	34		SL	FSL
04N06083	BA		24-41	S04NC-097-024-2	35		SCL	SCL
04N06084	Bt1		41-70	S04NC-097-024-3	36		C	CL
04N06085	Bt2		70-102	S04NC-097-024-4	37		C	C
04N06086	Bt3		102-145	S04NC-097-024-5	38		C	C
04N06087	2BCt1		145-185	S04NC-097-024-6	39		SCL	C
04N06088	2BCt2		185-243	S04NC-097-024-7	40		L	CL
04N06089	2BCt		243-260	S04NC-097-024-8	41		SCL	SCL

Pedon Calculations

Calculation Name	Result	Units of Measure
Weighted Particles, 0.1-75mm, 75 mm Base	37	% wt
Volume, >2mm, Weighted Average	1	% vol
Clay, total, Weighted Average	35	% wt
Clay, carbonate free, Weighted Average	35	% wt
CEC Activity, CEC7/Clay, Weighted Average, CECd, Set 1	0.11	(NA)
LE, Whole Soil, Summed to 1m	1	cm/m

Weighted averages based on control section: 24-74 cm

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled As : Braddock Fine, mixed, semiactive, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 04N1090

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay (Total)	-2- Silt (Total)	-3- Sand (Total)	-4- Fine Clay	-5- CO_3	-6- Fine Silt	-7- Coarse Silt	-8- VF Sand	-9- F Sand	-10- M Sand	-11- C Sand	-12- VC Sand	-13- 2-5 mm	-14- 5-20 mm	-15- 20-75 mm	-16- .1-75 mm	-17- >2 mm wt % whole soil
				< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	Rock Fragments (mm) Weight				
				% of <2mm Mineral Soil												% of <75mm				
				3A1a1a			3A1a1a		3A1a1a		3A1a1a	3A1a1a	3A1a1a	3A1a1a	3A1a1a					
04N06082	0-24	A	S	15.7	26.0	58.3	4.9		15.1	10.9	15.3	17.2	15.6	8.6	1.6	1	1	1	45	3
04N06083	24-41	BA	S	23.7	21.7	54.6	8.7		13.2	8.5	8.7	22.8	15.6	6.8	0.7	1	tr	--	46	1
04N06084	41-70	Bt1	S	38.8	21.4	39.8	16.1		13.6	7.8	8.0	15.3	11.2	4.6	0.7	2	tr	--	33	2
04N06085	70-102	Bt2	S	54.5	14.2	31.3	25.9		9.1	5.1	5.1	13.3	8.6	3.8	0.5	2	tr	--	28	2
04N06086	102-145	Bt3	S	49.6	22.0	28.4	22.8		17.7	4.3	5.8	8.1	7.2	6.5	0.8	1	tr	--	23	1
04N06087	145-185	2BCt1	S	40.2	24.3	35.5	19.1		18.7	5.6	9.5	11.6	7.6	6.0	0.8	1	--	--	27	1
04N06088	185-243	2BCt2	S	35.1	26.1	38.8	15.5		18.9	7.2	11.5	13.7	8.2	4.9	0.5	tr	--	--	27	tr
04N06089	243-260	2BCt	S	27.4	22.7	49.9	12.2		17.1	5.6	11.5	22.3	10.8	4.3	1.0	3	tr	--	40	3

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- Bulk Density 33 kPa	-2- Bulk Density Oven Dry	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- Water Content 10 kPa	-6- Water Content 33 kPa	-7- Water Content 1500 kPa	-8- Water Content 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- Ratio/Clay CEC7	-13- Ratio/Clay 1500 kPa
				(- - - g cm^{-3} - - -)			(- - - - - - - - - - - - % of < 2mm - - - - - - - - - - - -)						cm^3 cm^{-3}	%		
				DbWR1	DbWR1				DbWR1	3C2a1a		3D1				
04N06082	0-24	A	S	1.57	1.60	0.006			14.0	6.9		1.007	0.11		0.24	0.44
04N06083	24-41	BA	S	1.57	1.62	0.010			15.1	9.5		1.007	0.09		0.11	0.40
04N06084	41-70	Bt1	S	1.46	1.54	0.018			23.9	15.5		1.012	0.12		0.11	0.40
04N06085	70-102	Bt2	S	1.41	1.49	0.018			27.8	22.3		1.016	0.08		0.10	0.41
04N06086	102-145	Bt3	S	1.44	1.53	0.020			28.9	22.6		1.019	0.09		0.13	0.46
04N06087	145-185	2BCt1	S	1.45	1.53	0.018			28.7	20.6		1.017	0.12		0.16	0.51
04N06088	185-243	2BCt2	S	1.38	1.45	0.017			30.2	19.6		1.016	0.15		0.13	0.56
04N06089	243-260	2BCt	S	1.33	1.41	0.019			29.0	16.3		1.013	0.17		0.15	0.59

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled As : Braddock Fine, mixed, semiactive, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 04N1090

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- C	-2- N	-3- S	-4- Org C	-5- C/N Ratio	-6- Dith-Cit Ext Fe	-7- Al	-8- Mn	-9- Ammonium Oxalate Extraction Al+½Fe	-10- ODOE	-11- Fe	-12- Al	-13- Si	-14- Mn	-15- Na Pyro-Phosphate C	-16- Fe	-17- Al	-18- Mn
				(- - - - - Total - - - - -)					(- - - -)			(- - - - - -)						(- - - - - -)			
				% of <2 mm					% of < 2mm								mg kg^{-1}	% of < 2mm			
				4H2a	4H2a	4H2a			4G1	4G1	4G1		4G2a	4G2a	4G2a	4G2a	4G2a				
04N06082	0-24	A	S	1.12	0.08	0.01		14	1.3	0.2	--	0.13	0.04	0.07	0.10	--	61.8				
04N06083	24-41	BA	S	0.39	0.04	0.01		10	1.8	0.2	--	0.12	0.01	0.06	0.09	--	30.8				
04N06084	41-70	Bt1	S	0.47	0.03	0.01		16	2.9	0.4	tr	0.19	0.03	0.12	0.13	0.01	92.4				
04N06085	70-102	Bt2	S	0.24	0.02	0.03		10	4.3	0.5	--	0.21	0.02	0.15	0.13	0.02	10.3				
04N06086	102-145	Bt3	S	0.09	0.03	0.02		3	4.0	0.3	--	0.20	0.02	0.11	0.14	0.02	--				
04N06087	145-185	2BCt1	S	0.05	--	0.02			3.7	0.2	--	0.17	0.01	0.08	0.13	0.02	--				
04N06088	185-243	2BCt2	S	0.04	0.04	0.02		1	4.0	0.2	--	0.16	0.01	0.10	0.12	0.01	--				
04N06089	243-260	2BCt	S	0.04	0.01	0.01		3	3.1	0.2	--	0.14	0.01	0.08	0.10	0.01	--				

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)												(- - - - Base - - - -)	
				cmol(+) kg^{-1}							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - -)		
				4B1a1a	4B1a1a	4B1a1a	4B1a1a		4B2b1a	4B3a1a	4B3a1a		4B1a1a				
04N06082	0-24	A	S	0.4	0.1	--	0.1	0.6	8.2	1.0	0.6	8.8	3.7	1.6	63	7	16
04N06083	24-41	BA	S	0.2	tr	--	0.1	0.3	6.5	0.9	0.2	6.8	2.6	1.2	75	4	12
04N06084	41-70	Bt1	S	0.8	0.1	--	0.1	1.0	9.0	0.8	1.2	10.0	4.2	1.8	44	10	24
04N06085	70-102	Bt2	S	1.5	0.4	--	0.1	2.0	8.6	0.2	--	10.6	5.3	2.2	9	19	38
04N06086	102-145	Bt3	S	0.6	0.3	--	0.1	1.0	8.9	1.9	--	9.9	6.6	2.9	66	10	15
04N06087	145-185	2BCt1	S	0.2	0.2	--	0.1	0.5	8.6	2.4	--	9.1	6.4	2.9	83	5	8
04N06088	185-243	2BCt2	S	0.1	0.1	--	0.1	0.3	8.1	2.5	--	8.4	4.6	2.8	89	4	7
04N06089	243-260	2BCt	S	0.1	0.1	--	0.1	0.3	7.2	2.4	--	7.5	4.1	2.7	89	4	7

Salt

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- Water Extracted From Saturated Paste -)																			
				(- - - - - mmol(+) L^{-1} - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - - -)		%	
04N06082	0-24	A	S																			--	
04N06083	24-41	BA	S																			--	
04N06084	41-70	Bt1	S																			--	
04N06085	70-102	Bt2	S																			--	
04N06086	102-145	Bt3	S																			--	
04N06087	145-185	2BCt1	S																			--	
04N06088	185-243	2BCt2	S																			--	
04N06089	243-260	2BCt	S																			--	

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl	-2- $CaCl_2$ 0.01M 1:2	-3- H_2O 1:1	-4- Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4*2H_2O$ <2mm	-10- Gypsum As $CaSO_4*2H_2O$ <20mm	-11- Resist ohms cm^{-1}
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - -)						(- - - - - - - - - - - - % - - - - - - - - - - -)				
				4C1a2a3	4C1a2a	4C1a2a			4C1a1a1					
04N06082	0-24	A	S	4.1	4.2	4.8								
04N06083	24-41	BA	S	4.0	4.2	4.8								
04N06084	41-70	Bt1	S	4.1	4.4	5.0								
04N06085	70-102	Bt2	S	4.6	4.8	5.4								
04N06086	102-145	Bt3	S	4.2	4.3	5.2			9.5					
04N06087	145-185	2BCt1	S	4.1	4.2	5.0								
04N06088	185-243	2BCt2	S	4.2	4.2	5.0								
04N06089	243-260	2BCt	S	4.2	4.2	5.0								

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled As : Braddock Fine, mixed, semiactive, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 04N1090

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ %	-3- Acid Oxal (mg kg^{-1}) 4G2a	-4- Bray 1 (mg kg^{-1}) 4D3	-5- Bray 2 (mg kg^{-1})	-6- Olsen (mg kg^{-1})	-7- H_2O (mg kg^{-1})	-8- Citric Acid (mg kg^{-1})	-9- Mehlich III (mg kg^{-1})	-10- Extr NO_3 mg kg^{-1}
04N06082	0-24	A	S			72.1	13.0						
04N06083	24-41	BA	S			30.8	1.1						
04N06084	41-70	Bt1	S			51.3	0.4						
04N06085	70-102	Bt2	S			62.0	0.1						
04N06086	102-145	Bt3	S			61.5	tr						
04N06087	145-185	2BCt1	S			62.2	0.1						
04N06088	185-243	2BCt2	S			--	0.1						
04N06089	243-260	2BCt	S			--	0.2						

Trace Elements Tier 1

Layer	Depth (cm)	Horz	Prep	-1- Ag mg/kg 4H1a	-2- As mg/kg 4H1a	-3- Ba mg/kg 4H1a	-4- Be mg/kg 4H1a	-5- Cd mg/kg 4H1a	-6- Co mg/kg 4H1a	-7- Cr mg/kg 4H1a	-8- Cu mg/kg 4H1a	-9- Mn mg/kg 4H1a	-10- Mo mg/kg 4H1a	-11-	-12- Hg ug/kg 4H1a
04N06082	0-24	A	HM	--	2.46	50.08	0.61	--	4.37	16.88	3.70	131.44	--		27
04N06083	24-41	BA	HM	--	1.63	49.59	0.57	tr	3.95	21.50	4.67	91.62	--		26
04N06084	41-70	Bt1	HM	--	0.83	75.52	0.93	--	8.32	36.35	10.47	201.73	--		44
04N06085	70-102	Bt2	HM	0.01	--	42.75	0.66	--	4.60	39.08	10.20	78.33	--		96
04N06086	102-145	Bt3	HM	--	--	43.09	1.19	--	4.26	32.61	7.52	66.46	--		193
04N06087	145-185	2BCt1	HM	--	--	44.03	1.41	--	4.04	27.41	6.30	75.20	--		94
04N06088	185-243	2BCt2	HM	--	--	40.44	1.47	--	4.44	28.74	5.63	90.99	--		46
04N06089	243-260	2BCt	HM	--	--	38.80	1.17	--	3.92	22.57	5.41	90.91	--		29

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled As : Braddock Fine, mixed, semiactive, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 04N1090

Trace Elements Tier 2

Layer	Depth (cm)	Horz	Prep	-1- Ni mg/kg 4H1a	-2- P mg/kg 4H1a	-3- Pb mg/kg 4H1a	-4- Sb mg/kg 4H1a	-5- Se ug/kg 4H1a	-6- Sn mg/kg 4H1a	-7- Sr mg/kg	-8- Tl mg/kg	-9- V mg/kg 4H1a	-10- W mg/kg 4H1a	-11- Zn mg/kg 4H1a
04N06082	0-24	A	HM	5.66	261.43	14.64	--	448.26	--			31.59	0.87	19.04
04N06083	24-41	BA	HM	7.15	183.85	13.70	--	563.17	0.52			41.71	1.05	19.42
04N06084	41-70	Bt1	HM	13.07	274.53	31.21	--	863.93	0.53			79.82	1.88	33.71
04N06085	70-102	Bt2	HM	10.28	268.52	20.26	--	927.91	0.69			100.67	1.89	26.52
04N06086	102-145	Bt3	HM	8.93	303.61	25.12	--	1078.62	1.53			90.88	2.20	25.70
04N06087	145-185	2BCt1	HM	7.35	315.24	27.28	--	768.06	1.46			74.93	2.45	22.31
04N06088	185-243	2BCt2	HM	6.26	382.48	32.81	--	800.63	1.62			80.13	2.00	24.74
04N06089	243-260	2BCt	HM	5.35	274.23	32.76	--	744.62	1.45			64.98	1.78	23.22

Major Elements

Layer	Depth (cm)	Horz	Prep	-1- Al mg/kg 4H1b	-2- Ca mg/kg 4H1b	-3- Fe mg/kg 4H1b	-4- K mg/kg 4H1b	-5- Mg mg/kg 4H1b	-6- Mn mg/kg 4H1b	-7- Na mg/kg 4H1b	-8- P mg/kg 4H1b	-9- Si mg/kg 4H1b	-10- Sr mg/kg 4H1b	-11- Ti mg/kg 4H1b	-12- Zr mg/kg 4H1b
04N06082	0-24	A	HM	39974	842	15671	10413	787	250	744	289	36926	728	5614	252
04N06083	24-41	BA	HM	50987	759	21736	8354	875	245	616	256	27535	822	6379	222
04N06084	41-70	Bt1	HM	80892	802	36968	7166	1106	300	510	376	28641	322	7994	173
04N06085	70-102	Bt2	HM	105267	856	51761	4443	1022	207	336	356	27797	614	8214	151
04N06086	102-145	Bt3	HM	125508	665	49760	2096	913	124	101	380	228715	--	6174	114
04N06087	145-185	2BCt1	HM	96641	578	45598	2593	807	127	104	353	265848	--	5887	151
04N06088	185-243	2BCt2	HM	120691	566	53338	3854	1111	151	141	428	266933	--	6337	158
04N06089	243-260	2BCt	HM	124298	593	43295	4307	1311	155	153	401	265784	--	5328	158

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled As : Braddock Fine, mixed, semiactive, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 04N1090

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract			7A1a1					7A4a										tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
04N06082	0-24	A	tcly	KK 4	GI 2	VR 2	HE 1	QZ 1													CMIX
04N06084	41-70	Bt1	tcly	KK 4	GI 2	VR 2	HE 1	QZ 1			KK 52	GI 9									KAOL
04N06085	70-102	Bt2	tcly	KK 4	GI 2	VR 1	HE 1	GE 1			KK 33	GI 8									CMIX
				QZ 1																	
04N06087	145-185	2BCt1	tcly	KK 3	GI 1	HE 1															CMIX
04N06088	185-243	2BCt2	tcly	KK 3	GI 1	HE 1	QZ 1														CMIX

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GE - Goethite GI - Gibbsite HE - Hematite KK - Kaolinite QZ - Quartz

VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled As : Braddock Fine, mixed, semiactive, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 04N1090

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
																7B1a2					tion
				(--------- peak size --------)					(-------- % --------)				(----------------------- % -----------------------)						mg g^{-1}	
04N06082	0-24	A	fs										86	QZ 85	FK 13	MS 1	FE 1	OP tr	PR tr		SMIX
														ZR tr	AR tr	BT tr					
04N06084	41-70	Bt1	fs										91	QZ 89	FK 8	OP 1	FE 1	PR tr	VM tr		SILI
														ZR tr	MS tr	AR tr	BT tr				
04N06085	70-102	Bt2	fs										90	QZ 85	FK 7	FE 4	MS 2	OP 1	AR 1		SMIX
														BT 1	ZR tr	PR tr					
04N06086	102-145	Bt3	fs										42	QZ 38	MS 32	BT 24	FE 3	VM 2	OP 1		PMIC
														PR tr	FK tr	ZR tr					
04N06087	145-185	2BCt1	fs										31	MS 48	QZ 28	BT 20	FE 3	GS tr	OP tr		PMIC
														PR tr	VM tr						
04N06088	185-243	2BCt2	fs										18	BT 43	MS 38	QZ 17	FE 1	OP tr	VM tr		MICA
														ZR tr							

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

AR - Weatherable Aggregates BT - Biotite FE - Iron Oxides (Goethite FK - Potassium Feldspar GS - Glass

MS - Muscovite OP - Opaques PR - Pyroxene QZ - Quartz VM - Vermiculite-Mica

ZR - Zircon

*** Primary Characterization Data ***

Pedon ID: S04NC-097-024 (Iredell, North Carolina) Print Date: May 1 2011 8:55AM

Sampled As : Braddock Fine, mixed, semiactive, mesic Typic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 04N1090

INTERPRETATION (BY HORIZON):

MICA - Micaceous PMIC - Paramicaceous SILI - Siliceous SMIX - Mixed Sand

SAUNOOK PEDON DESCRIPTION – LOW TERRACE

Description Date: 9/1/1987

State: North Carolina

Describer: Robert Ranson, Ernest Hayhurst, Benny Brasher

County: Yancey

Site ID: 87NC199005

MLRA: 130 -- Blue Ridge

Soil Name as Described/Sampled: Saunook

Latitude: 35 degrees 53 minutes 34.00 seconds north

Soil Name as Correlated: Saunook

Longitude: 82 degrees 20 minutes 38.00 seconds west

Classification: Fine-loamy, mixed, active, mesic Humic Hapludults

Datum:

Physiographic Division:

Primary Earth Cover: Grass/herbaceous cover

Geomorphic Setting: on footslope of head slope of terrace--outwash or marine
on footslope of head slope of intermontane basin

Bedrock Depth:

Description origin: Converted from SSL-CMS data

Description database: NSSL

Diagnostic Features: ochric epipedon 0 to 23 cm.
argillic horizon 23 to 100 cm.

Cont. Site ID: 87NC199005

Pedon ID: 87NC199005

Ap--0 to 23 centimeters; dark brown (7.5YR 3/2) interior loam; moderate fine granular, and weak medium subangular blocky structure; very friable; many fine and very fine roots; many fine and medium tubular pores; common fine mica flakes; clear wavy boundary. (Lab sample # 87P4566).

Bt1--23 to 51 centimeters; brown (7.5YR 4/4) interior clay loam; weak fine granular, and moderate medium subangular blocky structure; friable; many fine and common very fine roots; many fine and medium tubular pores; 15 percent discontinuous faint clay films on faces of peds; common fine mica flakes; slightly acid, pH 6.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4567).

Bt2--51 to 77 centimeters; strong brown (7.5YR 4/6) interior clay loam; moderate fine subangular blocky, and moderate medium subangular blocky structure; friable; common fine and very fine roots; common fine and medium tubular pores; 37 percent discontinuous faint clay films on faces of peds; common fine mica flakes; neutral, pH 7.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4568).

Bt3--77 to 100 centimeters; strong brown (7.5YR 4/6) interior clay loam; moderate medium subangular blocky, and moderate medium angular blocky structure; friable; common fine and very fine roots; common fine and medium tubular pores; 37 percent discontinuous faint clay films on faces of peds and 37 percent discontinuous faint clay bridges between sand grains; common fine and medium mica flakes; slightly acid, pH 6.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4569).

BC1--100 to 124 centimeters; dark yellowish brown (10YR 4/6) interior loam; moderate medium subangular blocky, and moderate medium angular blocky structure; friable; common fine and very fine roots; common fine and medium tubular pores; 15 percent patchy faint clay films on faces of peds and 15 percent discontinuous faint clay bridges between sand grains; common fine and medium and few coarse mica flakes; moderately acid, pH 5.7, Hellige-Truog; gradual wavy boundary. (Lab sample # 87P4570).

BC2--124 to 144 centimeters; dark yellowish brown (10YR 4/4) interior sandy loam; weak medium subangular blocky structure; friable; common fine and very fine roots; few fine and medium tubular pores; 15 percent discontinuous faint clay bridges between sand grains; common fine, medium and coarse mica; moderately acid, pH 6.0, Hellige-Truog; clear wavy boundary. (Lab sample # 87P4571).

C--144 to 200 centimeters; dark yellowish brown (10YR 3/6) interior very cobbly sandy loam; massive; friable; common fine and very fine roots; few fine and medium tubular pores; many fine, medium, and common coarse mica; 5 percent by volume, 250- to 600-millimeter metamorphic rock fragments (stones) and 15 percent by volume,

75- to 250-millimeter metamorphic rock fragments (cobbles) and 10 percent by volume, 2- to 75-millimeter metamorphic rock fragments (gravels); moderately acid, pH 6.0, Hellige-Truog. (Lab sample # 87P4572).

*** Primary Characterization Data ***

Pedon ID: 87NC199005 — (Yancey, North Carolina) — Print Date: May 1 2011 8:58AM

Sampled as on Sep 01, 1987 : Saunook ; Fine-loamy, mixed, mesic Humic Hapludult
Revised to correlated on Dec 01, 1994 : Saunook ; Fine-loamy, mixed, active, mesic Humic Hapludult

SSL - Project CP87NC264 MOUNTIAN SOILS
- Site ID 87NC199005 Lat: 35° 53' 34.00" north Long: 82° 20' 38.00" west MLRA: 130
- Pedon No. 87P0828
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
87P04566	Ap	AP L	0-23					SCL
87P04567	Bt1	Bt1 CL	23-51					SCL
87P04568	Bt2	Bt2 CL	51-77					SCL
87P04569	Bt3	Bt3 CL	77-100					SCL
87P04570	BC1	BC1 L	100-124					SCL
87P04571	BC2	BC2 SL	124-144					COSL
87P04572	C	C SL	144-200					SL

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.41	(NA)
Clay, carbonate free, Weighted Average	26	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	47	% wt
Volume, >2mm, Weighted Average	3	% vol
Clay, total, Weighted Average	26	% wt
LE, Whole Soil, Summed to 1m	0	cm/m

Weighted averages based on control section: 23-73 cm

PSDA & Rock Fragments				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
																(- - - - - - - - Weight - - - - - - -)				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC					>2 mm
	Depth			< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	wt % whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - -)				soil
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
87P04566	0-23	Ap	S	20.4	21.1	58.5	4.7		15.9	5.2	8.0	16.4	14.2	11.9	8.0	5	2	--	54	7
87P04567	23-51	Bt1	S	25.4	21.8	52.8	9.1		16.8	5.0	7.6	15.6	12.8	9.9	6.9	4	1	--	48	5
87P04568	51-77	Bt2	S	27.8	21.8	50.4	10.6		17.4	4.4	8.0	14.7	12.0	9.0	6.7	5	1	--	46	6
87P04569	77-100	Bt3	S	27.7	19.3	53.0	11.5		15.8	3.5	8.3	15.4	12.4	10.2	6.7	3	2	--	47	5
87P04570	100-124	BC1	S	20.9	16.4	62.7	8.1		13.1	3.3	7.7	17.2	14.2	12.3	11.3	6	5	--	60	11
87P04571	124-144	BC2	S	15.7	11.9	72.4	7.1		8.4	3.5	7.7	18.8	15.8	14.1	16.0	6	4	--	68	10
87P04572	144-200	C	S	16.0	18.5	65.5	5.5		14.0	4.5	7.3	18.0	16.6	13.3	10.3	--	--	131	113	126

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:58AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa (- - - g cm^{-3} - - -) 4A1d	-2- Oven Dry	-3- Cole Whole Soil	-4- (- - - - - - - - - - - - Water Content - - - - - - - - - - - -) 6 kPa (- - - - - - - - - - - - % of < 2mm - - - - - - - - - - - -)	-5- 10 kPa	-6- 33 kPa 4B1c	-7- 1500 kPa 4B2a	-8- 1500 kPa Moist	-9- Ratio AD/OD 4B5	-10- WRD Whole Soil cm^3 cm^{-3} 4C1	-11- Aggst Stabl 2-0.5mm % 4G1	-12- (- - Ratio/Clay - -) CEC7 8D1	-13- 1500 kPa 8D1
87P04566	0-23	Ap	S	1.39	1.46	0.016			23.5	12.1		1.020	0.15	62	0.74	0.59
87P04567	23-51	Bt1	S	1.55	1.63	0.016			21.1	13.7		1.017	0.11		0.43	0.54
87P04568	51-77	Bt2	S	1.50	1.58	0.017			22.3	14.5		1.016	0.11		0.39	0.52
87P04569	77-100	Bt3	S	1.42	1.50	0.018			24.1	15.0		1.022	0.12		0.39	0.54
87P04570	100-124	BC1	S	1.44	1.48	0.009			20.2	13.0		1.018	0.10		0.44	0.62
87P04571	124-144	BC2	S	1.48	1.51	0.006			17.1	10.5		1.017	0.09		0.50	0.67
87P04572	144-200	C	S							10.4		1.015			0.41	0.65

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (- - Atterberg - -) (- - - Limits - - -) LL pct <0.4mm 4F1	-2- PI 4F	-3- (- - - - - Bulk Density - - - - -) Field (- - - - - - - - g cm^{-3} - - - - - -)	-4- Recon 33 kPa	-5- Recon Oven Dry	-6- (- Water Content -) Field (- % of < 2mm -)	-7- Recon 33 kPa	-8- (- - - - - - - - - - - - - - Sieved Samples - - - - - - - - - - - -) 6 kPa	-9- 10 kPa	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa	-13- 500 kPa
87P04566	0-23	Ap	S	38	11											
87P04567	23-51	Bt1	S	41	15											
87P04570	100-124	BC1	S	45	15											
87P04572	144-200	C	S	36	12											

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:58AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Carbon & Extractions

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				(- - - - - Total - - - - -)			Org	C/N	(- - - Dith-Cit Ext - - -)			(- - - - - - Ammonium Oxalate Extraction - - - - - -)						(- - - Na Pyro-Phosphate - - -)			
	Depth			C	N	S	C	Ratio	Fe	Al	Mn	Al+½Fe	ODOE	Fe	Al	Si	Mn	C	Fe	Al	Mn
Layer	(cm)	Horz	Prep	(- - - - - - % of <2 mm - - - - - -)					(- % of < 2mm - - - - - - - - - - - - - - - -)								mg kg^{-1}	(- - - - - - % of < 2mm - - - - -)			
					6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9a	6G12	6V2	6D5b				
87P04566	0-23	Ap	S		0.174		2.22	13	3.1	0.6	0.1	0.60	0.05	0.47	0.36	0.03	959.5				
87P04567	23-51	Bt1	S		0.042		0.38	9	3.9	0.6	0.1	0.48	0.06	0.47	0.24	0.04	565.5				
87P04568	51-77	Bt2	S		0.037		0.25	7	4.3	0.6	0.1	0.51	0.05	0.55	0.23	0.06	472.5				
87P04569	77-100	Bt3	S		0.034		0.22	6	4.5	0.6	0.1										
87P04570	100-124	BC1	S				0.14		3.9	0.6	tr	0.41	0.04	0.46	0.18	0.06	385.4				
87P04571	124-144	BC2	S				0.09		3.6	0.5	tr	0.42	0.04	0.49	0.17	0.05	426.3				
87P04572	144-200	C	S				0.15		2.7	0.4	tr	0.32	0.04	0.32	0.16	0.04	360.2				

CEC & Bases

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
	Depth			Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH_4 OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH_4OAC
Layer	(cm)	Horz	Prep	(- cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - - % - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9b		5A3a	5A8b	5A3b	5G1	5C3	5C1
87P04566	0-23	Ap	S	4.4	0.7	--	0.2	5.3	14.2	0.6		19.5	15.0	5.9	10	27	35
87P04567	23-51	Bt1	S	3.5	0.7	tr	tr	4.2	9.6			13.8	10.9			30	39
87P04568	51-77	Bt2	S	3.8	1.2	0.1	tr	5.1	7.6			12.7	10.8			40	47
87P04569	77-100	Bt3	S	3.0	1.7	tr	tr	4.7	7.7			12.4	10.7			38	44
87P04570	100-124	BC1	S	1.4	1.2	--	0.1	2.7	7.2	0.4		9.9	9.1	3.1	13	27	30
87P04571	124-144	BC2	S	1.1	1.0	--	0.1	2.2	5.9			8.1	7.8			27	28
87P04572	144-200	C	S	1.2	1.0	--	0.1	2.3	5.0			7.3	6.6			32	35

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:58AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Salt

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- - - - - - - Water Extracted From Saturated Paste - - - - - - -)																			
				(- - - - mmol(+) L^{-1} - - -)				(- - - - - - mmol(-) L^{-1} - - - - - -)										(- - - % - - -)		(- - dS m^{-1} - -)		%	
																		8A			8I	5D2	
87P04566	0-23	Ap	S																			--	
87P04567	23-51	Bt1	S																			--	
87P04568	51-77	Bt2	S																			1	
87P04569	77-100	Bt3	S																			--	
87P04570	100-124	BC1	S															59.5			0.01	--	
87P04571	124-144	BC2	S																			--	
87P04572	144-200	C	S																			--	

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl	-2- $CaCl_2$ 0.01M 1:2	-3- H_2O 1:1	-4- Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4*2H_2O$ <2mm	-10- Gypsum As $CaSO_4*2H_2O$ <20mm	-11- Resist ohms cm^{-1}
				(- - - - - - - - pH - - - - - - - -)						(- - - - - - - % - - - - - - -)				
				8C1g	4C1a2a	4C1a2a	8C1b							8E1
87P04566	0-23	Ap	S	4.3	4.8	5.2								
87P04567	23-51	Bt1	S	4.7	5.4	5.9								
87P04568	51-77	Bt2	S	4.7	5.5	6.0								
87P04569	77-100	Bt3	S	4.6	5.2	5.8								
87P04570	100-124	BC1	S	4.3	4.7	5.5	5.6							88000
87P04571	124-144	BC2	S	4.4	4.8	5.6								
87P04572	144-200	C	S	4.4	4.9	5.7								

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:58AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ	-3- Acid Oxal	-4- Bray 1	-5- Bray 2	-6- Olsen	-7- H_2O	-8- Citric Acid	-9- Mehlich III	-10- Extr NO_3
					(- - - - - - - Phosphorous - - - - - - -)								
					%	(- - - - - - - mg kg^{-1} - - - - - - -)							mg kg^{-1}
					6S4								
87P04566	0-23	Ap	S		43								
87P04567	23-51	Bt1	S		40								
87P04568	51-77	Bt2	S		43								
87P04570	100-124	BC1	S		45								
87P04571	124-144	BC2	S		33								
87P04572	144-200	C	S		33								

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:58AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray					Thermal				Elemental							EGME Retn	Interpretation
				7A2i					7A4b				SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O		
				7C3																	
				(- - - - - - - - - - peak size - - - - - -)					(- - - - - - - - - - %)				(- %)							mg g^{-1}	
87P04566	0-23	Ap	tcly	KK 3	VR 3	MI 1	GI 1	GE 1			KK 33	GI 4		22	12.9			0.9			
				HE 1																	
87P04567	23-51	Bt1	tcly	KK 3	VR 3	GE 2	HE 1	GI 1			KK 33	GI 3		25	14.3			0.9			
				MI 1	LE 1																
87P04570	100-124	BC1	tcly	KK 3	VR 2	GE 2	HE 1	GI 1			KK 36	GI 3		25	12.6			0.7			
				MI 1	LE 1																
87P04572	144-200	C	tcly	KK 3	VR 2	GE 2	GI 1	MI 1			KK 43	GI 3		26	10.0			0.8			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GE - Goethite GI - Gibbsite HE - Hematite KK - Kaolinite LE - Lepidocrocite

MI - Mica VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 87NC199005 (Yancey, North Carolina) Print Date: May 1 2011 8:58AM

Sampled As : Saunook Fine-loamy, mixed, mesic Humic Hapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 87P0828

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray					Thermal				Tot Re	Optical						EGME Retn	Interpretation
				7B1a																	
				(- - - - - - - - - - peak size - - - - - -)					(- - - - - - - - - - %)				(- %)							mg g^{-1}	
87P04567	23-51	Bt1	vfs										37	BT 50	QZ 30	MS 10	GE 4	OT 3	OP 3		
														FK tr	PO tr	RU tr	HN tr	FP tr	HE tr		
														ZR tr	GN tr						
87P04572	144-200	C	vfs										30	BT 56	QZ 21	MS 9	GE 7	OT 4	OP 2		
														FK tr	ZR tr	CA tr	FP tr	RU tr	GN tr		

FRACTION INTERPRETATION:

vfs - Very Fine Sand, 0.05-0.1 mm

MINERAL INTERPRETATION:

BT - Biotite CA - Calcite FK - Potassium Feldspar FP - Plagioclase Feldspar GE - Goethite

GN - Garnet HE - Hematite HN - Hornblende MS - Muscovite OP - Opaques

OT - Other PO - Plant Opal QZ - Quartz RU - Rutile ZR - Zircon

NIKWASI PEDON DESCRIPTION – FLOOD PLAIN

Description Date: 7/1/1986
Describer: D. Thomas
Site ID: 86NC113024
Soil Name as Described/Sampled: Nikwasi
Soil Name as Correlated:
Physiographic Section:
State Physiographic Area:
Geomorphic Setting: intermontane basin flood plain
Particle Size Control Section: 25 to 100 cm.
Description origin: Converted from SSL-CMS data
Diagnostic Features: umbric epipedon 0 to 85 cm.
cambic horizon 13 to 36 cm.

State: North Carolina
County: Macon
MLRA: 130 -- Blue Ridge
Latitude: 35 degrees 6 minutes 27.00 seconds north
Longitude: 83 degrees 13 minutes 47.00 seconds west
Existing Vegetation: eastern white pine, hemlock, sweet birch
Parent Material:
Bedrock Depth:
Surface Fragments:
Description database: NSSL

Oe--7 to 0 centimeters; black (10YR 2/1) interior mucky loam; 50 percent sand; 10 percent clay; moderate fine and medium granular, and moderate coarse and very coarse granular structure; very friable; many fine to coarse roots throughout; many fine to coarse tubular pores; 30 percent fine and medium platy mica flakes, unspecified; 5 percent by volume, 2- to 75-millimeter metamorphic rock fragments; very strongly acid, pH 4.7, Hellige-Truog; clear wavy boundary. (Lab sample # 86P4500).

A--0 to 13 centimeters; very dark grayish brown (10YR 3/2) interior loam, very dark grayish brown (10YR 3/2) crushed, dry; 50 percent sand; 8 percent clay; moderate medium and coarse subangular blocky structure; friable; common fine to coarse roots throughout; many fine to coarse tubular pores; 30 percent fine and medium platy mica flakes, unspecified; 5 percent by volume, 2- to 75-millimeter metamorphic rock fragments; very strongly acid, pH 5.0, Hellige-Truog; clear wavy boundary. (Lab sample # 86P4501).

Bw--13 to 36 centimeters; very dark brown (10YR 2/2) interior sandy loam, dark grayish brown (10YR 4/2) crushed, dry; 70 percent sand; 5 percent clay; massive; 30 percent fine and medium platy mica flakes, unspecified; 10 percent 2- to 75-millimeter metamorphic rock fragments; strongly acid, pH 5.3, Hellige-Truog; gradual wavy boundary. (Lab sample # 86P4502).

C1--36 to 67 centimeters; very dark gray (10YR 3/1) interior sandy loam, dark grayish brown (10YR 4/2) crushed, dry; 50 percent sand; 6 percent clay; massive; 30 percent fine and medium platy mica flakes, unspecified; 5 percent by volume, 2- to 75-millimeter metamorphic rock fragments; strongly acid, pH 5.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 86P4503).

C2--67 to 85 centimeters; very dark grayish brown (10YR 3/2) interior loamy sand; 50 percent sand; 2 percent clay; massive; 30 percent fine and medium platy mica flakes, unspecified; 5 percent 2- to 75-millimeter metamorphic rock fragments. (Lab sample # 86P4504).

2C--85 to 100 centimeters; dark grayish brown (10YR 4/2) interior very cobbly loamy sand. (Lab sample # 86P4505).

*** Primary Characterization Data ***

Pedon ID: 86NC113024 (Macon, North Carolina) Print Date: May 1 2011 9:03AM

Sampled as : Nikwasi - Like ; Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Cumulic Humaquept
Revised to correlated: Nikwasi ; Sandy, mixed, acid, mesic Cumulic Humaquept

SSL - Project CP86NC207 MOUNTAIN SOILS
- Site ID 86NC113024 Lat: 35° 6' 27.00" north Long: 83° 13' 47.00" west MLRA: 130
- Pedon No. 86P0744
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
86P04500	Oe	OE	7-0				L	
86P04501	A1	A1	0-13				L	FSL
86P04502	A2	A2	13-36				SL	LS
86P04503	A3	A3	36-67				SL	LS
86P04504	A4	A4	67-85				LS	COS
86P04505	C	C	85-100				LS	COS

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	2.12	(NA)
Clay, carbonate free, Weighted Average	4	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	85	% wt
Volume, >2mm, Weighted Average	18	% vol
Clay, total, Weighted Average	4	% wt

Weighted averages based on control section: 25-100 cm

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay < .002	-2- Total Silt .002-.05	-3- Total Sand .05-2	-4- Clay Fine < .0002	-5- CO_3 < .002	-6- Silt Fine .002-.02	-7- Silt Coarse .02-.05	-8- Sand VF .05-.10	-9- Sand F .10-.25	-10- Sand M .25-.50	-11- Sand C .5-1	-12- Sand VC 1-2	-13- Rock Fragments Weight 2-5	-14- Rock Fragments Weight 5-20	-15- Rock Fragments Weight 20-75	-16- Rock Fragments Weight .1-75	-17- >2 mm wt % whole soil
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1			3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
86P04500	7-0	Oe	S													--	--	--		
86P04501	0-13	A1	S	12.5	17.5	70.0			13.6	3.9	10.3	30.1	22.3	5.7	1.6	tr	tr	--	60	tr
86P04502	13-36	A2	S	6.3	13.6	80.1			10.6	3.0	8.7	28.4	24.5	12.9	5.6	2	3	--	73	5
86P04503	36-67	A3	S	4.7	9.1	86.2			7.8	1.3	7.2	28.8	32.9	14.1	3.2	2	1	--	80	3
86P04504	67-85	A4	S	2.6	3.7	93.7			2.8	0.9	4.6	22.5	32.7	24.9	9.0	10	4	--	91	14
86P04505	85-100	C	S	0.7	1.2	98.1			1.0	0.2	2.5	11.7	28.9	36.5	18.5	6	17	58	99	85

Bulk Density & Moisture				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(Bulk Density)		Cole	(- - - - - - - - - - - - Water Content - - - - - - - - - -)						WRD	Aggst		
				33	Oven	Whole	6	10	33	1500	1500 kPa	Ratio	Whole	Stabl	(- - Ratio/Clay - -)	
	Depth			kPa	Dry	Soil	kPa	kPa	kPa	kPa	Moist	AD/OD	Soil	2-0.5mm	CEC7	1500 kPa
Layer	(cm)	Horz	Prep	(- - - g cm^{-3} - - -)			(- - - - - - - - - - - - % of < 2mm - - - - - - - - - -)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a	4B2b	4B5	4C1		8D1	8D1
86P04500	7-0	Oe	S	0.39	0.52				85.8	50.2		1.052				
86P04500	7-0	Oe	M								128.8					
86P04501	0-13	A1	S	0.91	0.96	0.018			37.6	14.5		1.025	0.21		2.39	1.16
86P04502	13-36	A2	S	1.22	1.24	0.005			14.8	6.8		1.012	0.10		2.14	1.08
86P04503	36-67	A3	S	1.31	1.32	0.003			12.3	5.2		1.008	0.09		2.04	1.11
86P04504	67-85	A4	S	1.29	1.33	0.009			18.9	3.0		1.004	0.19		2.12	1.15
86P04505	85-100	C	S							0.9		1.001				

Water Content				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(- - Atterberg - -)		(- - - - - Bulk Density - - - - -)			(- Water Content -)							
				(- - - Limits - - -)		Field	Recon	Recon	Field	Recon	(- - - - - - - - - - - - - - Sieved Samples - - - - - - - - - - - - - -)					
	Depth			LL	PI		33 kPa	Oven Dry		33 kPa	6 kPa	10 kPa	33 kPa	100 kPa	200 kPa	500 kPa
Layer	(cm)	Horz	Prep	pct <0.4mm		(- - - - - - - - g cm^{-3} - - - - - - -)			(- % of < 2mm -)							
					4F											
86P04502	13-36	A2	S		NP											
86P04504	67-85	A4	S		NP											

Carbon & Extractions				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				(- - - - - Total - - - - -)			Org	C/N	(- - - Dith-Cit Ext - - -)			(- - - - - - Ammonium Oxalate Extraction - - - - - -)						(- - - Na Pyro-Phosphate - - -)			
	Depth			C	N	S	C	Ratio	Fe	Al	Mn	Al+½Fe	ODOE	Fe	Al	Si	Mn	C	Fe	Al	Mn
Layer	(cm)	Horz	Prep	(- - - - - - % of <2 mm - - - - - -)					(- % of < 2mm -)								mg kg^{-1}	(- - - - - - % of < 2mm - - - - - -)			
					6B3a		6A1c		6C2b	6G7a			8J	6C9a	6G12	6V2			6C8a	6G10	
86P04500	7-0	Oe	S		1.362		24.76		1.3	0.7											
86P04501	0-13	A1	S		0.309		7.34	24	1.1	0.8		1.22	0.68	0.78	0.83	0.02			0.8	1.1	
86P04502	13-36	A2	S		0.096		2.99	31	0.2	0.5		0.67	0.27	0.10	0.62	0.04			0.2	0.9	
86P04503	36-67	A3	S		0.074		2.28	31	0.1	0.3		0.43	0.18	0.03	0.41	0.04			0.1	0.7	
86P04504	67-85	A4	S				1.28		0.1	0.2		0.23	0.11	0.01	0.22	0.02			tr	0.4	
86P04505	85-100	C	S				0.24		0.2	0.1											

*** Primary Characterization Data ***

Pedon ID: 86NC113024 (Macon, North Carolina) Print Date: May 1 2011 9:03AM

Sampled As : Nikwasi - Like Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Cumulic Humaquept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0744

CEC & Bases				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
	Depth			Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH_4 OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH_4OAC
Layer	(cm)	Horz	Prep	(- cmol(+) kg^{-1} - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9b		5A3a	5A8b	5A3b	5G1	5C3	5C1
86P04500	7-0	Oe	S	7.2	3.2	0.3	1.7		101.9				79.0				
86P04501	0-13	A1	S	0.1	0.1	0.1	0.2	0.5	47.5	7.1		48.0	29.9	7.6	93	1	2
86P04502	13-36	A2	S	0.1	tr	0.1	tr	0.2	20.0	3.4		20.2	13.5	3.6	94	1	1
86P04503	36-67	A3	S	0.1	tr	0.2	tr	0.3	14.2	2.0		14.5	9.6	2.3	87	2	3
86P04504	67-85	A4	S	0.1	tr	0.1	tr	0.2	8.1	1.3		8.3	5.5	1.5	87	2	4
86P04505	85-100	C	S	0.1	--	0.2	tr	0.3	1.6	0.2		1.9	1.6	0.5	40	16	19

Salt				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
	Depth			Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
Layer	(cm)	Horz	Prep	(- - - - - mmol(+) L^{-1} - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
86P04501	0-13	A1	S																			tr	
86P04502	13-36	A2	S																			1	
86P04503	36-67	A3	S																			2	
86P04504	67-85	A4	S																			2	
86P04505	85-100	C	S																			13	

*** Primary Characterization Data ***

Pedon ID: 86NC113024 (Macon, North Carolina) Print Date: May 1 2011 9:03AM

Sampled As : Nikwasi - Like Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Cumulic Humaquept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0744

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl 8C1g	-2- $CaCl_2$ 0.01M 1:2 4C1a2a	-3- H_2O 1:1 4C1a2a	-4- pH Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm (%)	-8- Carbonate As $CaCO_3$ <20mm (%)	-9- Gypsum As $CaSO_4*2H_2O$ <2mm (%)	-10- Gypsum As $CaSO_4*2H_2O$ <20mm (%)	-11- Resist ohms cm^{-1}
86P0450	7-0	Oe	S	3.4	3.7	4.3								
86P0450	10-13	A1	S	4.0	4.1	4.3								
86P0450	13-36	A2	S	4.2	4.4	4.7								
86P0450	36-67	A3	S	4.3	4.5	4.8								
86P0450	67-85	A4	S	4.3	4.5	4.8								
86P0450	85-100	C	S	4.6	4.7	5.0								

Phosphorous

Layer	Depth (cm)	Horz	Prep	-1- Melanic Index	-2- NZ % 6S4	-3- Acid Oxal (mg kg^{-1})	-4- Bray 1 (mg kg^{-1})	-5- Bray 2 (mg kg^{-1})	-6- Olsen (mg kg^{-1})	-7- H_2O (mg kg^{-1})	-8- Citric Acid (mg kg^{-1})	-9- Mehlich III (mg kg^{-1})	-10- Extr NO_3 (mg kg^{-1})
86P0450	10-13	A1	S		69								
86P0450	13-36	A2	S		47								
86P0450	36-67	A3	S		38								
86P0450	67-85	A4	S		24								

*** Primary Characterization Data ***

Pedon ID: 86NC113024 (Macon, North Carolina) Print Date: May 1 2011 9:03AM

Sampled As : Nikwasi - Like Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Cumulic Humaquept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0744

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray 7A2i peak size	-2-	-3-	-4-	-5-	-6- Thermal 7A6 %	-7-	-8-	-9-	-10- Elemental 7C3 % SiO_2	-11- Al_2O_3	-12- Fe_2O_3	-13- MgO	-14- CaO	-15- K_2O	-16- Na_2O	-17- EGME Retn mg g^{-1}	-18- Interpretation
86P04502	13-36	A2	tcly	VR 2	GI 1	KK 1			KK 9	GI 1					3.1			0.7			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GI - Gibbsite KK - Kaolinite VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 86NC113024 (Macon, North Carolina) Print Date: May 1 2011 9:03AM

Sampled As : Nikwasi - Like Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Cumulic Humaquept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 86P0744

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray peak size	-2-	-3-	-4-	-5-	-6- Thermal %	-7-	-8-	-9-	-10- Optical Grain Count 7B1a % Tot Re	-11-	-12-	-13-	-14-	-15-	-16-	-17- EGME Retn mg g^{-1}	-18- Interpretation
86P04502	13-36	A2	fs										41	QZ 40	MS 23	BT 14	FK 11	FP 9	HN 2		
														OP 1	PO tr	TM tr	SP tr				
86P04505	85-100	C	fs										42	QZ 38	BT 23	MS 11	FK 11	FP 9	HN 5		
														OP 2	GN 1	SP 1	ZR tr				

FRACTION INTERPRETATION:

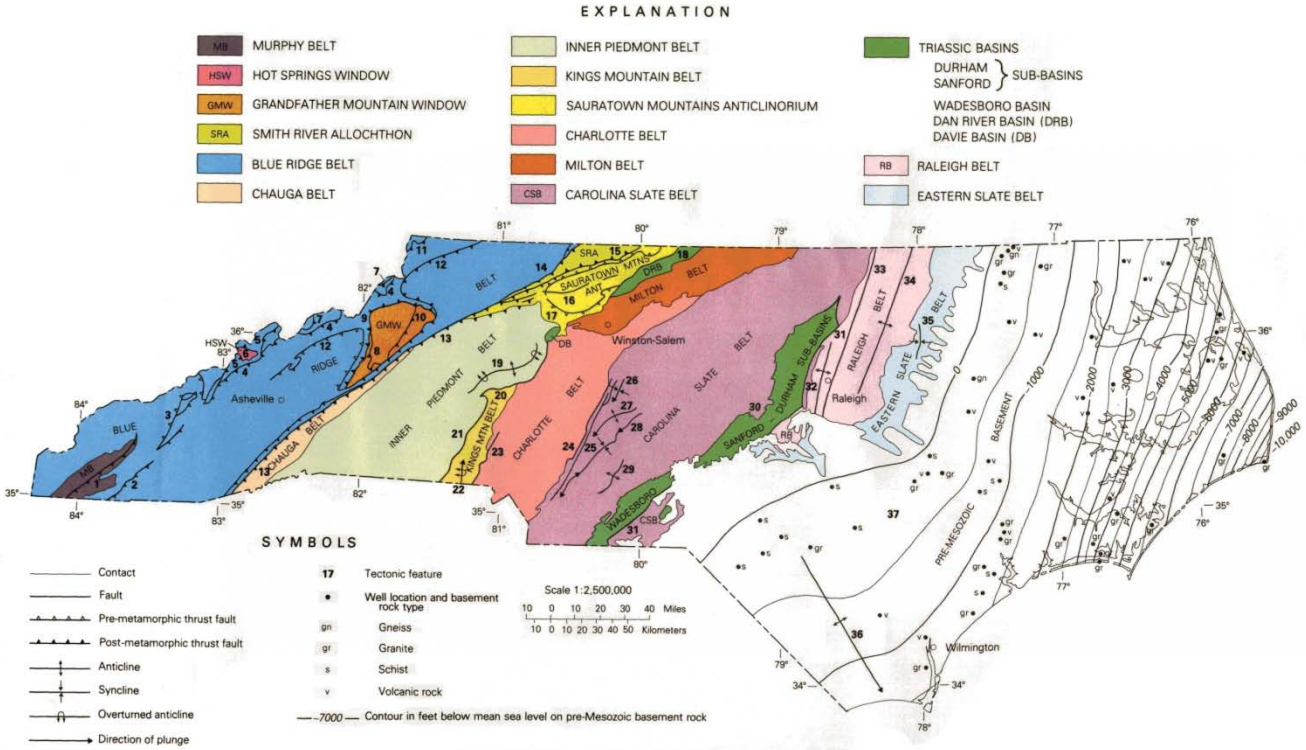
fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite FK - Potassium Feldspar FP - Plagioclase Feldspar GN - Garnet HN - Hornblende

MS - Muscovite OP - Opaques PO - Plant Opal QZ - Quartz SP - Sphene

TM - Tourmaline ZR - Zircon



MAP SHOWING MAJOR LITHO-TECTONIC FEATURES

1 Mary King Mountain fault

MAP SHOWING MAJOR LITHO-TECTONIC FEATURES

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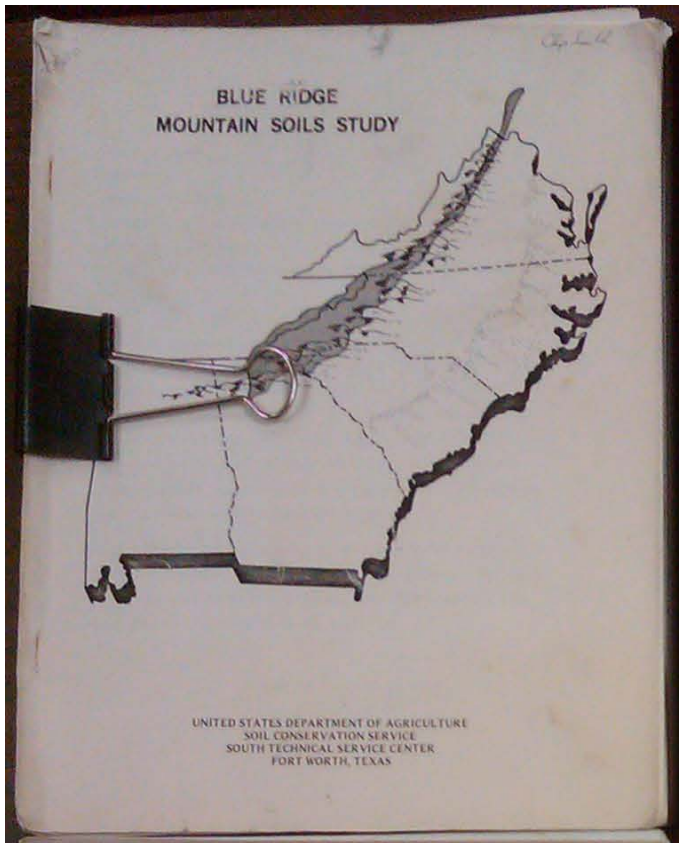
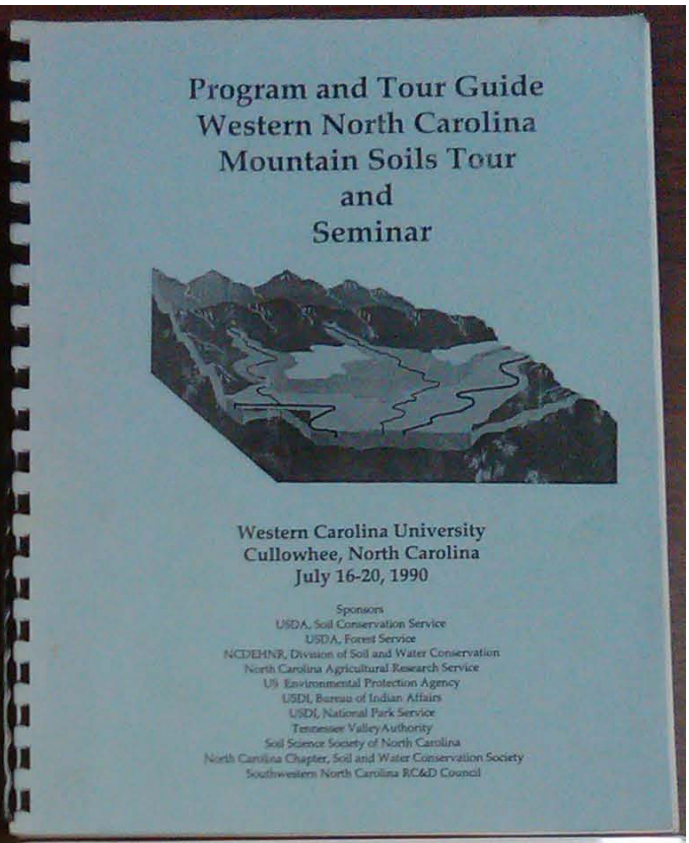
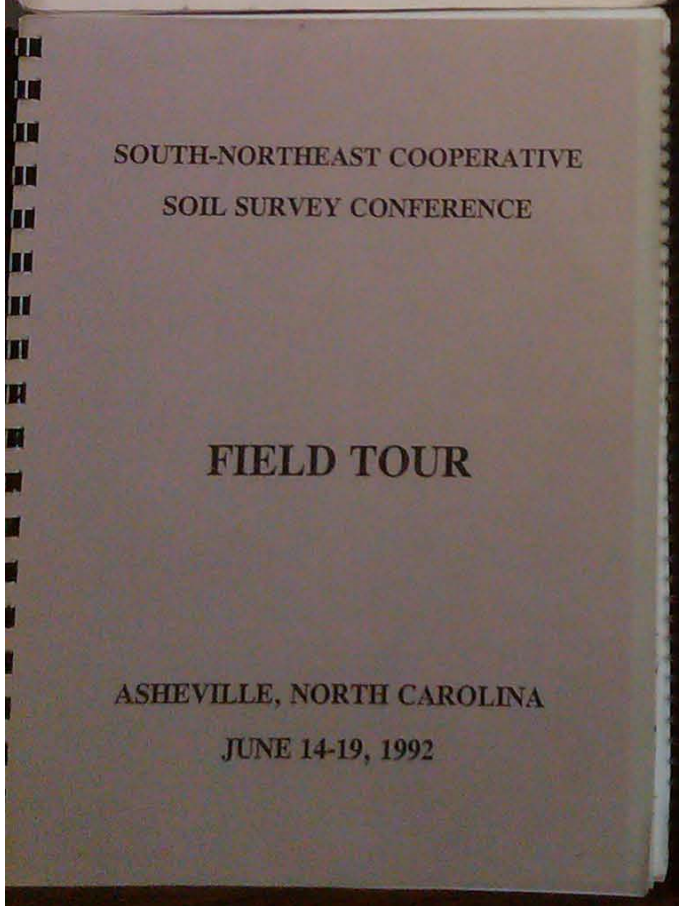
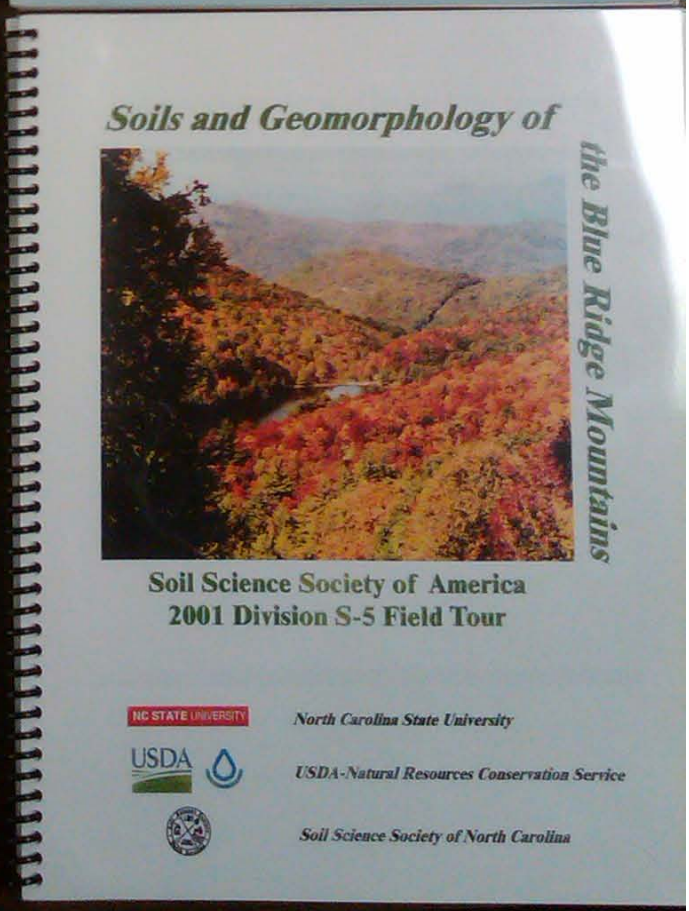

BLUE RIDGE
MOUNTAIN SOILS STUDY
UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
SOUTH TECHNICAL SERVICE CENTER
FORT WORTH, TEXAS


Program and Tour Guide
Western North Carolina
Mountain Soils Tour
and
Seminar
Western Carolina University
Cullowhee, North Carolina
July 16-20, 1990
Sponsors
USDA, Soil Conservation Service
USDA, Forest Service
NCDEHNR, Division of Soil and Water Conservation
North Carolina Agricultural Research Service
US Environmental Protection Agency
USDI, Bureau of Indian Affairs
USDI, National Park Service
Tennessee Valley Authority
Soil Science Society of North Carolina
North Carolina Chapter, Soil and Water Conservation Society
Southwestern North Carolina R/C&D Council


SOUTH-NORTHEAST COOPERATIVE
SOIL SURVEY CONFERENCE
FIELD TOUR
ASHEVILLE, NORTH CAROLINA
JUNE 14-19, 1992


Soils and Geomorphology of
the Blue Ridge Mountains
Soil Science Society of America
2001 Division S-5 Field Tour
NC STATE UNIVERSITY
North Carolina State University
USDA
USDA-Natural Resources Conservation Service
Soil Science Society of North Carolina

Midweek NCSS Conference Soil Tour
May 25, 2011

Mount Mitchell State Park

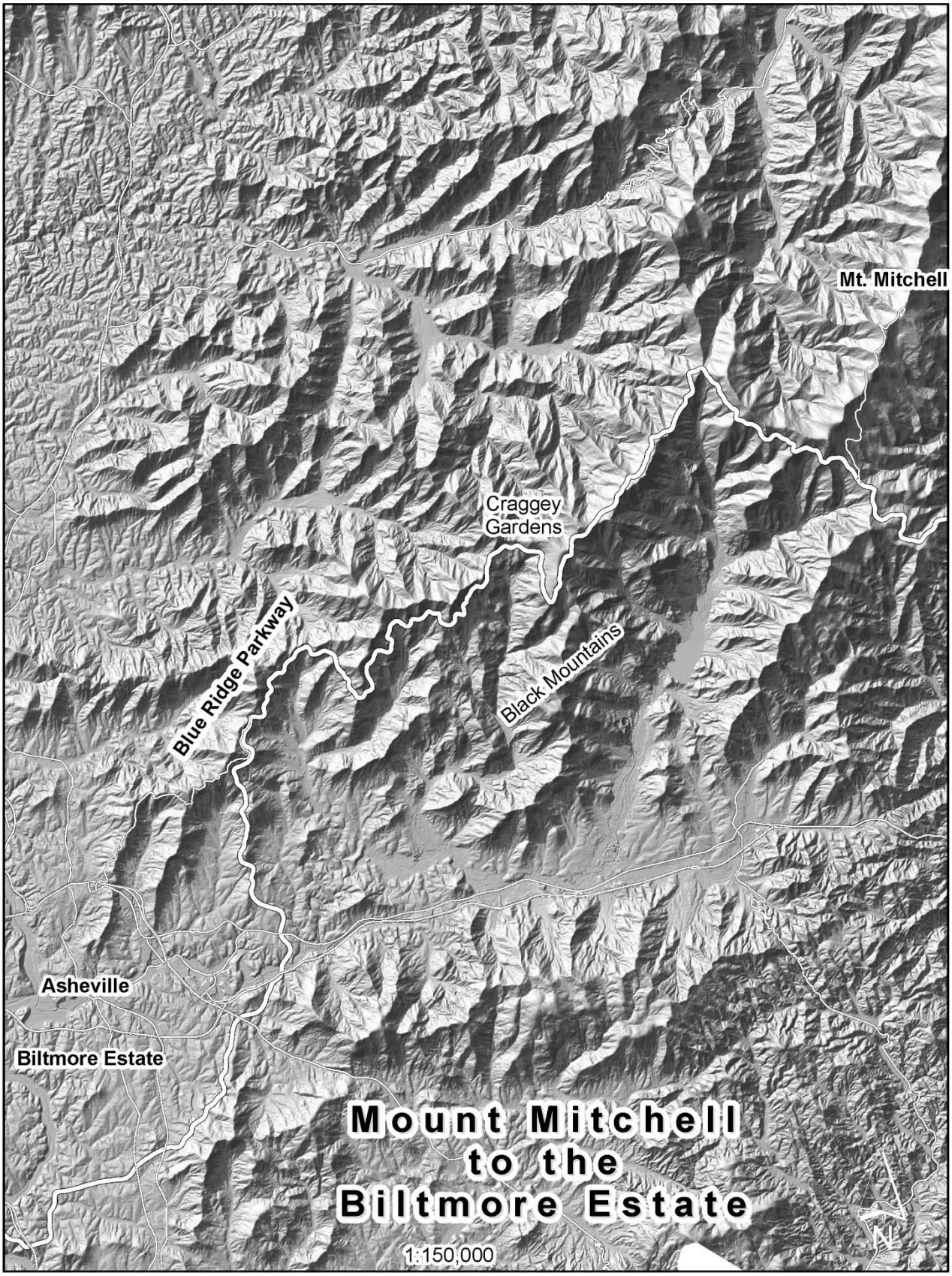
- Welcome – NCDENR Parks and Recreation
- On-site Wastewater Treatment and Dispersal – Steve Berkowitz and Karen Wallace, NCDENR Division of Water Quality
- Soils in Frigid Temperature Regime – Burton Series
- Acid Rain
- Ecological Sites – Michelle Clendenin, NRCS

Craggy Gardens

- Heath Balds – NRCS Staff
- Wayah Soils – Mark Hudson - NRCS

Biltmore Estate

- Biltmore Vineyard and Viticulture – Dennis Wynne, Biltmore and Dr. John Havlin, NC State University
- Hayesville (Clifton) Soils – Mark Hudson, NRCS
- Iotla Soils – Chip Smith, NRCS
- Overview – Curt Horn, Grounds Manager, Biltmore


Mt. Mitchell
Craggey
Gardens
Blue Ridge Parkway
Black Mountains
Asheville
Biltmore Estate
Mount Mitchell
to the
Biltmore Estate
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Blue Ridge Parkway

The Blue Ridge Parkway is a National Parkway and All-American Road in the United States, noted for its scenic beauty. It runs for 469 miles (755 km), mostly along the famous Blue Ridge, a major mountain chain that is part of the Appalachian Mountains. Its southern terminus is on the boundary between Great Smoky Mountains National Park and the Cherokee Indian Reservation in North Carolina, from which it travels north to Shenandoah National Park in Virginia and offers access to the Skyline Drive, the major north/south artery through the Park. The two All-American Byways are separate and distinct. The Blue Ridge Parkway was built to connect Shenandoah National Park to the Great Smoky Mountains National Park.

The Parkway is not a National Park, but is a National Scenic Byway and All-American Road, and is the most visited unit in the United States National Park System. Land on either side of the road is maintained by the National Park Service and, in many places, the park is bordered by land protected by the United States Forest Service. The Parkway will be depicted on North Carolina's version of the America the Beautiful quarter in 2015.

History

Begun during the administration of U.S. president Franklin D. Roosevelt, the project was originally called the Appalachian Scenic Highway. Most construction was carried out by private contractors under federal contracts under an authorization by Harold L. Ickes in his role as federal public works administrator. Work began on September 11, 1935, near Cumberland Knob in North Carolina; construction in Virginia began the following February. On June 30, 1936, Congress formally authorized the project as the Blue Ridge Parkway and placed it under the jurisdiction of the National Park Service. Some work was carried out by various New Deal public works agencies. The Works Progress Administration did some roadway construction. Crews from the Emergency Relief Administration carried out landscape work and development of parkway recreation areas. Personnel from four Civilian Conservation Corps camps worked on roadside cleanup, roadside plantings, grading slopes, and improving adjacent fields and forest lands. During World War II, the CCC crews were replaced by conscientious objectors in the Civilian Public Service program.

Construction of the parkway took over 52 years to complete, the last stretch (near the Linn Cove Viaduct) being laid around Grandfather Mountain in 1987. The Blue Ridge Parkway tunnels were constructed through the rock—one in Virginia and twenty-five in North Carolina. Sections of the parkway near the tunnels are often closed in winter. (Due to dripping groundwater from above, freezing temperatures, and the lack of sunlight, ice often accumulates inside these areas even when the surrounding areas are above freezing.) The highest point on the parkway (south of Waynesville, near Mount Pisgah in North Carolina) is 6053 feet or 1845 m above sea level (AMSL) on Richland Balsam Mountain at Milepost 431, and is often closed from November to April due to inclement weather such as snow, fog, and even freezing fog from low clouds. The parkway is carried across streams, railway ravines and cross roads by 168 bridges and six viaducts.

The parkway runs from the southern terminus of Shenandoah National Park's Skyline Drive in Virginia at Rockfish Gap to U.S. Route 441 at Oconaluftee in the Great Smoky Mountains National Park near Cherokee, North Carolina. There is no fee for using the parkway; however commercial vehicles are prohibited without approval from the Park Service Headquarters, near Asheville, North Carolina. The roadway is not maintained in the winter, and sections which pass over especially high elevations and through tunnels are often impassable and therefore closed from late fall through early spring. Weather is extremely variable in the mountains, so conditions and closures often change rapidly. The speed limit is never higher than 45 mph (70 km/h) and lower in some sections.

The parkway uses short side roads to connect to other highways, and there are no direct interchanges with interstate highways, making it possible to enjoy wildlife and other scenery without stopping for cross-traffic. Mileposts along the parkway start at zero at the northeast end in Virginia and count to 469 at the southern end in North Carolina. The mileposts can be found on the west side of the road. Major towns and cities along the way

include Waynesboro, Roanoke, and Galax in Virginia; and in North Carolina, Boone and Asheville, where it runs across the property of the Biltmore Estate. The Blue Ridge Music Center (also part of the park) is located in Galax, and Mount Mitchell (the highest point in eastern North America) is only accessible via a state road from the parkway at milepost 355.4.

Flowering shrubs and wildflowers dominate the parkway in the spring, including rhododendrons and dogwoods, moving from valleys to mountains as the cold weather retreats. Smaller annuals and perennials such as the daisy and aster flower through the summer. Brilliant autumn foliage occurs later in September on the mountaintops, descending to the valleys by later in October. Often in early to middle October and middle to late April, all three seasons can be seen simply by looking down from the cold and windy parkway to the green and warm valleys below. October is especially dramatic, as the colored leaves stand out boldly and occur mostly at the same time, unlike the flowers.

Major trees include oak, hickory, and tulip tree at lower elevations and buckeye and ash in the middle, turning into conifers such as fir and spruce at the highest elevations on the parkway. Trees near ridges, peaks, and passes (often called gaps or notches) are often distorted and even contorted by the wind, and persistent rime ice deposited by passing clouds in the winter.

Linn Cove Viaduct

Linn Cove Viaduct is a 1243-foot concrete segmental bridge which snakes around the slopes of Grandfather Mountain in North Carolina. It was completed in 1983 at a cost of $10 million and was the last section of the Blue Ridge Parkway to be finished. It is said to be the most complicated concrete bridge ever built.

The viaduct was needed because of the damage that a traditional cut-and-fill road would have caused to Grandfather Mountain. The viaduct was designed by Figg and Muller Engineers, Inc.; construction began in 1979. It is 1,243 feet long and consists of 153 segments weighing 50 tons each. The bridge's segments were precast at an indoor facility at the south side of the parkway. After being transported to the bridge site, each section was lowered into place by a custom crane placed on either edge of the existing structure. The only work done at ground level was drilling for the seven footings which support the viaduct. In particular, there was no access road other than the Blue Ridge Parkway itself. The bridge has received eleven design awards.

Mount Mitchell State Park

There are a few places in the world that still stand apart from the ordinary. Rising more than a mile high, surrounded by the gentle mist of low-hanging clouds, Mount Mitchell State Park is one of these extraordinary places.

In the Black Mountains lies the summit of Mount Mitchell, (elevation 6,684 feet) is the highest point east of the Mississippi. It is located about 35 miles northeast of downtown Asheville in the 1,946-acre Mount Mitchell State Park. The nearest higher point east of the Rocky Mountains is Harney Peak in the Black Hills of South Dakota, at 7,244 feet (2,208 m)- Forested and forever misty, 1,946-acre Mount Mitchell State Park will provide you with some of the most tranquil moments you'll ever experience.

History of Mount Mitchell State Park

More than a billion years ago, the Black Mountains were formed. This mighty range of peaks once stood lofty and rugged. But over millions of years, wind, water and other forces wore down the pinnacles to their rounded, more subdued profile of today. Only the erosion-resistant igneous and metamorphic rocks allowed Mount Mitchell to retain its dramatic height of 6,684 feet.

Because of the even elevation of its ridgeline, the Black Mountain range was referred to as a single mountain until the late 1850s. Of the separate peaks that have since been designated, six are among the ten highest in the eastern United States. Although the Black Mountain range is higher, its length and breadth do not equal that of the nearby Blue Ridge or Great Smoky mountains. From the air, the range bears the shape of the letter J, and the distance between its end points — Yeates Knob and Celo Knob — is merely 15 miles.

The climate of the Black Mountains is more like that of Canada than North Carolina. Extremely cold temperatures during the Pleistocene Era allowed the plants and animals of more northern latitudes to extend their ranges to the south, but as warmer climates returned, these cold-adapted species became restricted to the highest peaks. Therefore, many of the plants and animals of Mount Mitchell are much like those native to more northern alpine environments.

Long before explorers left Europe in search of the New World, various Native American tribes inhabited the area surrounding the Black Mountains. In the mid-1700s, the tribes were joined by settlers primarily of Scotch-Irish and English origin.

In 1787, French botanist Andre Michaux journeyed to the Black Mountains to seek the region's most valuable plants so the French government could cultivate them on their royal plantations. On his botanical excursions to the area, Michaux collected more than 2,500 specimens of trees, shrubs and other plants. About the same time that his French counterpart explored the area, Englishman John Fraser collected plants from the region to introduce to his native land. It was for this botanical explorer that the most abundant tree along the crest of the Black Mountains — the Fraser fir — was named.

Though botany was the first discipline to be explored in the Black Mountains, it was physical geography, particularly the measuring of mountains that had the greatest impact on the history of Mount Mitchell. In 1835, Dr. Elisha Mitchell, a science professor at the University of North Carolina, made an excursion to the area to measure the mountain elevations. At the time, Grandfather Mountain was assumed to be the highest point in the region, but previous trips to the area had persuaded Mitchell that the Black Mountains were higher. Through the use of barometric pressure readings and mathematical formulas, Mitchell figured the highest elevation of the range to be 6,476 feet, higher than that of Grandfather Mountain. Subsequent visits to the Black Mountains in 1838 and 1844 led Dr. Mitchell to calculate the height of the peak at 6,672 feet — amazingly, only a mere 12 feet in error of modern calculations.

In the 1850s, controversy arose about which peak in the range was the highest. Thomas Clingman, a former student of Dr. Mitchell's, and a United States senator, set the elevation of the highest peak at 6,941 feet and insisted that Mitchell had measured another peak. In 1857, Dr. Mitchell returned to the Black Mountains to verify his measurements and to support his claim. While hiking across the mountain, he fell from a cliff above a 40-foot waterfall. Knocked unconscious by the fall, Dr. Mitchell drowned in the water below. In honor of his work, the highest peak in the Black Mountain range was given his name in 1858. Though originally buried in Asheville, Mitchell's body was reburied atop Mount Mitchell a year later.

Until the late 1800s, the Black Mountains remained largely in a wilderness state. The only apparent influence of man upon the environment was a reduced animal population caused by increased settlement and hunting. This lack of exploitation of natural resources was not to last, however. By the early 1900s, extensive logging operations had denuded much of the Black Mountain range. Logging activity had expanded rapidly by 1913 and citizens began to voice their alarm about the destruction of the forest. Foremost among them was Locke Craig, governor of North Carolina from 1913 to 1917.

In 1915, a bill was introduced in the state legislature establishing Mount Mitchell as the first state park. The legislation passed both houses quickly and on March 3, 1915, the North Carolina State Parks System came into being. In appreciation of Governor Craig's efforts, the second highest peak east of the Mississippi, with an elevation of 6,647 feet and also in North Carolina, was named Mount Craig.

http://www.ncparks.gov/Visit/parks/momi/history.php

The Cradle of Forestry in America: Window to Our Forest Heritage

Nestled below the Blue Ridge Parkway near Mt. Pisgah is a unique historic site - the Cradle of Forestry in America. The Cradle is a place of people and nature, history and the future. The story of the birth of forestry in America is told here through exhibits in the Cradle's Forest Discovery Center, guided tours along historic trails, and interpretive programs.

To grasp the significance of this story, imagine the Western North Carolina mountains of the late 1800's. Heavily wooded slopes were interspersed with farms cut out of the forests. Immigrants looking for land to settle had pushed deep into mountain coves, where fragile soils soon eroded under continual subsistence farming.

Meanwhile, railroads connecting Asheville to cities to the east and north brought tourists, journalists, health-seekers, and investors to the scenic mountains. Investors bought huge tracts of land for timber cutting, some as large as 300,000 acres of virgin chestnut, oak, yellow poplar, spruce and hemlock.

Then in 1889, against the backdrop of virgin forest, eroded slopes, and abandoned farms, George W. Vanderbilt began to purchase land in Asheville as a site for his Biltmore House. Vanderbilt hired a young forester, Gifford Pinchot, to manage this estate of more than 8,000 acres, and to restore the abused and farmed-over land. Vanderbilt later expanded his estate to include an 80,000-acre tract of land extending to the slopes under Mount Pisgah. He named this area Pisgah Forest.

Dr. Carl Alwin Schenck succeeded Pinchot as Vanderbilt's forester in 1895, and for the next 14 years Schenck focused all his innovative forestry skills on transforming the woodlands that we know today as Pisgah National Forest.

The estate became a magnet for young men wishing to learn this new forestry, and in 1898 Schenck began the first forestry school in America, the Biltmore Forest School. Winter classes were held at the Biltmore Estate near Asheville, and summer sessions were held in Pisgah Forest. The "campus" at Biltmore Forest School consisted of mountaineer cabins and farm homes that had been part of a small community in the Pink Beds valley. The one-room community school and church became the forestry school's classroom.

Students at the Biltmore Forest School received field training in timber sale planning, erosion control, tree planting, sawmill and tanbark operations, and other aspects of forestry using the best knowledge the profession had at the time. Students learned to use care, concern, and scientific methods in the intelligent use of forests, and they came to know an equal care and concern for their protection and preservation for future generations.

Schenck left Vanderbilt in 1909, and took his school to new locations such as Sunburst, NC, Cadillac, Michigan, and overseas in Germany. The Biltmore Forest School graduated its last class in 1913.

George W. Vanderbilt died in 1914, and his widow, Edith, sold the family's land to the US government. It became part of Pisgah National Forest the same year. Congress established the 6,500-acre Cradle of Forestry in America as a historic site in 1968 to commemorate the beginning of forestry and forest education in the United States.

Dr. Schenck closed his autobiography, entitled Cradle of Forestry in America, with a tribute to Edith Vanderbilt who sold Pisgah Forest "so that the millions of Americans, be they foresters or not, who through the years frequent their hills and vales may draw inspiration from their beauty and some lessons from our pioneer forestry work."

The Cradle of Forestry is located 14 miles from Brevard on NC Highway 276 in the Pisgah National Forest. It is operated through a partnership between the US Forest Service and the Cradle of Forestry in America Interpretive Association. Together these organizations work to provide something at the Cradle for all ages to enjoy while learning about forests and the role they play in daily life. For more information about the site and programs please call 828-877-3130 or visit www.cradleofforestry.org.

A century ago, Congress passed legislation that enabled the U.S. Forest Service to purchase land and created the foundation for cooperative agreements with non-federal forest owners. Signed into law by President William Howard Taft on March 1, 1911, the Weeks Forest Purchase Act represented years of efforts by public and private advocates who wished to see Eastern forestlands come under Forest Service protection. By purchasing forests across the U.S., the Weeks Act allowed the national forest system to become truly national.

Just as significantly, the Act provided federal matching funds for state forestry programs for the first time. The matching funds for non-federal programs marked the beginning of a new era in cooperation that extended federal forest management policies beyond national forest boundaries that continues today. The Weeks Act provided the statutory foundation for cooperation and forest restoration work that remain key elements of our agency's current emphasis on forest ecosystem management.

Curtis Creek, approximately 25 miles east of Asheville was the first tract of eastern forest acquired through the Weeks Act.

U.S. Forest Service, Cradle of Forestry

TRAIL OF TEARS

In 1838, the Cherokee Nation was removed from their lands in the Southeastern United States to the Indian Territory (present day Oklahoma) in the Western United States, which resulted in the deaths of approximately 4,000 Cherokees. In the Cherokee language, the event is called *Nunna daul Isunyi*—"the Trail Where They Cried". The Cherokee Trail of Tears resulted from the enforcement of the Treaty of New Echota, an agreement signed under the provisions of the Indian Removal Act of 1830 which exchanged Native American land in the East for lands west of the Mississippi River, but which was never accepted by the elected tribal leadership or a majority of the Cherokee people.

Tensions between Georgia and the Cherokee Nation were brought to a crisis by the discovery of gold near Dahlonega, Georgia, in 1829, resulting in the Georgia Gold Rush, the first gold rush in U.S. history. Hopeful gold speculators began trespassing on Cherokee lands, and pressure began to mount on the Georgia government to fulfill the promises of the *Compact of 1802*.

President Andrew Jackson had no desire to use the power of the national government to protect the Cherokees from Georgia, since he was already entangled with states' rights issues in what became known as the nullification crisis. Andrew Jackson's military command and almost certainly his life were saved thanks to the aid of 500 Cherokee allies at the Battle of Horseshoe Bend in 1814. When Georgia moved to extend state laws over Cherokee tribal lands in 1830, the matter went to the U.S. Supreme Court. In *Cherokee Nation v. Georgia* (1831), the Marshall court ruled that the Cherokees were not a sovereign and independent nation, and therefore refused to hear the case. However, in *Worcester v. Georgia* (1832), the Court ruled that Georgia could not impose laws in Cherokee territory, since only the national government — not state governments — had authority in Indian affairs.

In order for Jackson to remove the Cherokee he would need for the Cherokee to agree to removal in a treaty. Following the recommendation of President James Monroe in his final address to Congress in 1825, the U.S. Congress passed the Indian Removal Act of 1830 that gave Jackson authority to negotiate removal treaties, exchanging Indian land in the East for land west of the Mississippi River. Jackson used the dispute with Georgia to put pressure on the Cherokees to sign a removal treaty, the Treaty of New Echota in 1835. The treaty, signed by a minority group of about 100 Cherokees known as the Treaty Party, relinquished all lands east of the Mississippi River in exchange for land in Indian Territory and the promise of money, livestock, various provisions, tools and other benefits. The Treaty violated Cherokee law since it was never ratified by a majority of the Cherokee people.

When these pro-removal Cherokee leaders signed the Treaty of New Echota, they also signed their own death warrants, since the Cherokee Nation Council had earlier passed a law calling for the death of anyone agreeing to give up tribal land. The signing and the removal led to bitter factionalism and ultimately to the deaths of most of the Treaty Party leaders once the Cherokee arrived in Indian Territory.

Andrew Jackson's successor, President Martin Van Buren, allowed Georgia, Tennessee, North Carolina, and Alabama an armed force of 7,000 made up of militia, regular army, and volunteers under General Winfield Scott to round up about 13,000 Cherokees into concentration camps at the U.S. Indian Agency near Cleveland, Tennessee before being sent to the West.

In the winter of 1838 the Cherokee began the thousand mile march with scant clothing and most on foot without shoes or moccasins. The march began in Red Clay, Tennessee, the location of the last Eastern capital of the Cherokee Nation. The Cherokee were given used blankets from a hospital in Tennessee where an epidemic of small pox had broken out. Because of the diseases, the Indians were not allowed to go into any towns or villages along the way; many times this meant traveling much farther to go around them. After crossing Tennessee and Kentucky, they arrived in Southern Illinois at Golconda about the 3rd of December, 1838. Here the starving Indians were charged a dollar a head to cross the river on "Berry's Ferry" which typically charged twelve cents. They were not allowed passage until the

ferry had serviced all others wishing to cross and were forced to take shelter under "Mantle Rock," a shelter bluff on the Kentucky side, until "Berry had nothing better to do". Many died huddled together at Mantle Rock waiting to cross. Several Cherokee were murdered by locals. The killers filed a lawsuit against the U.S. Government through the courthouse in Vienna, suing the government for $35 a head to bury the murdered Cherokee.

On December 26, Martin Davis, Commissary Agent for Moses Daniel's detachment wrote: "There is the coldest weather in Illinois I ever experienced anywhere. The streams are all frozen over something like eight or twelve inches thick. We are compelled to cut through the ice to get water for ourselves and animals. It snows here every two or three days at the fartherest. We are now camped in Mississippi swamp four miles from the river, and there is no possible chance of crossing the river for the numerous quantity of ice that comes floating down the river every day. We have only traveled sixty-five miles on the last month, including the time spent at this place, which has been about three weeks. It is unknown when we shall cross the river....

Removed Cherokees initially settled near Tahlequah, Oklahoma. The population of the Cherokee Nation eventually rebounded, and today the Cherokees are the largest American Indian group in the United States.

There were some exceptions to removal. Perhaps 100 Cherokees evaded the U.S. soldiers and lived off the land in Georgia and other states. Those Cherokees who lived on private, individually owned lands (rather than communally owned tribal land) were not subject to removal. In North Carolina, about 400 Cherokees, known as the Oconaluftee Cherokee, lived on land in the Great Smoky Mountains owned by a white man named William Holland Thomas (who had been adopted by Cherokees as a boy), and were thus not subject to removal. Added to this were some 200 Cherokee from the Nantahala area allowed to stay after assisting the U.S. Army hunt down and capture the family of the old prophet Tsali (Tsali faced a firing squad). These North Carolina Cherokees were recognized by the U.S. Government as the Eastern Band of the Cherokee Nation in 1868. Those who remained in Oklahoma became the Cherokee Nation. It was not until 1984 that the two branches of Cherokee met formally since the removal.

Trail of Tears National Historic Trail

In 1987, about 2,200 miles (3,500 km) of trails were authorized by Federal law to mark the removal of seventeen detachments of the Cherokee people. Called the "Trail of Tears National Historic Trail," it traverses portions of nine states and includes land and water routes.

Acid Rain

The Causes, History, and Effects of Acid Rain

From Amanda Briney, Contributing Writer
http://geography.about.com/od/globalproblemsandissues/a/acidrain.htm

Acid rain is rain consisting of water droplets that are unusually acidic because of atmospheric pollution - most notably the excessive amounts of sulfur and nitrogen released by cars and industrial processes. Acid rain is also called acid deposition because this term includes other forms of acidic precipitation such as snow.

Acidic deposition occurs in two ways: wet and dry. Wet deposition is any form of precipitation that removes acids from the atmosphere and deposits them on the Earth's surface. Dry deposition polluting particles and gases stick to the ground via dust and smoke in the absence of precipitation. This form of deposition is dangerous however because precipitation can eventually wash pollutants into streams, lakes, and rivers.

Acidity itself is determined based on the pH level of the water droplets. PH is the scale measuring the amount of acid in the water and liquid. The pH scale ranges from 0 to 14 with lower pH being more acidic while a high pH is alkaline; seven is neutral. Normal rain water is slightly acidic and has a pH range of 5.3-6.0. Acid deposition is anything below that scale. It is also important to note that the pH scale is logarithmic and each whole number on the scale represents a 10-fold change.

Today, acid deposition is present in the northeastern United States, southeastern Canada, and much of Europe including portions of Sweden, Norway, and Germany. In addition, parts of South Asia, South Africa, Sri Lanka, and Southern India are all in danger of being impacted by acid deposition in the future.

Causes and History of Acid Rain

Acid deposition can occur via natural sources like volcanoes but it is mainly caused by the release of sulfur dioxide and nitrogen oxide during fossil fuel combustion. When these gases are discharged into the atmosphere they react with the water, oxygen, and other gases already present there to form sulfuric acid, ammonium nitrate, and nitric acid. These acids then disperse over large areas because of wind patterns and fall back to the ground as acid rain or other forms of precipitation.

The gases responsible for acid deposition are normally a byproduct of electric power generation and the burning of coal. As such, it began entering the atmosphere in large amounts during the Industrial Revolution and was first discovered by a Scottish chemist, Robert Angus Smith, in 1852. In that year, he discovered the relationship between acid rain and atmospheric pollution in Manchester, England.

Although it was discovered in the 1800s, acid deposition did not gain significant public attention until the 1960s and the term acid rain was coined in 1972. Public attention further increased in the 1970s when the New York Times published reports about problems occurring in the Hubbard Brook Experimental Forest in New Hampshire.

Effects of Acid Rain

After studying the Hubbard Brook Forest and other areas today, there are several important impacts of acid deposition on both natural and man-made environments. Aquatic settings are the most clearly impacted by acid deposition though because acidic precipitation falls directly into them. Both dry and wet deposition also runs off of forests, fields, and roads and flows into lakes, rivers, and streams.

As this acidic liquid flows into larger bodies of water, it is diluted but over time, acids can accrue and lower the overall pH of the body. Acid deposition also causes clay soils to release aluminum and magnesium further lowering the pH in some areas. If the pH of a lake drops below 4.8, its plants and animals risk death and it is estimated that around 50,000 lakes in the United States and Canada have a pH below normal (about 5.3 for water). Several hundred of these have a pH too low to support any aquatic life.

Aside from aquatic bodies, acid deposition can significantly impact forests. As acid rain falls on trees, it can make them lose their leaves, damage their bark, and stunt their growth. By damaging these parts of the tree, it makes

them vulnerable to disease, extreme weather, and insects. Acid falling on a forest's soil is also harmful because it disrupts soil nutrients, kills microorganisms in the soil, and can sometimes cause a calcium deficiency. Trees at high altitudes are also susceptible to problems induced by acidic cloud cover as the moisture in the clouds blankets them.

Damage to forests by acid rain is seen all over the world, but the most advanced cases are in Eastern Europe. It's estimated that in Germany and Poland, half of the forests are damaged, while 30% in Switzerland have been affected.

Finally, acid deposition also has an impact on architecture and art because of its ability to corrode certain materials. As acid lands on buildings (especially those constructed with limestone) it reacts with minerals in the stones sometimes causing it to disintegrate and wash away. Acid deposition can also corrode modern buildings, cars, railroad tracks, airplanes, steel bridges, and pipes above and below ground.

What's Being Done?

Because of these problems and the adverse effects air pollution has on human health, a number of steps are being taken to reduce sulfur and nitrogen emissions. Most notably, many governments are now requiring energy producers to clean smoke stacks by using scrubbers which trap pollutants before they are released into the atmosphere and catalytic converters in cars to reduce their emissions. Additionally, alternative energy sources are gaining more prominence today and funding is being given to the restoration of ecosystems damaged by acid rain worldwide.

Acid Rain Program 2003 Progress Report
http://www.epa.gov/airmarkets/progress/arp03.html

Congress created the Acid Rain Program in Title IV of the 1990 Clean Air Act Amendments. The Acid Rain Program has the goals of lowering the electric power industry's annual emissions of:

- Sulfur dioxide (SO_2) to half of 1980 levels, capping them at 8.95 million tons starting in 2010, and
- Nitrogen oxide (NO_x) to 2 million tons lower than the forecasted level for 2000, reducing annual emissions to a level of 6.1 million tons in 2000.

In 2003, Acid Rain Program emission controls on the electric power industry resulted in:

- SO_2 emissions of 10.6 million tons, a reduction of 38 percent from 1980 levels. (See Figure 1) Emissions were 0.4 million tons higher in 2003 than in 2002. This small increase resulted from increased production of electricity by coal-fired and oil-fired units that emit much more SO_2 than natural gas units that generated less power in 2003. The main cause of this was the substantial increase in natural gas prices. Large, early SO_2 reductions that were very beneficial at the program's outset enabled banked allowances to be available to cover these emissions.
- NO_X emissions of 4.2 million tons, which were close to 4 million tons less than the emissions forecasted for 2000 (See Figure 2). Other regulations, such as the NO_x Budget Program in the Northeast, also contributed to this reduction in emissions.

Figure 1: Trends in SO_2 emissions since 1980 for all Title IV affected sources.

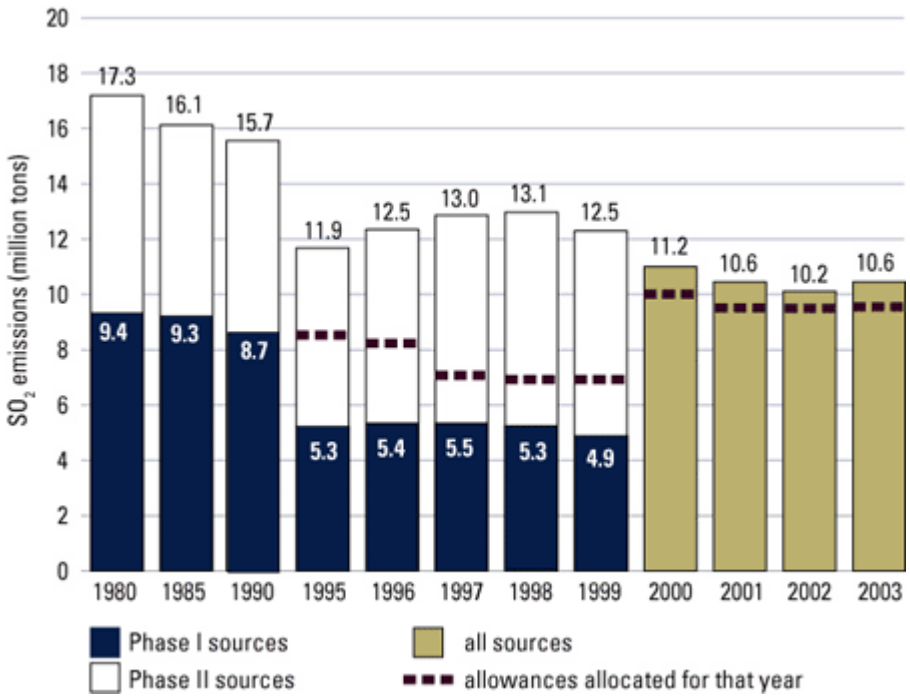
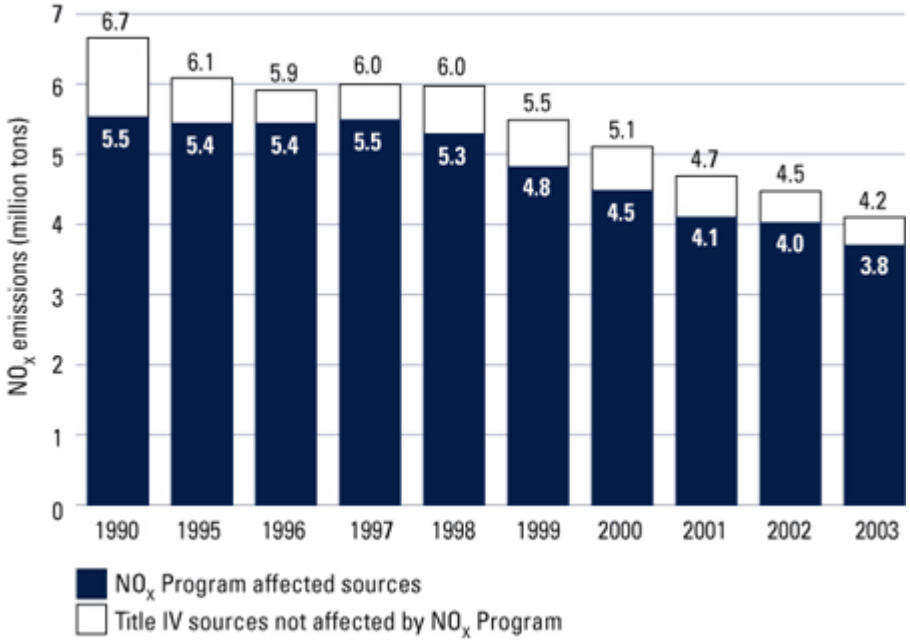


Figure 2: Trends in NO_x emissions under the Acid Rain Program.



As in years past, the electric power industry achieved nearly 100 percent compliance with Acid Rain Program requirements — only 1 unit had emissions exceeding the SO_2 allowances that it held and no units were out of compliance with the NO_x program. This exceptionally high level of compliance was, in part, achieved as a result of the Acid Rain Program's continued provision of accurate and complete SO_2 and NO_x emissions data. This process was augmented by a substantial auditing effort and accountability through rigorous, yet streamlined, reporting systems.

SO_2 and NO_x are the key pollutants in the formation of acid rain. These pollutants also contribute to the formation of fine particles (sulfates and nitrates) that are associated with significant health effects and regional haze. Additionally, NO_x combines with volatile organic compounds (VOCs) to form ozone (smog), and nitrates that are transported and deposited at environmentally detrimental levels in parts of the country. The United States (U.S.) electric power industry accounts for approximately 67 percent of total annual SO_2 emissions and 22 percent of total annual NO_x emissions.

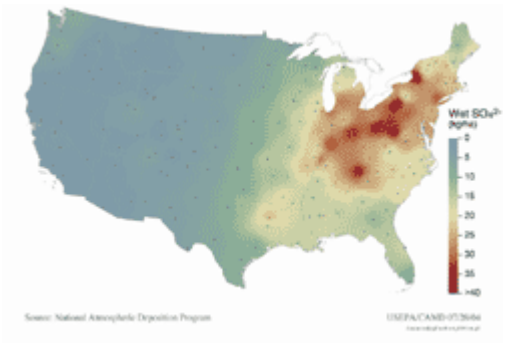
Since the Acid Rain Program began in 1995, the lower SO_2 and NO_x emissions levels from the power sector have contributed to significant air quality and environmental improvements that EPA's Clean Air Status and Trends Network (CASTNET) and other long-term environmental monitoring networks are reporting.

Over the last decade:

- Ambient SO_2 and sulfate levels are down more than 40 percent and 30 percent, respectively, in the eastern U.S.
- Wet sulfate deposition, which acidifies sensitive lakes, streams and forest soils, has decreased 39 percent in the northeastern U.S. and 17 percent in the southeastern U.S. (See Figure 3)
- Some modest reductions in inorganic nitrogen deposition and wet nitrate concentrations have occurred in the Northeast and Mid-Atlantic regions, but other areas have not shown much improvement.
- Signs of recovery in acidified lakes and streams are evident in the Adirondacks, the northern Appalachian Plateau, and the upper Midwest. These signs include lower concentrations of sulfates, nitrates, and improvements in acid neutralizing capacity. Response of surface water chemistry to the Clean Air Act Amendments of 1990.

Figure 3

Annual Mean Wet Sulfate Deposition 1989 through 1991



Annual Mean Wet Sulfate Deposition 2001 through 2003

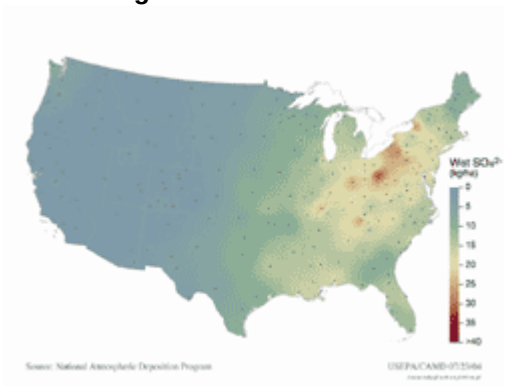


Figure 3: Wet sulfate deposition decreased throughout the early 1990s in much of the Ohio River Valley and Northeastern U.S. Other less dramatic reductions were observed across much of New England, portions of the Southern Appalachian Mountains and in the Midwest. Average decreases in wet deposition of sulfate range from 39 percent in the Northeast to 17 percent in the Southeast. Click images to view larger maps.

Acid Rain: Do you need to start wearing a rain hat?

Depending on where you live, maybe you've heard of acid rain. Now, acid rain is not pure acid falling from the sky, but rather it is rainfall or atmospheric moisture that has been mixed with elements and gases that have caused the moisture to become more acidic than normal. Pure water has a pH of 7, and, generally, rainfall is somewhat on the acidic side (a bit less than 6). But, acid rain can have a pH of about 5.0-5.5, and can even be in the 4 range in the northeastern United States, where there are a lot of industries and cars.

Causes of acid rain
"Acid rain is caused by human activity"

Credit: Tennessee Valley Authority (TVA)

Acid rain is a uniquely human-related phenomenon. The burning of fossil fuels (coal and oil) by power-production companies and industries releases sulfur into the air that combines with oxygen to form sulfur dioxide (SO_2). Exhausts from cars cause the formation of nitrogen oxides in the air. From these gases, airborne sulfuric acid (H_2SO_4) and nitric acid (HNO_3) can be formed and be dissolved in the water vapor in the air. Although acid-rain gases may originate in urban areas, they are often carried for hundreds of miles in the atmosphere by winds into rural areas. That is why forests and lakes in the countryside can be harmed by acid rain that originates in cities.

Effects of acid rain

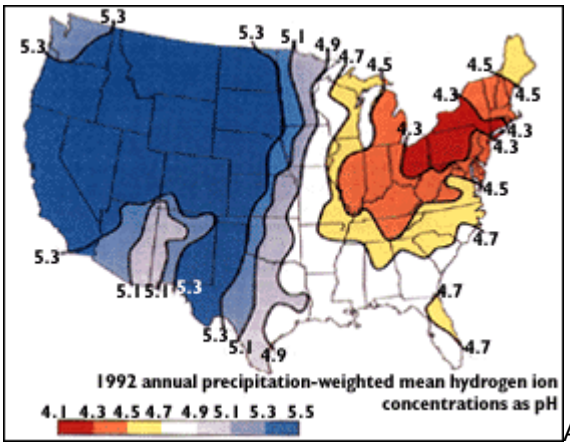
Acid rain withers trees in a coniferous forest in Europe.
Photo by The Ministry of Foreign Affairs of Japan

The environment can generally adapt to a certain amount of acid rain. Often soil is slightly basic (due to naturally occurring limestone, which has a pH of greater than 7). Because bases counteract acids, these soils tend to balance out some of the acid rain's acidity. But in areas, such as some of the Rocky Mountains and parts of the northwestern and southeastern United States, where limestone does not naturally occur in the soil, acid rain can harm the environment.

Some fish and animals, such as frogs, have a hard time adapting to and reproducing in an acidic environment. Many plants, such as evergreen trees, are damaged by acid rain and acid fog. I've seen some of the acid-rain damage to the evergreen forests in the Black Forest of Germany. Much of the Black Forest was indeed black

because so much of the green pine needles had been destroyed, leaving only the black trunks and limbs! You also might notice how acid rain has eaten away the stone in some cities' buildings and stone artwork.

Geographic distribution of acid rain



Acidity in rain is measured by collecting samples of rain and measuring its pH. To find the distribution of rain acidity, weather conditions are monitored and rain samples are collected at sites all over the country. The areas of greatest acidity (lowest pH values) are located in the Northeastern United States. This pattern of high acidity is caused by the large number of cities, the dense population, and the concentration of power and industrial plants in the Northeast. In addition, the prevailing wind direction brings storms and pollution to the Northeast from the Midwest, and dust from the soil and rocks in the Northeastern United States is less likely to neutralize acidity in the rain.

Acid rain and stone

When you hear or read in the media about the effects of acid rain, you are usually told about the lakes, fish, and trees in New England and Canada. However, we are becoming aware of an additional concern: many of our historic buildings and monuments are located in the areas of highest acidity. In Europe, where buildings are much older and pollution levels have been ten times greater than in the United States, there is a growing awareness that pollution and acid rain are accelerating the deterioration of buildings and monuments.

Stone weathers (deteriorates) as part of the normal geologic cycle through natural chemical, physical, and biological processes when it is exposed to the environment. This weathering process, over hundreds of millions of years, turned the Appalachian Mountains from towering peaks as high as the Rockies to the rounded knobs we see today. Our concern is that air pollution, particularly in urban areas, may be accelerating the normal, natural rate of stone deterioration, so that we may prematurely lose buildings and sculptures of historic or cultural value.

What about buildings?

Many buildings and monuments are made of stone, and many buildings use stone for decorative trim. Granite is now the most widely used stone for buildings, monuments, and bridges. Limestone is the second most used building stone. It was widely used before Portland cement became available in the early 19th century because of its uniform color and texture and because it could be easily carved. Sandstone from local sources was commonly used in the Northeastern United States, especially before 1900. Nationwide, marble is used much less often than the other stone types, but it has been used for many buildings and monuments of historical significance. Because of their composition, some stones are more likely to be damaged by acidic deposition than others. Granite is primarily composed of silicate minerals, like feldspar and quartz, which are resistant to acid attack. Sandstone is also

primarily composed of silica and is thus resistant. A few sandstones are less resistant because they contain a carbonate cement that dissolves readily in weak acid. Limestone and marble are primarily composed of the mineral calcite (calcium carbonate), which dissolves readily in weak acid; in fact, this characteristic is often used to identify the mineral calcite.

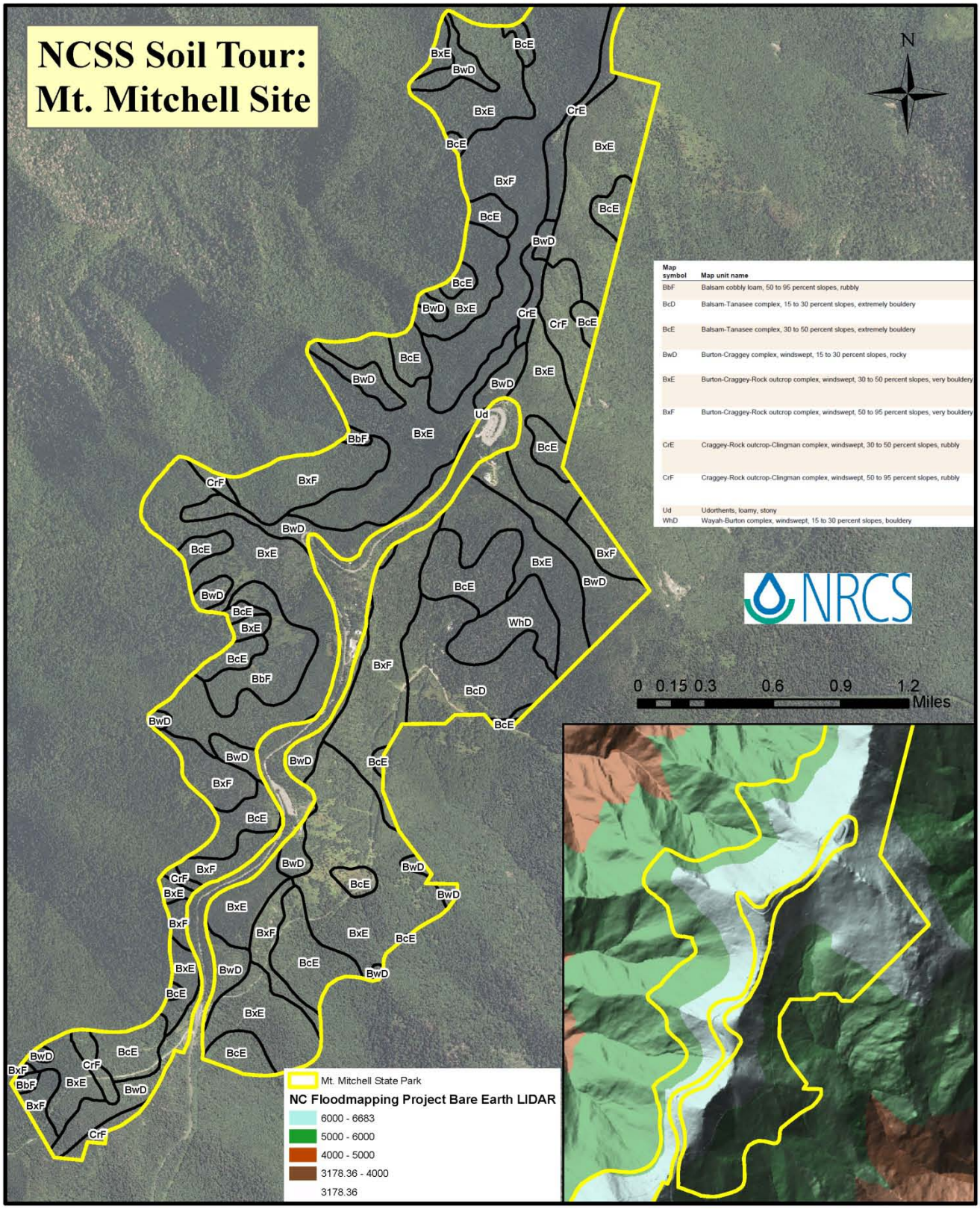
How does acid precipitation affect marble and limestone buildings?

Acid precipitation affects stone primarily in two ways: dissolution and alteration. When sulfurous, sulfuric, and nitric acids in polluted air react with the calcite in marble and limestone, the calcite dissolves. In exposed areas of buildings and statues, we see roughened surfaces, removal of material, and loss of carved details. Stone surface material may be lost all over or only in spots that are more reactive.

You might expect that sheltered areas of stone buildings and monuments would not be affected by acid precipitation. However, sheltered areas on limestone and marble buildings and monuments show blackened crusts that have spalled (peeled) off in some places, revealing crumbling stone beneath. This black crust is primarily composed of gypsum, a mineral that forms from the reaction between calcite, water, and sulfuric acid. Gypsum is soluble in water; although it can form anywhere on carbonate stone surfaces that are exposed to sulfur dioxide gas (SO_2), it is usually washed away. It remains only on protected surfaces that are not directly washed by the rain. Gypsum is white, but the crystals form networks that trap particles of dirt and pollutants, so the crust looks black. Eventually the black crusts blister and spall off, revealing crumbling stone.

By the way, no, you don't need to start wearing a rain hat.

http://ga.water.usgs.gov/edu/acidrain.html


NCSS Soil Tour:
Mt. Mitchell Site
N
Map symbol | Map unit name
BbF | Balsam cobbly loam, 50 to 95 percent slopes, rubbly
BcD | Balsam-Tanasee complex, 15 to 30 percent slopes, extremely bouldery
BcE | Balsam-Tanasee complex, 30 to 50 percent slopes, extremely bouldery
BwD | Burton-Craggey complex, windswept, 15 to 30 percent slopes, rocky
BxE | Burton-Craggey-Rock outcrop complex, windswept, 30 to 50 percent slopes, very bouldery
BxF | Burton-Craggey-Rock outcrop complex, windswept, 50 to 95 percent slopes, very bouldery
CrE | Craggey-Rock outcrop-Clingman complex, windswept, 30 to 50 percent slopes, rubbly
CrF | Craggey-Rock outcrop-Clingman complex, windswept, 50 to 95 percent slopes, rubbly
Ud | Udorthents, loamy, stony
WhD | Wayah-Burton complex, windswept, 15 to 30 percent slopes, bouldery
NRCS
0 0.15 0.3 0.6 0.9 1.2
Miles
Mt. Mitchell State Park
NC Floodmapping Project Bare Earth LIDAR
6000 - 6683
5000 - 6000
4000 - 5000
3178.36 - 4000
3178.36

BURTON SERIES

The Burton series consists of moderately deep, well drained soils on ridges and side slopes at high elevations in the Southern Blue Ridge mountains, MLRA 130B. They formed in residuum that is affected in the upper part by soil creep, and weathered from felsic to mafic igneous and high-grade metamorphic rocks. Near the type location, mean annual air temperature is about 40 degrees F., and mean annual precipitation is 80 inches. Slope ranges from 2 to 95 percent.

TAXONOMIC CLASS: Fine-loamy, isotic, frigid Typic Humudepts

TYPICAL PEDON: Burton sandy clay loam on a 10 percent ridge top at an elevation of 5,673 feet--heath bald vegetation. (Colors are for moist soil unless otherwise stated.)

Oe--0 to 2 inches; mat of decomposing leaves and twigs laced with many fine to coarse live roots.

A1--2 to 9 inches; very dark brown (10YR 2/2) sandy clay loam; weak, fine granular structure; very friable; many very fine to coarse roots; 8 percent gravel and cobbles, and 3 percent stones by volume; common very fine and fine flakes of mica; very strongly acid; clear smooth boundary.

A2--9 to 17 inches; very dark grayish brown (10YR 3/2) fine sandy loam; weak medium and coarse subangular blocky structure; very friable; common very fine to coarse roots; 10 percent gravel and cobbles by volume; common very fine and fine flakes of mica; very strongly acid; clear smooth boundary. (Combined thickness of the A horizon is 10 to 20 inches.)

Bw--17 to 26 inches; dark yellowish brown (10YR 4/6) sandy loam; weak medium and coarse subangular blocky structure; very friable; few very fine and fine roots; 11 percent gravel and cobbles; common very fine and fine flakes of mica; very strongly acid; clear smooth boundary. (6 to 14 inches thick)

Cr--26 to 29 inches; weathered, partially consolidated bedrock that can be dug with difficulty with hand tools, few fine and medium roots in cracks that are spaced more than 4 inches apart; abrupt smooth boundary. (0 to 6 inches)

R--29 inches; hard, high-grade metagraywacke and kyanite garnet mica schist bedrock.

TYPE LOCATION: Buncombe County, North Carolina; 18 miles north east of Asheville on Blue Ridge Parkway, 0.25 miles west of Craggey Garden overlook to shelter, 600' south of shelter along trail: USGS Craggey Pinnacle topographic quadrangle; lat. 35 degrees 41 minutes 47 seconds N. and long. 82 degrees 23 minutes 00 seconds W., NAD 27.

This series was formerly placed in a coarse-loamy particle-size class. Laboratory PSA (pipette method) and corresponding field texture estimates (feel method) indicate control section clay contents of generally 12 to 24 percent, with most pedons marginally coarse-loamy. Fine-loamy particle-size class placement is based on the presence of amorphous (non-crystalline) clay-size material associated with the relatively high organic matter content found in these soils. Although field estimates, laboratory measurements, and calculated values may vary, clay content in the particle-size control section is generally less than 25 percent. Although Burton soils may exhibit some of the characteristics of andic soil properties, they lack the volcanic glass found in soils of similar taxa in the Western United States.

Diagnostic horizons and features recognized in this pedon are:

Umbric epipedon - the zone from the mineral soil surface to a depth of 17 inches (A1 and A2 horizons)
Cambic horizon - the zone between 17 and 26 inches (Bw horizon)
Paralithic contact - weathered bedrock contact at 26 inches (upper boundary of Cr horizon).
Lithic contact - the occurrence of hard bedrock at a depth of 29 inches (R horizon)
Isotic mineralogy class - In more than one-half of the control section, a 1500 kPa water to clay ratio of 0.6 or more and a pH in NaF solution of more than 8.4.

Sampled as on Sep 01, 1991 : Burton ; Coarse-loamy, mixed, frigid Typic Haplumbrept
Revised to correlated on Aug 01, 1996 : Burton ; Fine-loamy, isotic, frigid Andic Haplumbrept

SSL - Project CP92NC019 MOUNTAIN SOILS - BUNCOMBE COUNTY
- Site ID 91NC021007 Lat: 35° 41' 45.00" north Long: 82° 22' .00" west MLRA: 130
- Pedon No. 92P0087
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
92P00636	Oa	OA	0-7				FSL	SL
92P00637	A1	A1	7-23				FSL	SL
92P00638	A2	A2	23-38				FSL	SL
92P00639	Bw	BW	38-63				SL	SL

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	1.31	(NA)
Clay, carbonate free, Weighted Average	11	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	59	% wt
Volume, >2mm, Weighted Average	5	% vol
Clay, total, Weighted Average	11	% wt
LE, Whole Soil, Summed to 1m	0	cm/m

Weighted averages based on control section: 25-63 cm

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - Weight - - - - - - - -)				>2 mm
	Depth			< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	wt % whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - - -)				soil
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
92P00636	0-7	Oa	S	10.6	24.4	65.0	1.8		16.6	7.8	10.4	22.6	18.5	9.8	3.7	tr	tr	--	55	
92P00637	7-23	A1	S	13.3	25.0	61.7	2.0		17.4	7.6	11.1	19.8	18.4	8.9	3.5	1	1	1	52	3
92P00638	23-38	A2	S	11.1	26.7	62.2	1.1		18.4	8.3	10.4	18.8	16.8	10.8	5.4	2	1	2	54	5
92P00639	38-63	Bw	S	10.4	23.5	66.1	--		16.6	6.9	10.6	21.1	17.1	11.2	6.1	5	3	7	62	15

*** Primary Characterization Data ***

Pedon ID: 91NC021007 (Buncombe, North Carolina) Print Date: Apr 29 2011 3:47PM

Sampled As : Burton Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa	-2- Oven Dry	-3- Cole Whole Soil	-4- (Water Content) 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- (Ratio/Clay) CEC7	-13- 1500 kPa
				(g cm^{-3})			(% of < 2mm)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a		4B5	4C1		8D1	8D1
92P00636	0-7	Oa	S	0.51	0.58	0.044			47.1	34.1		1.044	0.07		3.58	3.22
92P00637	7-23	A1	S	0.90	1.13	0.078			60.3	17.2		1.031	0.38		1.83	1.29
92P00638	23-38	A2	S	0.88	1.03	0.053			52.6	13.6		1.030	0.34		1.88	1.23
92P00639	38-63	Bw	S	1.06	1.13	0.020			42.8	8.2		1.020	0.34		1.02	0.79

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (Atterberg) Limits LL	-2- PI	-3- (Bulk Density) Field	-4- Recon 33 kPa	-5- Recon Oven Dry	-6- (Water Content) Field	-7- Recon 33 kPa	-8- 6 kPa	-9- (Sieved Samples) 10 kPa	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa	-13- 500 kPa
				pct <0.4mm		(g cm^{-3})			(% of < 2mm)							
															4B1a	
92P00636	0-7	Oa	S												47.1	
92P00637	7-23	A1	S												24.1	
92P00638	23-38	A2	S												20.7	
92P00639	38-63	Bw	S												16.7	

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (Total) C	-2- N	-3- S	-4- Org C	-5- C/N Ratio	-6- (Dith-Cit Ext) Fe	-7- Al	-8- Mn	-9- (Ammonium Oxalate Extraction) Al+½Fe	-10- ODOE	-11- Fe	-12- Al	-13- Si	-14- Mn	-15- (Na Pyro-Phosphate) C	-16- Fe	-17- Al	-18- Mn
				(% of <2 mm)					(% of < 2mm)								mg kg^{-1}	(% of < 2mm)			
					6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9b	6G12b	6V2b	6D5b		6C8a	6G10	
92P00636	0-7	Oa	S		1.121		16.34		2.0	0.6	tr	0.98	0.53	0.99	0.49	0.05	227.7		1.4	0.6	
92P00637	7-23	A1	S		0.455		6.55		2.4	0.9	0.1	1.42	0.48	1.20	0.82	0.04	400.8		1.5	1.0	
92P00638	23-38	A2	S		0.328		4.76		2.1	1.0	0.1	1.83	0.44	1.28	1.18	0.11	579.6		1.1	1.2	
92P00639	38-63	Bw	S		0.100		1.32		1.4	0.6	tr	1.42	0.14	0.64	1.10	0.24	461.1		0.4	0.6	

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USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

CEC & Bases

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH$_4$OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
	Depth			Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH$_4$ OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH$_4$OAC
Layer	(cm)	Horz	Prep	(- - - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	6D3b	5A3a	5A8b	5A3b	5G1	5C3	5C1
92P00636	0-7	Oa	S	1.1	0.5	0.1	0.7	2.4	56.4	6.1	10.2	58.8	38.0	8.5	72	4	6
92P00637	7-23	A1	S	0.1	0.1	0.1	0.1	0.4	38.9	4.2	1.0	39.3	24.4	4.6	91	1	2
92P00638	23-38	A2	S	tr	tr	0.1	tr	0.1	32.5	3.2	0.6	32.6	20.9	3.3	97	tr	0
92P00639	38-63	Bw	S	--	--	0.1	tr	0.1	16.5	1.1	tr	16.6	10.6	1.2	92	1	1

Salt

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
	Depth			Ca	Mg	Na	K	CO$_3$	HCO$_3$	F	Cl	PO$_4$	Br	OAC	SO$_4$	NO$_2$	NO$_3$	H$_2$O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
Layer	(cm)	Horz	Prep	(- - - - - mmol(+) L^{-1} - - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
92P00636	0-7	Oa	S																			tr	
92P00637	7-23	A1	S																			tr	
92P00638	23-38	A2	S																			tr	
92P00639	38-63	Bw	S																			1	

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- pH -)						(- - Carbonate - -)		(- - Gypsum - - - -)		
					CaCl$_2$					As CaCO$_3$		As CaSO$_4$*2H$_2$O		Resist
	Depth				0.01M	H$_2$O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - - - - - - - - - % - - - - - - - - - - - - -)				cm^{-1}
				8C1g	4C1a2a	4C1a2a			8C1d					
92P00636	0-7	Oa	S	3.6	3.7	4.0			7.9					
92P00637	7-23	A1	S	4.1	4.2	4.4			10.8					
92P00638	23-38	A2	S	4.2	4.4	4.5			11.3					
92P00639	38-63	Bw	S	4.5	4.7	4.9			11.2					

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USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

Phosphorous				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-
					(- - - - Phosphorous - - - -)								
				Melanic Index	NZ	Acid Oxal	Bray 1	Bray 2	Olsen	H_2O	Citric Acid	Mehlich III	Extr NO_3
Layer	Depth (cm)	Horz	Prep		%	(- - - - mg kg^{-1} - - - -)							mg kg^{-1}
					6S4								
92P00636	0-7	Oa	S		71								
92P00637	7-23	A1	S		88								
92P00638	23-38	A2	S		87								
92P00639	38-63	Bw	S		79								

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Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray						Thermal			Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract	7A2i						7A4b			7C3								tion
Layer	(cm)	Horz	ion	(- - - - peak size - - - -)						(- - - % - - -)			(- - - - % - - - -)							mg g^{-1}	
92P00638	23-38	A2	tcly	GI 2	KK 1	MM 1	MT 1	MI 1			KK 37	GI 22		9	4.4			--			
92P00639	38-63	Bw	tcly	GI 3	KK 1	CL 1					GI 27	KK 19		23	5.7			--			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

CL - Chlorite GI - Gibbsite KK - Kaolinite MI - Mica MM - Montmorillonite-Mica

MT - Montmorillonite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

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Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a					tion
Layer	(cm)	Horz	ion	(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00638	23-38	A2	fs										53	QZ 52	BT 27	MS 10	OT 8	OP 1	PR 1		
														FK tr	GN tr						
92P00639	38-63	Bw	fs										37	BT 49	QZ 36	MS 13	OT 1	OP 1	FK tr		
														GN tr							

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite FK - Potassium Feldspar GN - Garnet MS - Muscovite OP - Opaques

OT - Other PR - Pyroxene QZ - Quartz

*** Primary Characterization Data ***

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USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0087

Fine Earth Mineralogy (<2.0 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract																	7D2	tion
Layer	(cm)	Horz	ion	(- - - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00636	0-7	Oa	feth																	32.0	
92P00637	7-23	A1	feth																	25.0	
92P00638	23-38	A2	feth																	23.0	
92P00639	38-63	Bw	feth																	14.0	

FRACTION INTERPRETATION:

feth - Fine Earth, <2 mm

MINERAL INTERPRETATION:

eg - Surface Area

Ecological Site Basics

Definition…

An ecological site is a distinctive kind of land with specific physical characteristics that differs from other kinds of land in its ability to produce a distinctive kind and amount of vegetation.

Differentiation between Ecological Sites…

This is a bit tricky, but NRCS differentiates ecological sites on the following factors:

Significant differences in the species that are in the characteristic plant community.

Significant differences in the relative proportion of species in the characteristic plant community.

Significant differences in the total annual production of the characteristic plant community.

In the Past…

Ecological Site Descriptions used to be called Range Site Descriptions and Woodland Site Descriptions.

Range Site Descriptions, in particular, were written to provide information targeted to production agriculture management techniques and interpretations. In essence, they typically focused on answering the age-old question, "How many animals can this land support?"

Range Site Descriptions were developed using the Clementsian model of succession. This model naively describes changes in plant communities as linear responses to management. In other words, if a grazed area is inventoried as being in "poor" condition, the mere removal of grazing would automatically cause the area to bounce back to its climax equilibrium ("excellent" condition). We know it's much more complicated than that.

In the Present…

Ecological site descriptions are written to describe all of the information we know about the site, including the dynamics of the site as it passes through various "states and transitions".

We no longer adhere to the old Clementsian model of succession. We know that ecological communities don't respond in a simple linear fashion to management inputs. The ecological model we use now is referred to as the State and Transition Model. This supports the fact that each individual site can go through any number of shifts in plant communities (*"states"*) and plant community dynamics. Those shifts, or *transitions*, may or may not be caused by factors within human control/management. We model those states and transitions within the site description.

Interpretations are much more extensive than they were in the past.

Nuts and Bolts of an Ecological Site Description…

Each site will describe the following features. Notice that it takes an interdisciplinary approach and involvement from people very familiar with the area to develop quality site descriptions.

Physiographic:

Landform; Aspect; Elevation; Slope; Water Table Depth; Flooding; Ponding; Runoff Class.

Climate:

Monthly Precipitation; Monthly Temperature; Mean Annual Precipitation; Frost-free Period; Freeze-Free Period.

Water:

Cowardin Wetland Classification; Rosgen Stream Classification.

Soil:

Parent Material; Surface Texture and Modifiers; Surface Fragments; Subsurface Fragments; Drainage Class; Permeability Class; Soil Depth; Electrical Conductivity; Sodium Absorption Ratio; Soil Reaction (pH); Available Water Capacity; Calcium Carbonate Equivalent.

Plant Communities:

Ecological dynamics of the site; State and Transition diagram; Plant communities, including: community narrative, annual production, species composition, growth curves, cover and structure, photograph(s).

Site Interpretations:

Animal community (including wildlife); Hydrology; Recreational uses; Wood products; Other products; Other information; Species preferences; Forest site productivity.

Supporting Information:

Associated sites; Similar sites; Inventory data references; State correlation; Type locality; Relationship to other classifications; Other references; Site description approval.

ECOLOGICAL SITES

(*Picea rubens-Abies fraserii*) Red Spruce-Fraser Fir

One of the highest elevation communities in western North Carolina is the spruce fir forest. In the northeastern US, spruce-fir forests extends from the mountains to the ocean's edge, but is restricted to high elevation (> 5000 ft.) peaks in the southern Appalachians, where the growing season is short and cool, with long and cold winters. This forest type represents only about 1 % of the ecological communities of the southern Appalachian Mountains, where Fraser Fir is predominant. In the Northern Appalachian Mountains, Balsam Fir (*Abies balsamea*) is the dominant.

Red spruce are more abundant in lower, more sheltered elevations while fir dominate exposed sites at higher elevations, often forming nearly pure stands. Less common are deciduous trees such as yellow birch (*Betula alleghaniensis*), mountain maple (*Acer spicatum*), mountain ash (*Sorbus americana*) and fire cherry (*Prunus penslyvanica*). Other associated vegetation: (shrubs) blackberries (Rubus), elderberry (*Sambucus racemosa*) gooseberry (*Ribes rotundifolia*), rhododendron (*Rhododendron catawbiense*), mountain wood fern (*Drytopteris campyloptera*) and southern lady fern (*Athryium asplenioides*). A diverse array of bryophytes (mosses liverworts) and lichens are very common.

Spruce –fir forests in the Appalachian Mountains were intensely logged in the early 1900's, most of which survived are now set aside and conserved in National Parks and Forests.

Ecology: In a natural state, these communities are uneven-aged. Population dynamics – consisting as gap-phase regeneration being the typical mode of tree regeneration are most often seen where one or more dead trees, usually in conjunction with ice and wind disturbances, create small openings which facilitate the establishment of shade-intolerant species such as yellow birch and fire cherry. Firs are more likely to capture gaps, but spruce often remains dominant in the canopy because of their persistence (300-400 years vs. 70-100 for fir).

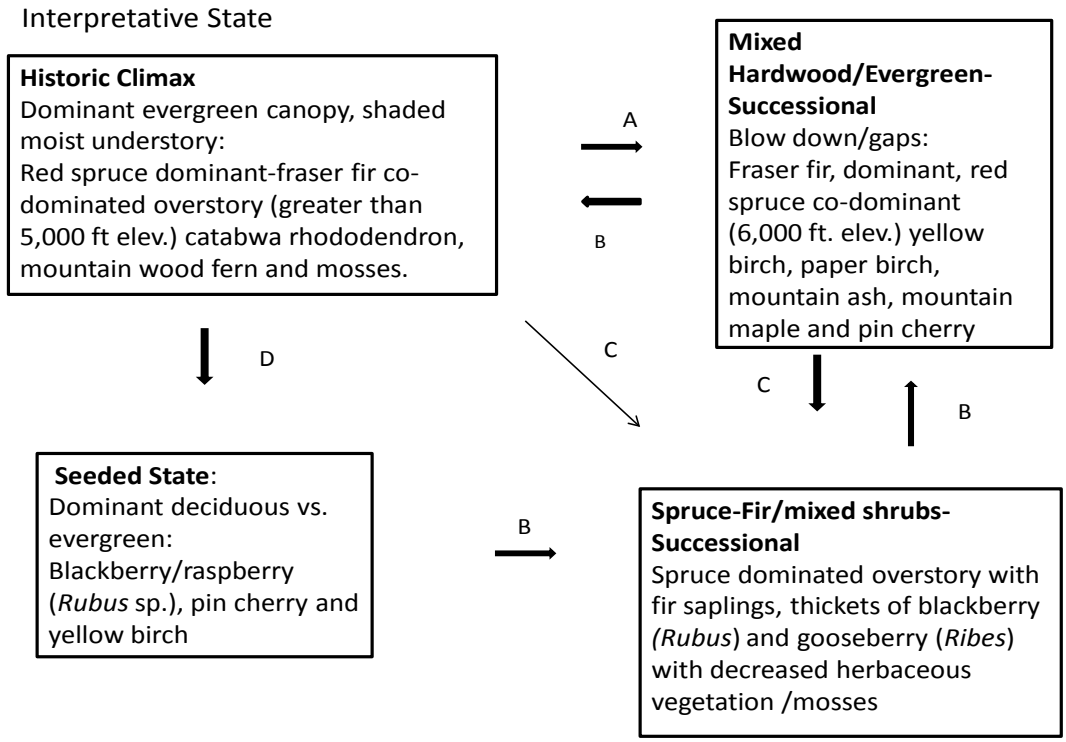
Fire is relatively uncommon, and when introduced can adversely affect spruce, which has the inability to regenerate in burned over areas.

Other associated communities: Heath and grassy balds, Mountain bogs and rock outcrops. Subalpine spruce-fir grades into Northern Hardwood and Mixed-Oak/Chestnut Forests further down in elevation.

Threats: air pollution, balsam woolly adelgid and fire. The adelgid was introduced from Europe in the 1950s and has eliminated approximately 90 percent of adult fir trees in the southern Appalachian forests. When the adelgid pierce the tree for sap, reaction of the tree results in swelling along the xylem-which in turn affects the tree's ability to carry nutrients and water. Within a few years of attack, needles turn red and fall off, with mortality resulting from severe water stress. On Mt. Mitchell, more than 1.5 million trees have been impacted. Throughout its range, red spruce are showing a remarkable decline in the last 20th century, with theories suggesting these shifts may be due to air pollution, and rising climatic temperatures.

STATE AND TRANSITION DIAGRAM

Spruce-Fir Forests occupy high mountain areas in all topographic positions, generally above 5000 ft. elevation. The soils are highly variable, from deep mineral soils to well-developed boulder fields. Soils often characterized with a thick organic layer. These forests are mostly associated with the Burton Series (Typic Humudepts). Hydrology: mesic to wet due to high rainfall, fog deposition, low temperatures, shading by tree canopy and high water-holding capacity of the soil. Stable spruce-fir forests have a dominant evergreen canopy, shaded, moist, understory of ferns, herbs and bryophytes.



Legend:
A-Gaps (created by wind/ice)
B-Natural Regeneration
C-Balsam Woolly adelgid infestation
D-Logging and/or Fire

Andic Soil Properties in North Carolina

NOTES TO ACCOMPANY THE CLASSIFICATION & CORRELATION OF THE SOILS OF SWAIN COUNTY, NORTH CAROLINA

BY
CHIP SMITH
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&
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AREA RESOURCE SOIL SCIENTIST-WAYNESVILLE, N.C.

This survey area is in southern portion of the Blue Ridge Major Land Resource Area (MLRA 130B).

1. Series classifications are based on the *Keys to Soil Taxonomy*, Tenth Edition, 2006.

2. Soils that classify as Humic Dystrudepts actually classify in the Andic subgroups of Dystrudepts. This is because these soils generally have a low bulk density (<1 g/cm^3 at 33 kPa water retention) and high extractable iron and aluminum contents (ammonium oxalate-extractable aluminum (AOE) plus 1/2 iron greater than 1.0) in horizons within 75 cm of the mineral soil surface. The latter property indicates significant amounts of amorphous materials. However, these soils are classified to the Humic subgroup of Dystrudepts for this correlation. Although these soils exhibit at least some of the characteristics of andic soil properties, they lack the volcanic glass commonly found in soils of related taxa in the Western United States. Official Series Descriptions (OSED's) will be revised to reflect the changes mentioned above.

3. Soils that classify as Humic Dystrudepts and those Typic Dystrudepts with umbric-like surface layers that formerly had a coarse-loamy particle size class have been correlated and reclassified to the fine-loamy particle size class. Field texture estimates (feel method) indicate control section clay contents of generally 12 to 24 percent. Laboratory data generally indicates a coarse-loamy particle size class by pipette and hydrometer methods. However, 1500 kPa water to clay ratios and ammonium oxalate Fe and Al values indicate sufficient amorphous materials to push the majority of pedons into a fine-loamy particle-size class. Calculations of clay content where dispersion is poor (% 1500 kPa water retention/% clay equal to or greater than 0.6) are probably unrealistically high (greater than 25 percent clay with most being higher than 30 percent). Therefore, these soils generally are on the lower end of fine-loamy, with less than about 25 percent clay. Soils affected by this reclassification are Cataloochee, Cheoah, Guyot, Oconaluftee, Santeetlah, Tanasee, Tuckasegee, Wayah, and Whiteoak. This reclassification will not affect loamy-skeletal families of these subgroups since the calculated or estimated increase in clay in these soils is insufficient to place them in a clayey-skeletal family. However, the range in characteristics of the fine-earth texture of B horizons, and possibly A horizons, should include sandy clay loam in these subgroups. These Official Series Descriptions (OSED's) have been revised to reflect the changes mentioned above.

References

Pg 28, 7th Edition of the *Keys to Soil Taxonomy*: Andic soil properties... Hence the content of volcanic glass is one of the characteristics used in defining andic soil properties.

Pg 15, 11th Edition of the *Keys to Soil Taxonomy*: Andic Soil Properties
Andic soil properties commonly form during weathering of tephra or other parent materials containing a significant content of volcanic glass.

The Death and Resurrection of the Umbric Dystrochrepts in Soil Taxonomy

With the 1998 revision to the Keys to Soil Taxonomy, moisture regimes were added at the Suborder level for Inceptisols, assumedly to be more consistent with other Soil Orders.

In Soil Taxonomy, 1975, the separation for soils with Umbric Epipedons was at the Suborder level:

IE. Other Inceptisols that have an ochric epipedon; or that have an umbric or mollic epipedon that is <25 cm thick and have also a mesic or warmer soil temperature regime.

Ochrepts, p. 246

IF. Other Inceptisols.

Umbrepts, p. 264

There are many soils with a dark surface layer in the Blue Ridge that did not meet the thickness requirement for an Umbric Epipedon that still exhibited most of the characteristics of those that did. Both had a prominent place in the classification system:

Umbric Dystrochrepts.—These soils have an epipedon that is darker than that of Typic Dystrochrepts but are otherwise like the soils of the typic subgroup. They are mainly under coniferous forests on steep slopes. Weakly consolidated sedimentary rock is present at a shallow depth. These soils resemble the Umbrepts but have a higher chroma in the epipedon.

Typic Haplumbrepts.—The central concept or typic subgroup of Haplumbrepts is fixed on freely drained soils that show little or no influence of pyroclastic materials, have an umbric epipedon <50 cm thick resting on a cambic horizon, have a loamy or clayey particle-size class within the upper 50 cm, do not have a lithic contact within 50 cm of the soil surface, and formed from country rock or from old alluvium.

Low bulk density and some amorphous clay are properties of Andepts, and a surface mantle that has these properties is used to define the andic subgroup.

Those who recall the proposed revisions in 1998 remember a thick document sent out for review. No one I communicated with noticed that with the moisture regime additions to Inceptisols that several categories had vanished. One was the Umbric Dystrochrepts. The ability to query an important interpretive place in the classification system was gone.

A snapshot from NASIS in 2002, using available reports, show that more than 1.3 million acres of soils in Umbric Subgroups no longer had a slot in the classification system. Not captured were acres for those reclassified to Humic or Andic subgroups.

So to fill the void, notes were added to the “Remarks” sections of Official Series Descriptions to capture the importance of the properties as series criteria. Here is an example of note added to an OSD to explain the change in taxonomic criteria:

Ochric epipedon - The zone from the surface to a depth of 12 inches (Oi and A horizons) The mineral soil materials (A horizon) of the ochric epipedon of Cashiers soils have properties similar to an umbric epipedon except for thickness. This feature is a result of the influence and interaction of a number of factors including aspect, climate, elevation, and vegetation. This feature was formerly identified at the subgroup level in earlier editions of Soil

Taxonomy. It remains as series criteria in the Blue Ridge (MLRA 130) because of its distinguishable influence on plant growth and diversity.

The following illustrates the trail of changes that finally resulted in restoring the importance of these soils in a higher level of the soil classification system:

1996 Keys to Soil Taxonomy

JD. Other Inceptisols that have *either*:

1. An ochric epipedon; *or*

2. A mesic or warmer soil temperature regime and an umbric or a mollic epipedon less than 25 cm thick.

Ochrepts, p. 338

JE. Other Inceptisols.

Umbrepts, p. 370

IDHO. Other Dystrochrepts that have an Ap horizon vith a color value, moist, of 3 or less and a color value, lry, of 5 or less (crushed and smoothed sample), or naterials between the soil surface and a depth of 18 :m which have these color values after mixing.

Umbric Dystrochrepts

1998 Keys to Soil Taxonomy

Former Typic Haplumbrepts became:

KFET. Other Dystrudepts that have an umbric or mollic epipedon.

Humic Dystrudepts

Former Umbric Dystrochrepts became:

KFEW. Other Dystrudepts.
Typic Dystrudepts

2002 Proposal to return the Umbric Subgroup:

KFET. Other Dystrudepts that have an ~~umbric or mollic epipedon,~~ an Ap horizon with a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed), or materials between the soil surface and a depth of 18cm which have these color values after mixing.
Humic Dystrudepts

11th Edition of the Keys to Soil Taxonomy

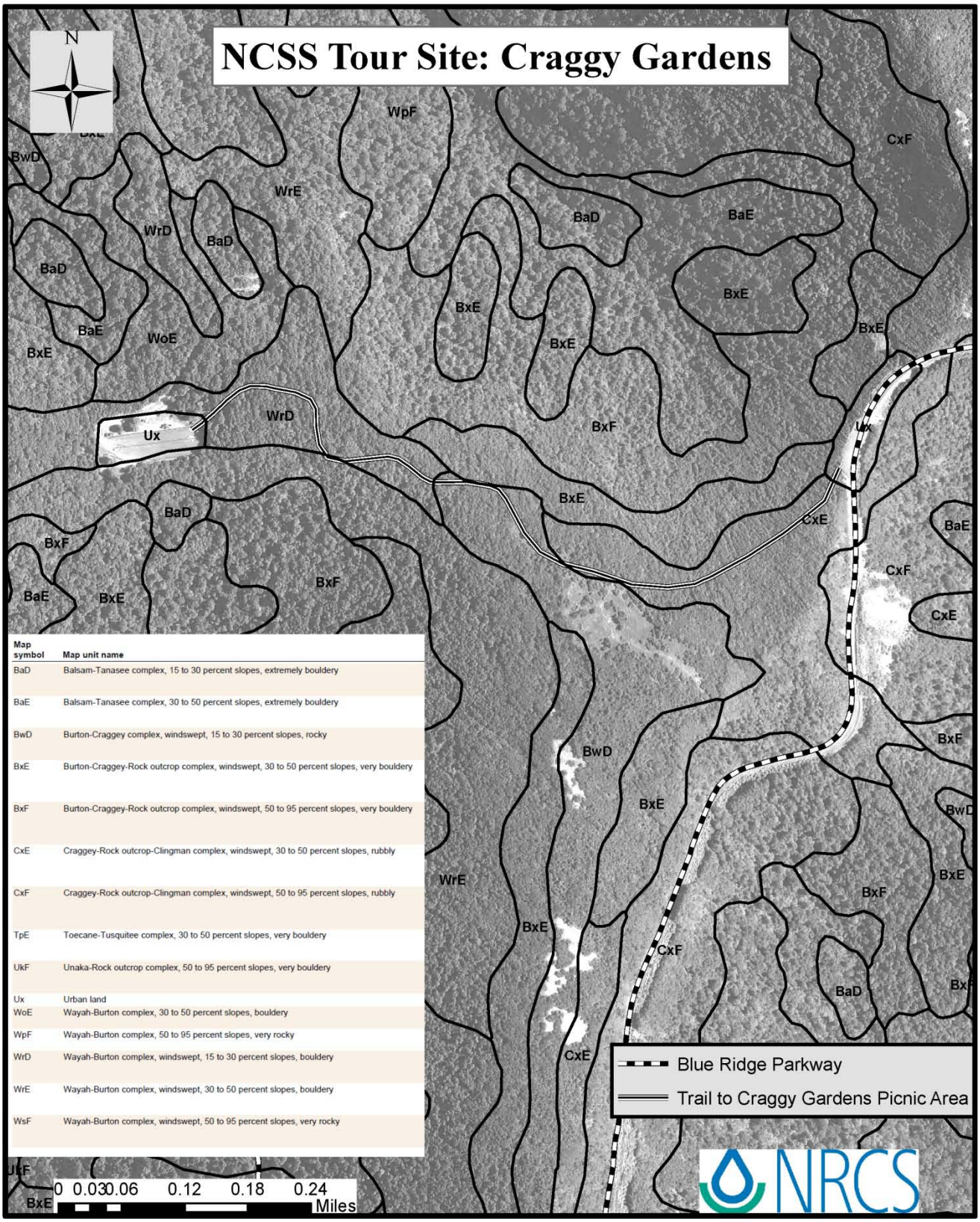
A new Great Group, Humudepts:

KGD. Other Udepts that have an umbric or mollic epipedon.
Humudepts, p. 180

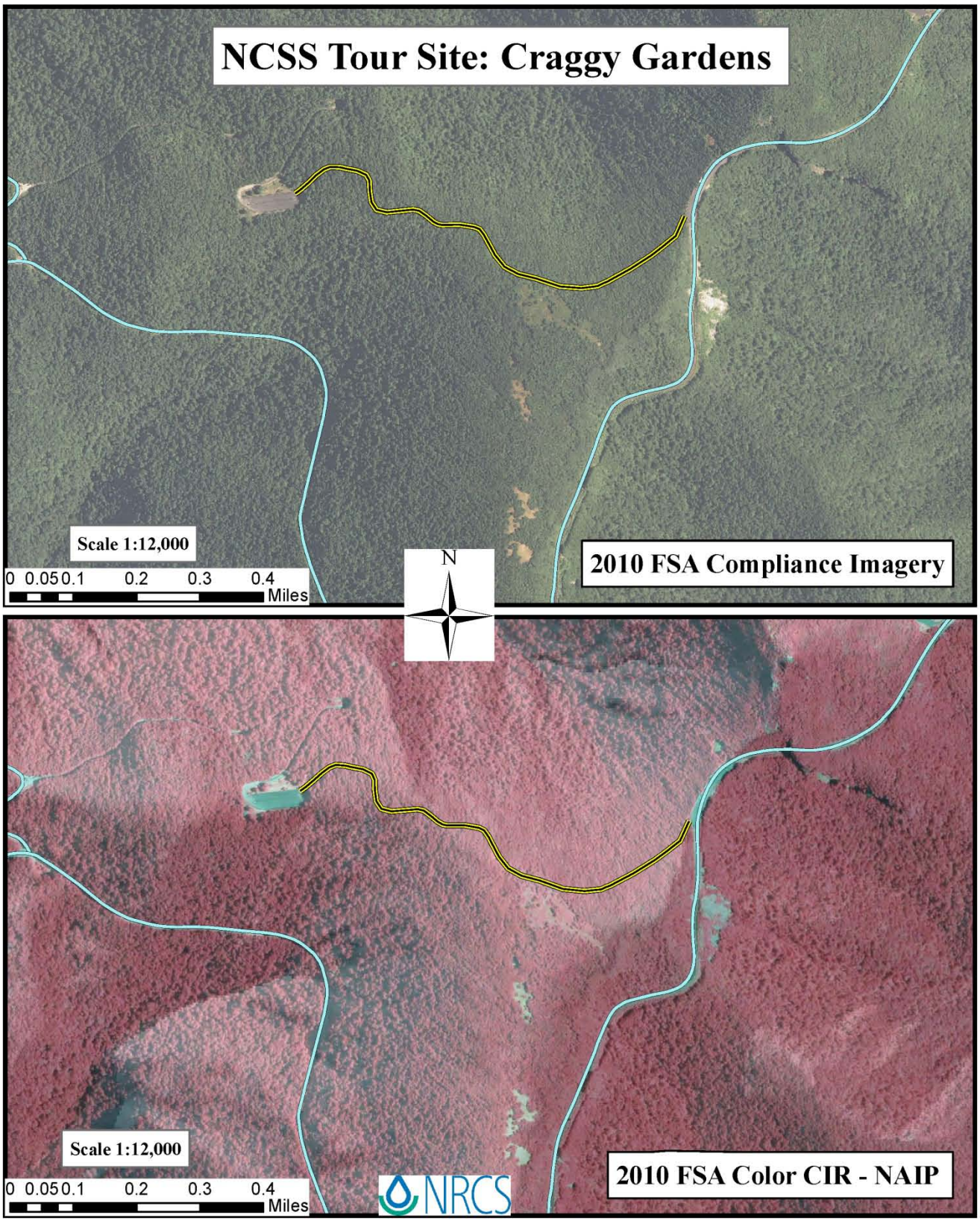
A resurrected Subgroup, Humic Dystrudepts for the old Umbric Dystrochrepts:

KGFV. Other Dystrudepts that have a color value, moist, of 3 or less and a color value, dry, of 5 or less (crushed and smoothed sample) either throughout the upper 18 cm of the mineral soil (unmixed) or between the mineral soil surface and a depth of 18 cm after mixing.
Humic Dystrudepts

Series	1996 Subgroup	1998 Subgroup	2010 Subgroup
Balsam	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Burton	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Cashiers	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts
Cheoah	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Chestoa	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts
Cullowhee	Aquic Haplumbrepts	Fluvaquentic Dystrudepts	Fluvaquentic Humudepts
Craggey	Lithic Haplumbrepts	Humic Lithic Dystrudepts	Lithic Humudepts
Crossnore	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts
Cullasaja	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Dellwood	Fluventic Haplumbrepts	Oxyaquic Dystrudepts	Oxyaquic Humudepts
Jeffrey	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts
Oconaluftee	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Plott	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Porters	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts
Reddies	Fluventic Haplumbrepts	Oxyaquic Dystrudepts	Oxyaquic Humudepts
Rosman	Fluventic Haplumbrepts	Fluventic Humic Dystrudepts	Fluventic Humudepts
Spivey	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Tanasee	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Transylvania	Cumulic Haplumbrepts	Humic Pachic Dystrudepts	Cumulic Humudepts
Tuckasegee	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Tusquitee	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts
Unaka	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts
Wayah	Typic Haplumbrepts	Humic Dystrudepts	Typic Humudepts
Whiteoak	Umbric Dystrochrepts	Typic Dystrudepts	Humic Dystrudepts



Map symbol	Map unit name
BaD	Balsam-Tanasee complex, 15 to 30 percent slopes, extremely bouldery
BaE	Balsam-Tanasee complex, 30 to 50 percent slopes, extremely bouldery
BwD	Burton-Craggey complex, windswept, 15 to 30 percent slopes, rocky
BxE	Burton-Craggey-Rock outcrop complex, windswept, 30 to 50 percent slopes, very bouldery
BxF	Burton-Craggey-Rock outcrop complex, windswept, 50 to 95 percent slopes, very bouldery
CxE	Craggey-Rock outcrop-Clingman complex, windswept, 30 to 50 percent slopes, rubbly
CxF	Craggey-Rock outcrop-Clingman complex, windswept, 50 to 95 percent slopes, rubbly
TpE	Toecane-Tusquitee complex, 30 to 50 percent slopes, very bouldery
UkF	Unaka-Rock outcrop complex, 50 to 95 percent slopes, very bouldery
Ux	Urban land
WoE	Wayah-Burton complex, 30 to 50 percent slopes, bouldery
WpF	Wayah-Burton complex, 50 to 95 percent slopes, very rocky
WrD	Wayah-Burton complex, windswept, 15 to 30 percent slopes, bouldery
WrE	Wayah-Burton complex, windswept, 30 to 50 percent slopes, bouldery
WsF	Wayah-Burton complex, windswept, 50 to 95 percent slopes, very rocky


NCSS Tour Site: Craggy Gardens
Scale 1:12,000
0 0.05 0.1 0.2 0.3 0.4
Miles
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2010 FSA Compliance Imagery
Scale 1:12,000
0 0.05 0.1 0.2 0.3 0.4
Miles
NRCS
2010 FSA Color CIR - NAIP

Craggy Pinnacle (left), Craggy Dome (right), and the Craggy Pinnacle tunnel as seen from the path through the Gardens. You can almost see the Visitor Center behind the mountain-ash tree. The trail enters a tunnel of Catawba Rhododendrons. This is a heath bald, and during June, the rhododendrons have large, purple flowers.

The trail travels from the Visitor Center, through a trail shelter at Craggy Flats, to the Craggy Gardens Picnic Area below in Bearpen Gap. The section of trail from the Visitor Center to the flats near the trail shelter is a short, self-guiding nature trail that travels uphill through a forest of stunted, twisted high-elevation mountain ash, birch, beech, and finally a heath bald. Shortly after leaving the parking area, you'll reach the intersection with the Mountains to Sea/Douglas Falls trail. The Mountains to Sea Trail stretches from the Blue Ridge to the Outer Banks. It is approximately a 20 minute hike to the shelter and back. Along the way, signs point out elements of the high-elevation environment and identify some of the plants and animals you may encounter. You'll pass under tunnels of tall, twisted Catawba Rhododendron and you'll pass a small spring along the way. At the end is the old trail shelter, built from Chestnut logs – a species long since relegated to stubby sprouts from dying root systems, due to an introduced blight.

Ecology of Heath Balds

Heath and grassy balds are an interesting ecological mystery. The lack of soil deep enough to support trees, generally associated with rock outcrops, would seem the obvious answer. A common theory is that balds are not actually natural communities but remnants of clearing my prehistoric native Americans or early settlers. Weigl and Knowles note that "the presence of both rare, endemic plants and northern relicts requiring open habitat suggests a long evolutionary history" and offer a scenario in which grazing pressure of the giant herbivores of the Pleistocene retained the open habitat as the Wisconsin glaciations retreated far to the north. With the arrival of the native Americans and the disappearance of megaherbivores, pressure was maintained by deer and elk, and then by the grazing animals of European settlers. Another idea of how balds have been created is fire (Blevins, Schafale 2010). However, Ice Age fauna have been extinct for over 10,000 years, native Americans gone for centuries, and heath balds aren't prone to intense fires since they are surrounded by moist forests. Whatever the case may be, balds don't stay bald.

A typical heath bald has 10-20 vascular species, dominated mostly by the heath family (Ericaceae), broad-leafed, evergreen shrubs adapted to xeric, acidic conditions. Nearly all the species found in balds are also understory species of the surrounding forests. These shrubs include Catawba rhododendron (*Rhododendron catawbiensis*), rosebay rhododendron (*R. maximum*), Carolina rhododendron (*R. carolinianum*), mountain laurel (*Kalmia latifolia*), and blueberries (*Vaccinium spp*.). Catawba rhododendron is dominant at higher elevations, and mixtures of the other species occupy lower sites (Schafale and Weakley 1990). Soils under the shrub cover are usually rocky, shallow, and acidic. The harsh soil conditions, heavy shrub cover, and thick leaf litter seem to preclude the establishment of trees making these stable, shrub dominated communities (Whittaker 1956; White et.al 1993). The largest heath balds occur on steep south- and west-facing slopes of high rugged ridges in the Great Smoky Mountains (White et al. 2001). They also found that many sites having similar topography were occupied by forest, not heath balds. One common theme is that heath balds occur in areas previously forested with a history of logging or windfall that eliminated the trees but not the understory shrubs.

Heath balds can be seen at Craggy Gardens on the Blue Ridge Parkway, and Roan Mountain in nearby Tennessee, and Newfound Gap Road in the Great Smoky National Park. Grassy balds (Andrews and Gregory Balds) can be seen on the Appalachian Trail.

***Rhododendron catawbiense* Michx.**
Catawba rosebay, Purple rhododendron, Red laurel, Catawba rhododendron, Mountain rosebay
Ericaceae (Heath Family)
USDA Symbol: RHCA8
USDA Native Status: Native to U.S.

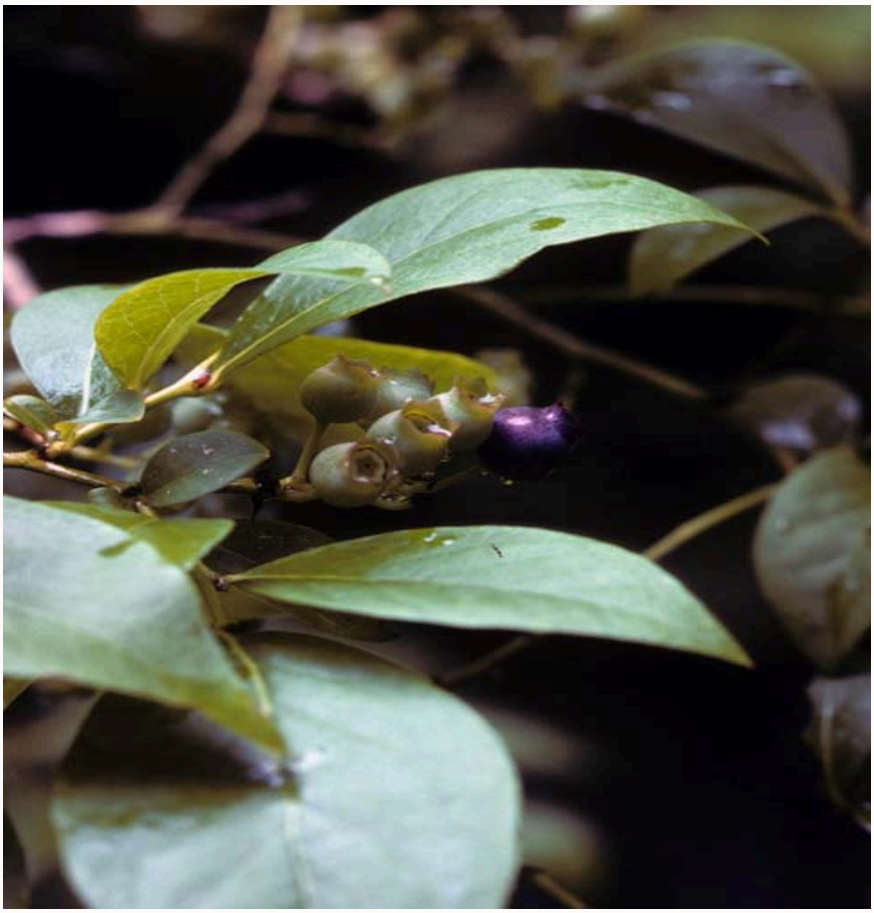
A mound-shaped, broadleaf evergreen shrub, 6-20 ft. tall, with stout, picturesque, ascending branches. The foliage is dense, thick, glossy and dark green, often in winter developing a yellow-green cast. The numerous bell-shaped, rosy-lilac flowers occur in dense, terminal clusters. An evergreen shrub with clusters of large, rose or purple-lilac, funnel-shaped flowers.

***Prunus pensylvanica* L. f.**
Pin cherry, Fire cherry
Rosaceae (Rose Family)
USDA Symbol: PRPE2
USDA Native Status: Native to U.S.

Fire cherry or pin cherry is a slender, sometimes shrubby, tree, 35-50 ft. tall. Fine-textured, bright red branches; reddish to yellow-orange, mature bark; flat-topped clusters of white flowers; and bright red fruit are some of the plant's attributes. Small tree or shrub with horizontal branches; narrow, rounded, open crown; shiny red twigs; bitter, aromatic bark and foliage; and tiny red cherries. Fall foliage is colorful.

***Vaccinium corymbosum* L.**
Highbush blueberry
Ericaceae (Heath Family)
USDA Symbol: VACO
USDA Native Status: Native to U.S.

This blueberry species is a 6-12 ft. high and wide, deciduous shrub with numerous upright stems and twiggy branches forming a rounded, compact outline. Reddish-green spring leaves turn blue-green in summer and red, yellow, orange and purple in fall. White or pink, bell-shaped flowers in drooping clusters are followed by edible, blue fruit. A multi-stemmed shrub with green, or often red, twigs and terminal clusters of small, urn-shaped white flowers.



***Kalmia latifolia* L.**
Mountain laurel, Calico bush
Ericaceae (Heath Family)
Synonyms: *Kalmia latifolia var. laevipes*
USDA Symbol: KALA
USDA Native Status: Native to U.S.

The broadleaf evergreen mountain-laurel is usually a 12-20 ft. shrub, but is occasionally taller and single-trunked, attaining small tree stature. Evergreen, many-stemmed, thicket-forming shrub or sometimes a small tree with short, crooked trunk; stout, spreading branches; a compact, rounded crown; and beautiful, large, pink flower clusters. Its flowers are very showy. They are bell-shaped, white to pink with deep rose spots inside, and occur in flat-topped clusters. The leaves are oval, leathery, and glossy, and change from light-green to dark-green to purple throughout the year.

***Diervilla sessilifolia* Buckl.**
Southern bush honeysuckle, Southern bush-honeysuckle
Caprifoliaceae (Honeysuckle Family)
USDA Symbol: DISE
USDA Native Status: Native to U.S.

A low shrub with sulfur-yellow flowers in clusters of 3-7 atop stems and atop small, nearly square branches. Southern bush-honeysuckle is a low-growing, suckering shrub, 3-5 ft. high and at least as wide. The foliage is dark-green, often with red veins and stems, and seldom colors in the fall. Small, but abundant, yellow flowers are borne on the tip of new growth.

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Craggey Series

CRAGGEY SERIES

The Craggey series consists of shallow, somewhat excessively drained, loamy soils on ridges and side slopes at high elevations in the Southern Blue Ridge mountains, MLRA 130B. They formed in residuum that is affected by soil creep and weathered from felsic to mafic, igneous and high-grade metamorphic rocks. Near the type location, mean annual air temperature is 40 degrees F., and mean annual precipitation is 64 inches. Slopes range from 8 to 95 percent.

TAXONOMIC CLASS: Loamy, isotic, frigid Lithic Humudepts

TYPICAL PEDON: Craggey loam on an 18 percent ridge top at an elevation of 5,812 feet--heath bald vegetation. (Colors are for moist soil unless otherwise stated.)

Oe--0 to 1 inch; mat of decomposing leaves and twigs laced with many fine live roots.

A1--1 to 8 inches; very dark brown (10YR 2/2) loam; weak fine granular structure; very friable; many very fine and few medium roots; 3 percent by volume gravel; common very fine and fine flakes of mica, very strongly acid; clear smooth boundary.

A2--8 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam; weak medium granular structure; very friable; few very fine and fine roots; 5 percent by volume gravel; strongly acid; clear wavy boundary. (Combined thickness of the A horizon is 10 to 20 inches thick)

R--14 inches; hard, high-grade metagraywacke and kyanite garnet mica schist bedrock.

TYPE LOCATION: Buncombe County, North Carolina; 18.5 miles northeast of Asheville on Blue Ridge Parkway; 0.25 miles west on Craggey Pinnacle Trail, 50 feet west of trail in a grassy area; USGS Craggy Pinnacle topographic quadrangle; lat. 35 degrees 42 minutes 14 seconds N. and long. 82 degrees 22 minutes 40 seconds W., NAD 27.

Craggey series was initially placed in a mesic soil temperature class. Soil temperature data collected in North Carolina support placement of this series in the frigid soil temperature class. Although Craggey soils may exhibit some of the characteristics of andic soil properties, they lack the volcanic glass found in soils of similar taxa in the Western United States.

Diagnostic horizons and features recognized in this pedon are:

Umbric epipedon - the zone from the mineral soil surface to a depth of 14 inches (A1 and A2 horizons)
Lithic contact - the occurrence of hard bedrock at a depth of 14 inches (R horizon)
Isotic mineralogy class - In more than one-half of the control section, a 1500 kPa water to clay ratio of 0.6 or more and a pH in NaF solution of more than 8.4.

Sampled as on Oct 01, 1991 : Craggey ; Loamy, mixed, frigid Lithic Haplumbrept
Revised to correlated on Aug 01, 1996 : Craggey ; Loamy, isotic, frigid Lithic Haplumbrept

SSL - Project CP92NC019 MOUNTAIN SOILS - BUNCOMBE COUNTY
- Site ID 91NC021009 Lat: 35° 42' 28.00" north Long: 82° 22' 7.00" west NAD27 MLRA: 130
- Pedon No. 92P0089
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
92P00644	Oe	OE	3-0					
92P00645	A1	A1	0-17				L	SL
92P00646	A2	A2	17-32				SL	LCOS

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	9.79	(NA)
Clay, carbonate free, Weighted Average	7	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	64	% wt
Volume, >2mm, Weighted Average	1	% vol
Clay, total, Weighted Average	7	% wt

Weighted averages based on control section: 0-32 cm

PSDA & Rock Fragments

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
																(- - - - - - - - Weight - - - - - - - -)				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC					>2 mm
	Depth			< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2	2 -5	5 -20	20 -75	.1- 75	wt % whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - -)				soil
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
92P00644	3-0	Oe	S													2	tr	--		
92P00645	0-17	A1	S	11.7	22.2	66.1	1.6		14.2	8.0	11.0	17.4	16.8	13.0	7.9	2	tr	--	56	2
92P00646	17-32	A2	S	1.4	17.3	81.3	--		10.2	7.1	11.1	22.3	20.2	18.1	9.6	4	2	--	72	6

*** Primary Characterization Data ***

Pedon ID: 91NC021009 (Buncombe, North Carolina) Print Date: Apr 27 2011 3:30PM

Sampled As : Craggey Loamy, mixed, frigid Lithic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0089

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa (- - - g cm^{-3} - - -) 4A1d	-2- Oven Dry 4A1h	-3- Cole Whole Soil	-4- (- - - - - - - - - - Water Content - - - - - - - - - -) 6 kPa (- - - - - - - - - - - - % of < 2mm - - - - - - - - - -)	-5- 10 kPa	-6- 33 kPa 4B1c	-7- 1500 kPa 4B2a	-8- 1500 kPa Moist	-9- Ratio AD/OD 4B5	-10- WRD Whole Soil cm^3 cm^{-3} 4C1	-11- Aggst Stabl 2-0.5mm %	-12- (- - Ratio/Clay - -) CEC7 8D1	-13- 1500 kPa 8D1
92P00644	3-0	Oe	S							26.9		1.051				
92P00645	0-17	A1	S	0.69	0.85	0.072			52.5	21.9		1.038	0.21		5.63	1.87
92P00646	17-32	A2	S	0.83	0.97	0.052			61.8	9.7		1.028	0.42		14.50	6.93

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (- - Atterberg - -) (- - - Limits - - -) LL PI pct <0.4mm	-2-	-3- (- - - - - Bulk Density - - - -) Field (- - - - - - - - g cm^{-3} - - - - -)	-4- Recon 33 kPa	-5- Recon Oven Dry	-6- (- Water Content -) Field (- % of < 2mm -)	-7- Recon 33 kPa	-8- (- - - - - - - - - - - - - - Sieved Samples - - - - - - - - - - - -) 6 kPa	-9- 10 kPa	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa 4B1a	-13- 500 kPa
92P00644	3-0	Oe	S												63.0	
92P00645	0-17	A1	S												28.1	
92P00646	17-32	A2	S												13.6	

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (- - - - - Total - - - - - -) C (- - - - - - % of <2 mm - - - - -) 6A2d	-2- N 6B3a	-3- S	-4- Org C 6A1c	-5- C/N Ratio	-6- (- - - Dith-Cit Ext - - - -) Fe (- % of < 2mm - - - - - - - - - - - - - - - -) 6C2b	-7- Al 6G7a	-8- Mn 6D2a	-9- (- - - - - - Ammonium Oxalate Extraction - - - - - -) Al+½Fe	-10- ODOE 8J	-11- Fe 6C9b	-12- Al 6G12b	-13- Si 6V2b	-14- Mn mg kg^{-1} 6D5b	-15- (- - - Na Pyro-Phosphate - - -) C (- - - - - - % of < 2mm - - - - -)	-16- Fe 6C8a	-17- Al 6G10	-18- Mn
92P00644	3-0	Oe	S	27.71	1.117		22.91	21	1.8	0.5	tr		0.37	1.30	0.58	0.09	556.9		1.4	tr	
92P00645	0-17	A1	S		0.516		8.75		2.5	0.8	tr	1.91	0.42	1.99	0.91	0.06	107.4		2.0	tr	
92P00646	17-32	A2	S		0.161		3.06		1.6	0.6	--	1.66	0.43	1.38	0.97	0.07	--		1.2	0.3	

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)													
				(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	6D3b	5A3a	5A8b	5A3b	5G1	5C3	5C1
92P00644	3-0	Oe	S	6.2	1.5	0.6	15.2		44.0	3.2	14.4		72.2				
92P00645	0-17	A1	S	1.0	0.2	0.1	0.2	1.5	42.1	3.9	1.2	43.6	65.9	5.4	72	3	2
92P00646	17-32	A2	S	--	tr	0.1	tr	0.1	27.6	2.7	--	27.7	20.3	2.8	96	tr	0

Salt

(- Water Extracted From Saturated Paste -)

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- - - - - mmol(+) L^{-1} - - - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
92P00645	0-17	A1	S																			tr	
92P00646	17-32	A2	S																			tr	

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- pH KCl	-2- pH $CaCl_2$ 0.01M 1:2	-3- pH H_2O 1:1	-4- pH Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4$*$2H_2O$ <2mm	-10- Gypsum As $CaSO_4$*$2H_2O$ <20mm	-11- Resist ohms cm^{-1}
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - - -)						(- - - - - - - - - - - - % - - - - - - - - - - - -)				
				8C1g	4C1a2a	4C1a2a			8C1d					
92P00644	3-0	Oe	S	3.7	4.0	4.4			6.0					
92P00645	0-17	A1	S	4.1	4.2	4.8			10.2					
92P00646	17-32	A2	S	4.3	4.4	4.8			11.3					

*** Primary Characterization Data ***

Pedon ID: 91NC021009 (Buncombe, North Carolina) Print Date: Apr 27 2011 3:30PM

Sampled As : Craggey Loamy, mixed, frigid Lithic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0089

Organic				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				Mineral	OM	OM+	(- Total -)			Fiber Content		NaPyro	Decomp	Limnic	(- - pH - -)		(- - Bulk Density - -)			Proj
	Depth			Content	TC*1.724	Min	C	N	C/N	Unrub	Rub	Color	State	Matter	$CaCl_2$	H_2O	33 kPa	33 kPa rewet	OD	Subs
Layer	(cm)	Horz	Prep	(- - - - - - - - % - - - - - - - -)					ratio	% (by vol)								g cm^{-3}		cm cm^{-1}
				8F1			6A2d	6B3a								4C1a2a				
92P00644	3-0	Oe	S	39			27.71	1.117	21							4.4				
92P00645	0-17	A1	S					0.516								4.8				1
92P00646	17-32	A2	S					0.161								4.8				2

Phosphorous				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-
					(- Phosphorous - - - - - - - - - - - - - - - - - -)								
	Depth			Melanic Index	NZ	Acid Oxal	Bray 1	Bray 2	Olsen	H_2O	Citric Acid	Mehlich III	Extr NO_3
Layer	(cm)	Horz	Prep		%	(- -mg kg^{-1} - - - - - - - - - - - - - - - - -)							mg kg^{-1}
					6S4								
92P00645	0-17	A1	S		82								
92P00646	17-32	A2	S		80								

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray						Thermal			Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract	7A2i						7A4b			7C3								tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - - -)						(- - - - - - - - - % - - - - - - - - - -)			(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00646	17-32	A2	tcly	KK 1	VR 1						KK 31	GI 21		7	5.7			--			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GI - Gibbsite KK - Kaolinite VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray						Thermal				Optical						EGME	Inter
													Tot Re	Grain Count						Retn	preta
	Depth		Fract											7B1a							tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - -)						(- - - - - - - - - % - - - - - - - - -)			(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00646	17-32	A2	fs										11	BT 76	MS 9	QZ 9	PR 2	OT 2	OP 1		
														GN 1							

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite GN - Garnet MS - Muscovite OP - Opaques OT - Other

PR - Pyroxene QZ - Quartz

*** Primary Characterization Data ***

Pedon ID: 91NC021009 (Buncombe, North Carolina) Print Date: Apr 27 2011 3:30PM

Sampled As : Craggey Loamy, mixed, frigid Lithic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0089

Fine Earth Mineralogy (<2.0 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray				Thermal						Elemental				EGME	Interpretation
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn 7D2	
				(- - - - - - - - - - peak size - - - -					(- - - - - - - - - % - - - - - -				(- % - - - - - - - - - - - - - -							mg g^{-1}	
92P00644	3-0	Oe	feth																	55.0	
92P00645	0-17	A1	feth																	27.0	
92P00646	17-32	A2	feth																	19.0	

FRACTION INTERPRETATION:

feth - Fine Earth, <2 mm

MINERAL INTERPRETATION:

eg - Surface Area

WAYAH PEDON DESCRIPTION – FRIGID RESIDUAL SOILS

Print Date: 05/01/2011
Description Date: 9/1/1991
Describer: Mark S. Hudson, Milton Martinez, John B. Allison
Site ID: 91NC021005
Pedon Note: Vegetation: sugar maple, yellow birch.
Lab Source ID: SSL
Lab Pedon #: 92P0085
Soil Name as Described/Sampled: Wayah
Soil Name as Correlated: Wayah
Classification: Fine-loamy, isotic, frigid Andic Haplumbrepts
Physiographic Division:
Physiographic Province:
Upslope Shape: undulating
Particle Size Control Section: 25 to 99 cm.
Description origin: Converted from SSL-CMS data
Diagnostic Features: umbric epipedon 0 to 38 cm.
cambic horizon 64 to 114 cm.

Country:
State: North Carolina
County: Buncombe
MLRA: 130 -- Blue Ridge
Quad Name:

Legal Description:
Latitude: 35 degrees 42 minutes 5.00 seconds north
Longitude: 82 degrees 23 minutes 23.00 seconds west
Datum:
Primary Earth Cover: Tree cover
Secondary Earth Cover: Hardwoods
Bedrock Hardness:
Surface Fragments: 0.1 percent
Description database: NSSL

Cont. Site ID: 91NC021005 **Pedon ID:** 91NC021005

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
35.0	1,573.0	0				160		well		

Oi--5 to 3 centimeters. No sample

Oe--3 to 0 centimeters. (Lab sample # 92P0618).

A1--0 to 8 centimeters; black (10YR 2/1) loam; weak fine granular structure; very friable, nonsticky, nonplastic; many very fine and fine and common medium and coarse roots throughout; many very fine and fine interstitial and tubular pores; 1 percent very fine and fine platy mica flakes, unspecified; 1 percent 250- to 600-millimeter unspecified fragments and 1 percent 75- to 250-millimeter unspecified fragments; extremely acid, pH 4.0, Hellige-Truog; abrupt smooth boundary. Lab sample # 92P0619 (0-4 cm) and 92P0620 (4-8 cm).

A2--8 to 20 centimeters; very dark brown (10YR 2/2) loam; weak fine and medium granular structure; very friable, nonsticky, nonplastic; many very fine and fine and common medium and coarse roots between peds; common very fine and fine and few medium vesicular and tubular pores; 1 percent very fine and fine mica flakes, unspecified; 1 percent 75- to 250-millimeter unspecified fragments and 1 percent 2- to 75-millimeter unspecified fragments; very strongly acid, pH 4.5, Hellige-Truog; abrupt smooth boundary. (Lab sample # 92P0621).

A3--20 to 38 centimeters; dark brown (10YR 3/3) loam; weak fine and medium granular structure; very friable, nonsticky, nonplastic; common very fine, fine, medium and coarse roots between peds; many fine and few medium vesicular and tubular pores; 1 percent very fine and fine mica flakes, unspecified; 1 percent 250- to 600-millimeter unspecified fragments and 1 percent 75- to 250-millimeter unspecified fragments; very strongly acid, pH 4.5, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0622).

BA--38 to 64 centimeters; dark yellowish brown (10YR 4/4) sandy loam; 11 percent medium faint dark yellowish brown (10YR 3/4) mottles; weak fine subangular blocky structure; friable, nonsticky, nonplastic; common very fine

and fine and few medium and coarse roots between peds; many fine and few medium vesicular and tubular pores; 1 percent very fine and fine mica flakes, unspecified; 2 percent 250- to 600-millimeter unspecified fragments and 3 percent 2- to 75-millimeter unspecified fragments and 7 percent 75- to 250-millimeter unspecified fragments; very strongly acid, pH 5.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0623).

Bw1--64 to 89 centimeters; dark yellowish brown (10YR 4/6) sandy loam; weak medium and coarse subangular blocky structure; friable, nonsticky, nonplastic; few very fine and fine and common medium roots between peds; few fine vesicular and tubular and few fine tubular pores; 1 percent very fine and fine mica flakes, unspecified; 3 percent 250- to 600-millimeter unspecified fragments and 3 percent 75- to 250-millimeter unspecified fragments and 3 percent 2- to 75-millimeter unspecified fragments; strongly acid, pH 5.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0624).

Bw2--89 to 117 centimeters; dark yellowish brown (10YR 4/6) fine sandy loam; weak medium and coarse subangular blocky structure; friable, nonsticky, nonplastic; few medium roots between peds; few fine tubular pores; 1 percent very fine and fine mica flakes, unspecified; 4 percent 250- to 600-millimeter unspecified fragments and 6 percent 2- to 75-millimeter unspecified fragments and 10 percent 75- to 250-millimeter unspecified fragments; strongly acid, pH 5.5, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0625).

BC--117 to 150 centimeters; yellowish brown (10YR 5/4) sandy loam; weak fine subangular blocky structure; very friable, nonsticky, nonplastic; few very fine roots between peds; few very fine tubular pores; 1 percent very fine and fine mica flakes, unspecified; 2 percent 250- to 600-millimeter unspecified fragments and 5 percent 2- to 75-millimeter unspecified fragments and 10 percent 75- to 250-millimeter unspecified fragments; moderately acid, pH 6.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0626).

C--150 to 203 centimeters; yellowish brown (10YR 5/4) coarse sandy loam saprolite; massive; very friable, nonsticky, nonplastic; few very fine roots between peds; few very fine tubular pores; 1 percent very fine and fine mica flakes, unspecified; 5 percent 75- to 250-millimeter unspecified fragments and 5 percent 2- to 75-millimeter unspecified fragments; moderately acid, pH 6.0, Hellige-Truog. (Lab sample # 92P0627).

*** Primary Characterization Data ***

Pedon ID: 91NC021005 (Buncombe, North Carolina) Print Date: May 1 2011 8:13AM

Sampled as on Sep 01, 1991 : Wayah ; Coarse-loamy, mixed, frigid Typic Haplumbrept
Revised to correlated on Aug 01, 1996 : Wayah ; Fine-loamy, isotic, frigid Andic Haplumbrept

SSL - Project CP92NC019 MOUNTAIN SOILS - BUNCOMBE COUNTY
- Site ID 91NC021005 Lat: 35° 42' 5.00" north Long: 82° 23' 23.00" west MLRA: 130
- Pedon No. 92P0085
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
92P00618	Oe	OE	2-0					
92P00619	Oa	OA	0-4				L	SL
92P00620	A1	A1	4-8				L	SCL
92P00621	A2	A2	8-19				L	FSL
92P00622	A3	A3	19-39				L	SL
92P00623	BA	BA	39-64				SL	FSL
92P00624	Bw1	BW1	64-89				SL	SL
92P00625	Bw2	BW2	89-117				FSL	SL
92P00626	BC	BC	117-150				SL	SL
92P00627	C	C	150-200				COSL	LS

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	2.87	(NA)
Clay, carbonate free, Weighted Average	7	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	59	% wt
Volume, >2mm, Weighted Average	14	% vol
Clay, total, Weighted Average	7	% wt

Weighted averages based on control section: 25-100 cm

*** Primary Characterization Data ***

Pedon ID: 91NC021005 (Buncombe, North Carolina) Print Date: May 1 2011 8:13AM

Sampled As : Wayah Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0085

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay < .002	-2- Total Silt .002 -.05	-3- Total Sand .05 -2	-4- Clay Fine < .0002	-5- Clay CO_3 < .002	-6- Silt Fine .002 -.02	-7- Silt Coarse .02 -.05	-8- Sand VF .05 -.10	-9- Sand F .10 -.25	-10- Sand M .25 -.50	-11- Sand C .5 -1	-12- Sand VC 1 -2	-13- Rock Fragments (mm) Weight 2 -5	-14- 5 -20	-15- 20 -75	-16- .1-75	-17- >2 mm wt % whole soil
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
92P00618	2-0	Oe	S													1	1	--		
92P00619	0-4	Oa	S	8.7	26.5	64.8	3.1		17.4	9.1	11.7	15.2	15.6	14.6	7.7	3	4	--	56	13
92P00620	4-8	A1	S	21.1	27.5	51.4	7.4		19.0	8.5	10.8	15.8	13.7	7.7	3.4	1	1	1	42	7
92P00621	8-19	A2	S	12.7	34.9	52.4	3.0		25.7	9.2	11.1	14.8	13.6	9.3	3.6	1	1	3	44	8
92P00622	19-39	A3	S	4.5	27.1	68.4	0.9		17.2	9.9	14.9	22.3	16.5	10.1	4.6	1	1	10	59	16
92P00623	39-64	BA	S	7.2	30.8	62.0	0.8		22.1	8.7	12.2	21.7	13.8	9.2	5.1	2	1	7	55	26
92P00624	64-89	Bw1	S	8.4	27.5	64.1	1.2		19.7	7.8	12.8	19.7	15.8	10.2	5.6	4	7	6	60	27
92P00625	89-117	Bw2	S	8.3	26.3	65.4	1.0		18.1	8.2	11.6	21.8	17.3	10.1	4.6	4	5	14	64	41
92P00626	117-150	BC	S	5.6	20.5	73.9	1.2		13.3	7.2	11.9	22.7	19.0	13.1	7.2	7	9	11	72	42
92P00627	150-200	C	S	6.1	17.5	76.4	1.1		10.4	7.1	11.7	25.6	18.4	13.4	7.3	8	9	8	74	31

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa	-2- Oven Dry	-3- Cole Whole Soil	-4- Water Content 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- Ratio/Clay CEC7	-13- 1500 kPa
				(- - - g cm^{-3} - - -)			% of < 2mm						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a		4B5	4C1		8D1	8D1
92P00618	2-0	Oe	S							76.2		1.063				
92P00619	0-4	Oa	S							27.5		1.043			5.22	3.16
92P00620	4-8	A1	S							23.5		1.041			1.75	1.11
92P00621	8-19	A2	S	0.82	1.00	0.066			59.9	17.9		1.041	0.34		2.33	1.41
92P00622	19-39	A3	S	0.95	1.06	0.035			48.2	15.7		1.041	0.29		6.24	3.49
92P00623	39-64	BA	S	1.11	1.17	0.015			36.8	13.1		1.035	0.23		2.68	1.82
92P00624	64-89	Bw1	S	1.19	1.24	0.012			33.1	10.2		1.026	0.23		1.73	1.21
92P00625	89-117	Bw2	S	1.20	1.23	0.006			27.5	9.7		1.022	0.16		1.64	1.17
92P00626	117-150	BC	S	1.16	1.21	0.011			28.9	6.7		1.018	0.20		1.52	1.20
92P00627	150-200	C	S							5.9		1.015			1.18	0.97

*** Primary Characterization Data ***

Pedon ID: 91NC021005 (Buncombe, North Carolina) Print Date: May 1 2011 8:13AM

Sampled As : Wayah Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0085

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (Atterberg Limits) LL	-2- PI	-3- (Bulk Density) Field	-4- Recon 33 kPa	-5- Recon Oven Dry	-6- (Water Content) Field	-7- Recon 33 kPa	-8- (Sieved Samples) 6 kPa	-9- 10 kPa	-10- 33 kPa	-11- 100 kPa	-12- 200 kPa	-13- 500 kPa
				pct <0.4mm		(g cm^{-3})			(% of < 2mm)							
															4B1a	
92P00618	2-0	Oe	S												84.7	
92P00619	0-4	Oa	S												44.9	
92P00620	4-8	A1	S												31.4	
92P00621	8-19	A2	S												24.9	
92P00622	19-39	A3	S												21.6	
92P00623	39-64	BA	S												20.7	
92P00624	64-89	Bw1	S												18.3	
92P00625	89-117	Bw2	S												17.1	
92P00626	117-150	BC	S												12.7	
92P00627	150-200	C	S												12.2	

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (Total) C	-2- N	-3- S	-4- Org C	-5- C/N Ratio	-6- (Dith-Cit Ext) Fe	-7- Al	-8- Mn	-9- (Ammonium Oxalate Extraction) Al+½Fe	-10- ODOE	-11- Fe	-12- Al	-13- Si	-14- Mn	-15- (Na Pyro-Phosphate) C	-16- Fe	-17- Al	-18- Mn
				(% of <2 mm)					(% of < 2mm)								mg kg^{-1}	(% of < 2mm)			
				6A2d	6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9b	6G12b	6V2b	6D5b		6C8a	6G10	
92P00618	2-0	Oe	S	36.06	2.082		46.35	22	1.0	0.3	tr		0.18	0.42	0.23	0.06	107.3		0.6	0.2	
92P00619	0-4	Oa	S		0.683		18.24		2.5	0.6	tr	1.24	0.82	1.41	0.53	0.06	47.9		1.7	0.5	
92P00620	4-8	A1	S		0.623		11.31		3.1	0.8	tr	1.67	0.72	1.76	0.79	0.06	--		1.8	0.7	
92P00621	8-19	A2	S		0.470		7.04		3.2	1.0	tr	1.89	0.64	1.85	0.96	0.06	85.2		2.0	0.9	
92P00622	19-39	A3	S		0.317		4.90		3.3	1.5	tr	2.76	0.47	2.05	1.73	0.20	256.9		1.9	1.3	
92P00623	39-64	BA	S		0.295		2.36		2.4	1.4	tr	2.43	0.22	1.31	1.78	0.41	221.6		1.0	0.8	
92P00624	64-89	Bw1	S				1.43		1.9	0.9	tr	1.88	0.13	0.97	1.40	0.38	386.8		0.5	0.5	
92P00625	89-117	Bw2	S				1.11		1.5	0.6	tr	1.47	0.10	0.72	1.11	0.32	327.6		0.4	0.5	
92P00626	117-150	BC	S				0.56		1.2	0.4	tr	1.21	0.07	0.56	0.93	0.31	268.5		0.1	0.3	
92P00627	150-200	C	S				0.44		1.1	0.3	tr	1.03	0.06	0.44	0.81	0.29	286.7		0.1	0.3	

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
				Ca	Mg	Na	K	Sum Bases	Acid-ity	Extr Al	KCl Mn	Sum Cats	NH_4 OAC	Bases +Al	Al Sat	(- Saturation -) Sum	NH_4OAC
				(- cmol(+) kg^{-1} -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	6D3b	5A3a	5A8b	5A3b	5G1	5C3	5C1
92P00618	2-0	Oe	S	10.8	2.9	0.3	2.0		0.6	4.3	11.5		95.8				
92P00619	0-4	Oa	S	0.4	0.6	0.3	0.6	1.9	62.6	8.8	0.5	64.5	45.4	10.7	82	3	4
92P00620	4-8	A1	S	0.1	0.3	0.2	0.3	0.9	55.8	8.5	0.2	56.7	36.9	9.4	90	2	2
92P00621	8-19	A2	S	--	0.1	0.1	0.3	0.5	44.2	5.8	0.1	44.7	29.6	6.3	92	1	2
92P00622	19-39	A3	S	--	0.1	0.1	0.1	0.3	39.6	3.2	0.1	39.9	28.1	3.5	91	1	1
92P00623	39-64	BA	S	--	tr	0.1	0.1	0.2	27.6	1.4	tr	27.8	19.3	1.6	88	1	1
92P00624	64-89	Bw1	S	--	0.1	0.1	0.1	0.3	15.4	1.2	tr	15.7	14.5	1.5	80	2	2
92P00625	89-117	Bw2	S	--	--	0.1	tr	0.1	15.4	1.2	tr	15.5	13.6	1.3	92	1	1
92P00626	117-150	BC	S	--	--	0.1	tr	0.1	11.2	0.5	--	11.3	8.5	0.6	83	1	1
92P00627	150-200	C	S	--	--	0.1	--	0.1	8.8	0.2	tr	8.9	7.2	0.3	67	1	1

Salt

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-
				(- Water Extracted From Saturated Paste -)																	Pred		
				Ca	Mg	Na	K	CO_3	HCO_3	F	Cl	PO_4	Br	OAC	SO_4	NO_2	NO_3	H_2O	Total Salts	Elec Cond	Elec Cond	Exch Na	SAR
				(- - - - - mmol(+) L^{-1} - - -)				(- mmol(-) L^{-1} -)										(- - - - % - - - -)		(- - dS m^{-1} - -)		%	
																						5D2	
92P00619	0-4	Oa	S																			1	
92P00620	4-8	A1	S																			1	
92P00621	8-19	A2	S																			tr	
92P00622	19-39	A3	S																			tr	
92P00623	39-64	BA	S																			1	
92P00624	64-89	Bw1	S																			1	
92P00625	89-117	Bw2	S																			1	
92P00626	117-150	BC	S																			1	
92P00627	150-200	C	S																			1	

*** Primary Characterization Data ***

Pedon ID: 91NC021005 (Buncombe, North Carolina) Print Date: May 1 2011 8:13AM

Sampled As : Wayah Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0085

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - -)						(- - Carbonate - -)		(- - Gypsum - - -)		
					$CaCl_2$					As $CaCO_3$		As $CaSO_4*2H_2O$		Resist
	Depth				0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - - - - - - - - - - % - - - - - - - - - - -)				cm^{-1}
				8C1g	4C1a2a	4C1a2a			8C1d					
92P00618	2-0	Oe	S	2.9	3.1	3.8			6.1					
92P00619	0-4	Oa	S	3.2	3.3	3.5			7.0					
92P00620	4-8	A1	S	3.6	3.7	3.9			8.4					
92P00621	8-19	A2	S	3.9	4.0	4.4			10.1					
92P00622	19-39	A3	S	4.2	4.4	4.8			11.3					
92P00623	39-64	BA	S	4.5	4.6	5.0			11.4					
92P00624	64-89	Bw1	S	4.4	4.7	4.9			11.1					
92P00625	89-117	Bw2	S	4.4	4.6	5.0			11.0					
92P00626	117-150	BC	S	4.6	4.8	5.2			10.8					
92P00627	150-200	C	S	4.7	5.0	5.6			10.6					

Phosphorous

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-
					(- Phosphorous - - - - - - - - - - - - - - - - - - -)								
	Depth			Melanic Index	NZ	Acid Oxal	Bray 1	Bray 2	Olsen	H_2O	Citric Acid	Mehlich III	Extr NO_3
Layer	(cm)	Horz	Prep		%	(- -mg kg^{-1} - - - - - - - - - - - - - - - - - -)							mg kg^{-1}
					6S4								
92P00618	2-0	Oe	S		27								
92P00619	0-4	Oa	S		68								
92P00620	4-8	A1	S		85								
92P00621	8-19	A2	S		87								
92P00622	19-39	A3	S		100								
92P00623	39-64	BA	S		97								
92P00624	64-89	Bw1	S		86								
92P00625	89-117	Bw2	S		78								
92P00626	117-150	BC	S		56								
92P00627	150-200	C	S		53								

Clay Mineralogy (<.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray					Thermal				Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract	7A2i					7A4b				7C3								tion
Layer	(cm)	Horz	ion	(---------- peak size ----------)					(---------- % ----------)				(-------------------- % --------------------)							mg g^{-1}	
92P00622	19-39	A3	tcly	VR 2	GI 2	KK 2	MI 1				KK 40	GI 23		12	8.4			1.0			
92P00624	64-89	Bw1	tcly	GI 3	KK 1	VR 1	MM 1	MI 1			KK 33	GI 20		20	6.3			1.0			
92P00627	150-200	C	tcly	GI 4	MI 1	KK 1	MM 1				GI 41	KK 22		26	5.1			1.0			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GI - Gibbsite KK - Kaolinite MI - Mica MM - Montmorillonite-Mica VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a					tion
Layer	(cm)	Horz	ion	(- - - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00622	19-39	A3	fs										32	OT 40	QZ 31	BT 17	MS 10	OP 1	PR 1		
														GN tr	GS tr						
92P00624	64-89	Bw1	fs										27	BT 56	QZ 27	MS 15	OT 2	GN tr	PR tr		
														OP tr							
92P00627	150-200	C	fs										28	BT 56	QZ 28	MS 14	OT 1	PR 1	GN tr		
														OP tr	FK tr						

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite FK - Potassium Feldspar GN - Garnet GS - Glass MS - Muscovite

OP - Opaques OT - Other PR - Pyroxene QZ - Quartz

*** Primary Characterization Data ***

Pedon ID: 91NC021005 (Buncombe, North Carolina) Print Date: May 1 2011 8:13AM

Sampled As : Wayah Coarse-loamy, mixed, frigid Typic Haplumbrept

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0085

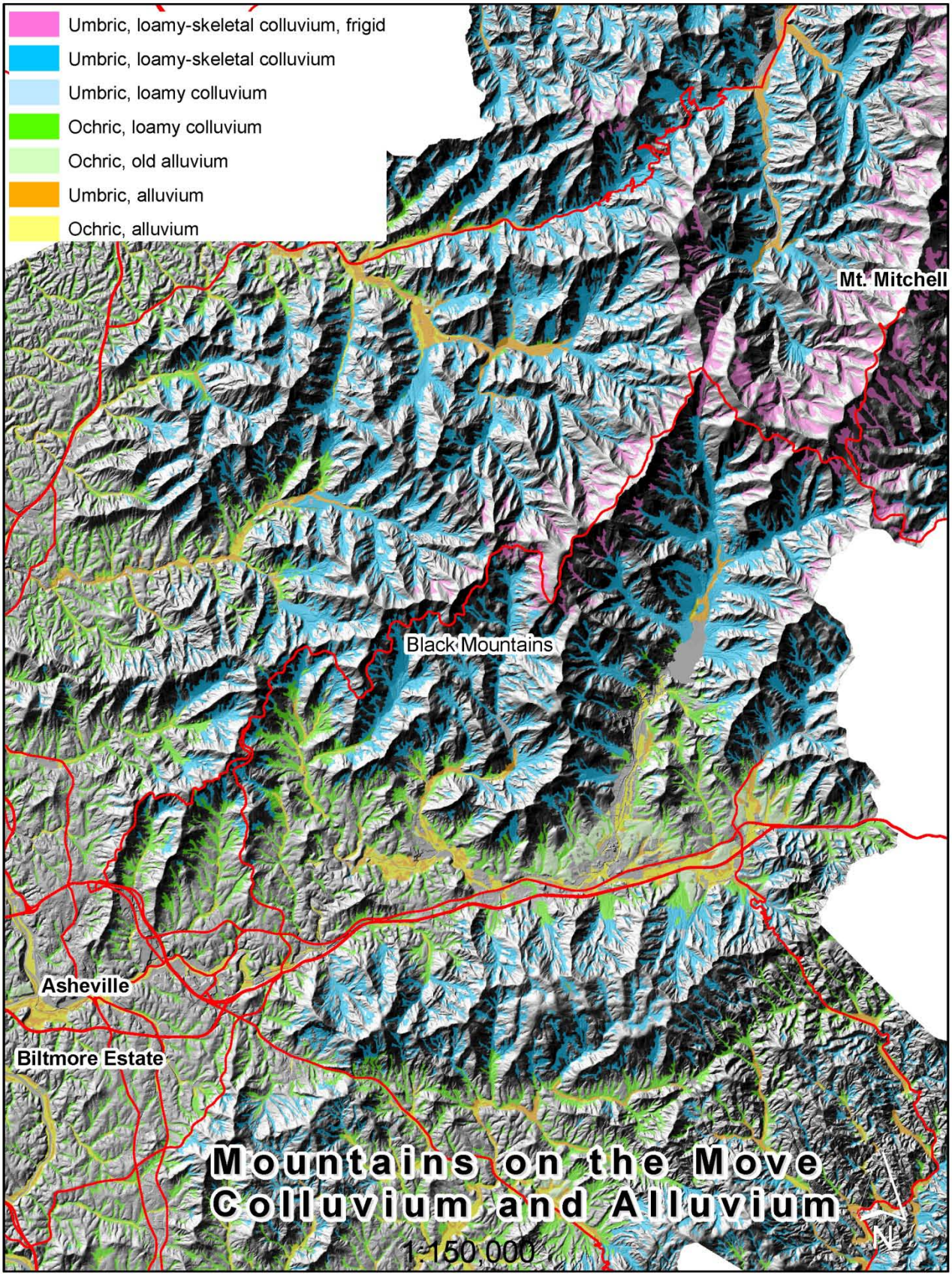
Fine Earth Mineralogy (<2.0 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract																	7D2	tion
Layer	(cm)	Horz	ion	(- - - - - - - - - - peak size - - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00618	2-0	Oe	feth																	82.0	
92P00619	0-4	Oa	feth																	41.0	
92P00620	4-8	A1	feth																	36.0	
92P00621	8-19	A2	feth																	33.0	
92P00622	19-39	A3	feth																	33.0	
92P00623	39-64	BA	feth																	28.0	
92P00624	64-89	Bw1	feth																	21.0	
92P00625	89-117	Bw2	feth																	19.0	
92P00626	117-150	BC	feth																	12.0	
92P00627	150-200	C	feth																	11.0	

FRACTION INTERPRETATION:

feth - Fine Earth, <2 mm

MINERAL INTERPRETATION:

eg - Surface Area


Umbric, loamy-skeletal colluvium, frigid
Umbric, loamy-skeletal colluvium
Umbric, loamy colluvium
Ochric, loamy colluvium
Ochric, old alluvium
Umbric, alluvium
Ochric, alluvium
Mt. Mitchell
Black Mountains
Asheville
Biltmore Estate
Mountains on the Move
Colluvium and Alluvium
1:150,000
N

The History of America's Largest Home

Building Biltmore was, at the time, one of the largest undertakings in the history of American residential architecture and the results were astounding. Over a six-year period, an entire community of craftsmen worked to build the country's premier home. The estate boasted its own brick factory, woodworking shop, and a three-mile railway spur for transporting materials to the site.

A New World Château

The celebrated architect Richard Morris Hunt modeled the house on three châteaux built in 16th-century France. It would feature 4 acres of floor space, 250 rooms, 34 bedrooms, 43 bathrooms, and 65 fireplaces. The basement alone would house a swimming pool, gymnasium and changing rooms, bowling alley, servants' quarters, kitchens, and more.

An Environmental Wonder

The grounds of the 125,000-acre estate were designed by Frederick Law Olmsted, the creator of New York's Central Park and the father of American landscape architecture. He not only developed acres of gardens and parkland, but in his efforts to protect the environment and reclaim over-farmed land, Olmsted established America's first managed forest.

A True Family Home

George Vanderbilt officially opened the home to friends and family on Christmas Eve in 1895. He had created a country retreat where he could pursue his passion for art, literature, and horticulture. After marrying the American Edith Stuyvesant Dresser (1873–1958) in Paris during the summer of 1898, George and his new bride came to live at the estate. Their only child, Cornelia (1900–1976), was born and grew up at Biltmore.

The Vanderbilt Family

The Vanderbilts were one of the oldest and best-known families in America. Jan Aertsen van der Bilt emigrated from Holland around 1650. Although his descendants prospered as farmers on Staten Island, New York, they lived modestly; it was only during the lifetime of Cornelius Vanderbilt (1794-1877), known as the “Commodore,” that the family name became synonymous with extraordinary wealth.

Patriarch to a sizable family—including his wife of 53 years, Sophia, 13 children, 37 grand-children, and 27 great-grandchildren—Cornelius established what became the Vanderbilt custom of luxurious residences. He also began the tradition of philanthropy, contributing $1 million in 1873 to Central University, a Methodist school in Nashville; it was later renamed Vanderbilt University.

Upon his death, the Commodore left most of his $100 million estate—a sum that made him the wealthiest industrialist of his time—to his eldest son, William Henry (1821-85). William Henry took over the family empire and eventually doubled its assets. He, too, was generous toward worthy causes, funding the Metropolitan Opera in

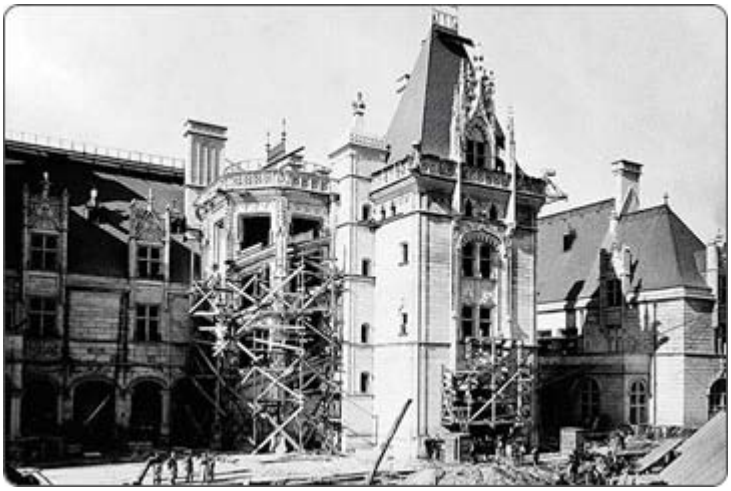
1883 and endowing the College of Physicians and Surgeons, now the Medical School of Columbia University. The shrewd financier proved to be an equally astute collector, assembling more than 200 paintings. These were displayed in the 59-room mansion he built in 1881 at 640 Fifth Avenue—the largest and most splendid house in Manhattan.

Only one of the eight children of William Henry and his wife, Maria Louisa (1821-96), was still living at home when the house was completed—the youngest, George Washington Vanderbilt, born in 1862. Quiet and intellectual, he had been greatly influenced by his mother's cultural interests, starting his own collection of art and books at an early age. Significantly, George would inherit the house and its contents after his mother's death.

Unlike the rest of his family, however, George Vanderbilt was little attracted to commerce and fashionable society. He preferred the world of learning and travel, visiting Europe at age 10 and journeying to Europe, Asia, or Africa about once a year throughout his adult life. It was while traveling in the mountains of North Carolina that Vanderbilt first glimpsed the site for his future country home.

Biltmore House Construction

Construction of Biltmore House was under way in 1889; it was a massive undertaking that included a mansion, gardens, farms, and woodlands. George Vanderbilt engaged two of the most distinguished designers of the 19th century: architect Richard Morris Hunt (1828-1895) and landscape designer Frederick Law Olmsted (1822-1903). The centerpiece was a four-story stone house with a 780-foot façade—a monument that would rival the surrounding mountains in grandeur. Hunt modeled the architecture on the richly ornamented style of the French Renaissance and adapted elements, such as the stair tower and the steeply pitched roof, from three famous early-16th-century châteaux in the Loire Valley: Blois, Chenonceau, and Chambord.



Even after six years, Biltmore House was not complete when George Vanderbilt opened it in 1895; work would continue for years. Its scale continues to be astounding: the house contains more than 11 million bricks; the massive stone spiral staircase rises four floors and has 102 steps. Through its center hangs an iron chandelier suspended from a single point, containing 72 electric light bulbs.

An Inspired Oasis

George Vanderbilt envisioned Biltmore in 1888, while on a short vacation to Asheville. His imagination was sparked by the area's beauty. He felt inspired to create a relaxed country estate in the Blue Ridge Mountains that would welcome family and friends for weeks, even months.

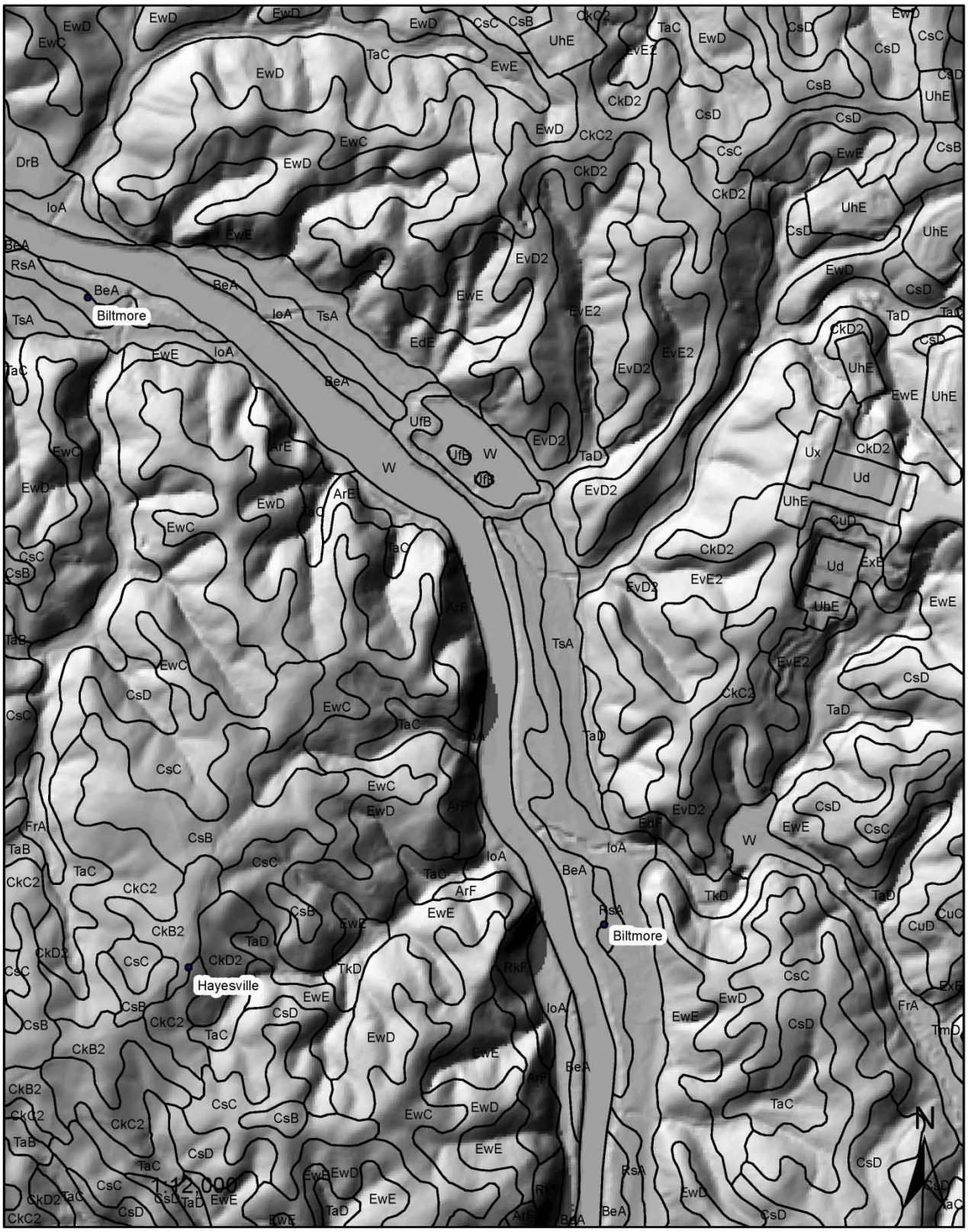
Through Biltmore, Mr. Vanderbilt's vision and inspiration lives to this day. We receive more than one million guests every year at our 8,000-acre estate, with more than 1,700 employees ready to make each guests visit special. Our other offerings include Biltmore Wine; a line of Biltmore-inspired home furnishings, home building products, and outdoor living and garden items; and our four-star Inn on Biltmore Estate.

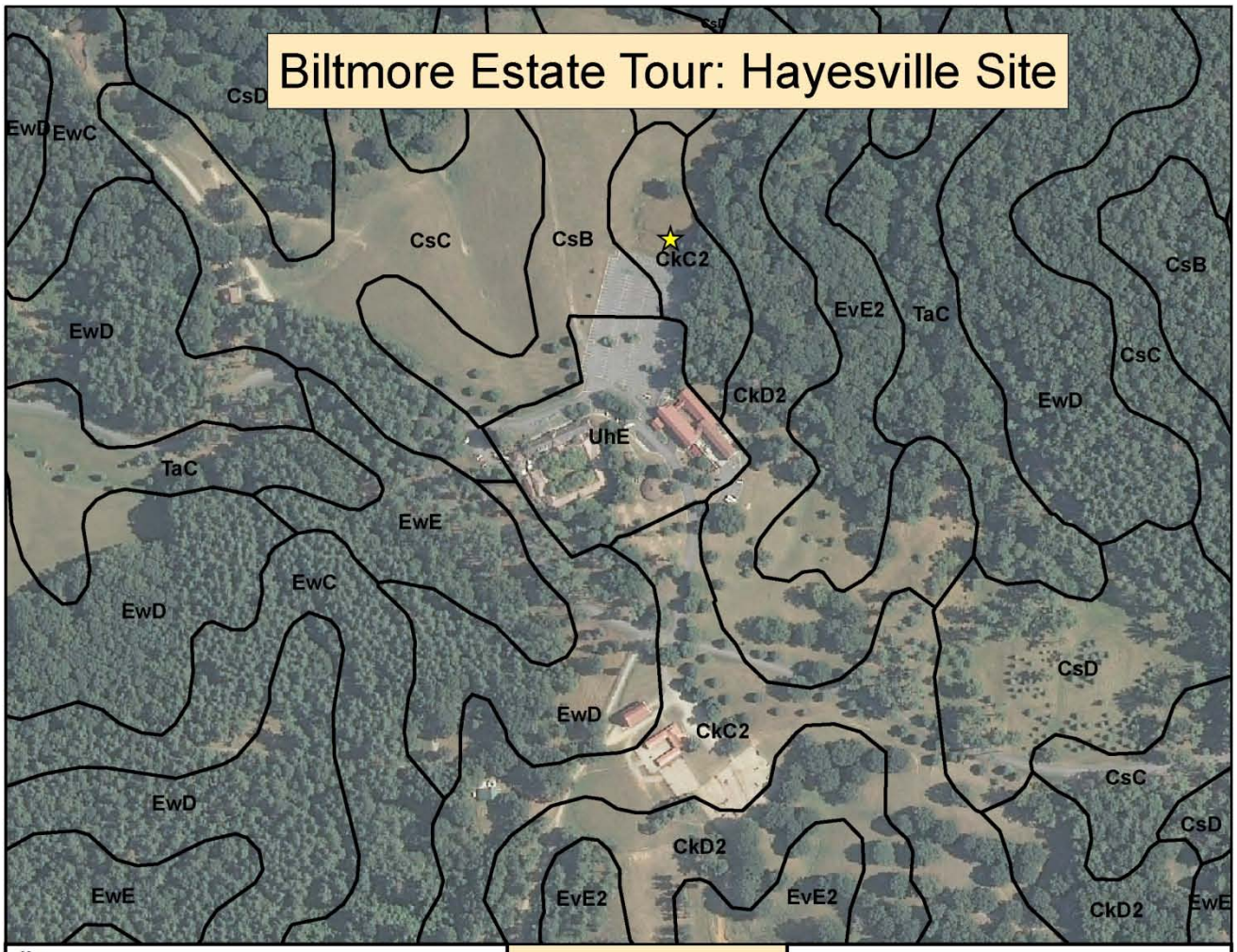
Self-Sufficient Estate

A family-owned company, our mission is the preservation of Biltmore as a privately-owned, profitable, working estate. Biltmore does not receive any governmental funding or grants, making it one of the United States' most significant National Historic Landmarks that is preserved solely through private funding.

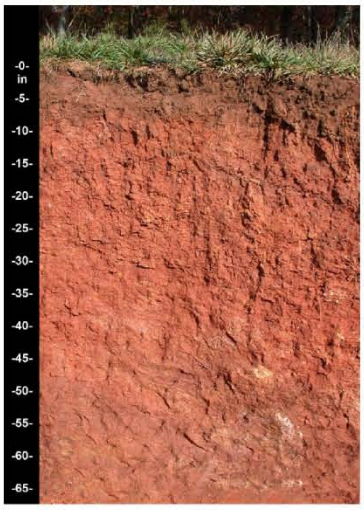
http://www.biltmore.com/our_story/

Soil Survey Biltmore Estate





Map symbol	Map unit name
CkC2	Clifton clay loam, 8 to 15 percent slopes, moderately eroded
CkD2	Clifton clay loam, 15 to 30 percent slopes, moderately eroded
CsB	Clifton sandy loam, 2 to 8 percent slopes
CsC	Clifton sandy loam, 8 to 15 percent slopes
CsD	Clifton sandy loam, 15 to 30 percent slopes
EvE2	Evard-Cowee complex, 30 to 50 percent slopes, moderately eroded
EwC	Evard-Cowee complex, 8 to 15 percent slopes, stony
EwD	Evard-Cowee complex, 15 to 30 percent slopes, stony
EwE	Evard-Cowee complex, 30 to 50 percent slopes, stony
TaB	Tate loam, 2 to 8 percent slopes
TaC	Tate loam, 8 to 15 percent slopes
UhE	Udorthents-Urban land complex, 2 to 50 percent slopes



0 0.035 0.07 0.14 0.21 0.28 Miles

PEDON DESCRIPTION – HAYESVILLE (CLIFTON) SERIES – UPLAND RESIDUUM

Description Date: 10/1/1991
Describer: Milton Martinez, John Allison, Mark Hudson
Site ID: 91NC021001
Pedon Note: 92P0589 (114-185 cm) was sampled
Soil Name as Described/Sampled: Hayesville
Soil Name as Correlated:
Physiographic Division:
Geomorphic Setting: on interfluve of None Assigned
Upslope Shape: convex
Cross Slope Shape:
Particle Size Control Section: 30 to 81 cm.
Description origin: Converted from SSL-CMS data
Diagnostic Features: ochric epipedon 0 to 20 cm.
argillic horizon 30 to 51 cm.
paralithic contact 203 to 254 cm.
Cont. Site ID: 91NC021001

State: North Carolina
County: Buncombe
MLRA: 130 -- Blue Ridge
Quad Name:
Latitude: 35 degrees 31 minutes 45.00 seconds north
Longitude: 82 degrees 34 minutes 12.00 seconds west
Primary Earth Cover: Crop cover
Bedrock Depth:
Bedrock Hardness:
Bedrock Fracture Interval:
Surface Fragments: 0.0 percent
Description database: NSSL
Pedon ID: 91NC021001

Ap--0 to 20 centimeters; reddish brown (5YR 4/4) fine sandy loam; weak medium granular structure; very friable, nonsticky, nonplastic; common very fine and fine roots between peds; common very fine and fine tubular pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; abrupt smooth boundary. (Lab sample # 92P0580).

BA--20 to 30 centimeters; red (2.5YR 4/8) clay loam; 11 percent medium distinct dark yellowish brown (10YR 4/6) and 11 percent fine faint yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine and fine roots between peds; many very fine and fine vesicular and common medium and coarse tubular pores; 15 percent discontinuous faint clay films on faces of peds and in pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0581).

Bt1--30 to 43 centimeters; red (2.5YR 4/6) clay; 1 percent fine faint yellowish red (5YR 4/6) mottles; moderate medium and coarse subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine and fine roots between peds; many very fine and fine vesicular and few medium and coarse tubular pores; 55 percent continuous faint clay films on faces of peds and in pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0582).

Bt2--43 to 71 centimeters; red (2.5YR 4/6) clay; 11 percent medium and coarse faint yellowish red (5YR 4/6) mottles; moderate medium and coarse subangular blocky structure; friable, slightly sticky, slightly plastic; common very fine and fine roots between peds; many very fine and fine vesicular and few medium and coarse tubular pores; 55 percent continuous faint clay films on faces of peds and in pores; 1 percent fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0583).

BC--71 to 91 centimeters; red (2.5YR 4/6) clay loam; 1 percent medium faint dark reddish gray (2.5YR 3/1) and 1 percent medium distinct reddish yellow (7.5YR 6/8) mottles; moderate medium subangular blocky structure; friable, slightly sticky, slightly plastic; few very fine and fine roots between peds; few very fine and fine tubular pores; 37 percent patchy faint clay films on faces of peds; 1 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; gradual wavy boundary. (Lab sample # 92P0584). Quartz vein running through BC 1-4".

C1--91 to 114 centimeters; red (2.5YR 4/6) sandy loam saprolite; 11 percent medium and coarse prominent dark reddish gray (2.5YR 3/1) and 11 percent medium and coarse prominent olive yellow (2.5Y 6/8) mottles; massive; very friable, nonsticky, nonplastic; few very fine and fine roots between peds; few very fine and fine tubular pores; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0585). Quartz vein running through C 1-4".

C2--114 to 185 centimeters; red (2.5YR 4/6) sandy loam saprolite; 11 percent medium and coarse prominent dark reddish gray (2.5YR 3/1) and 11 percent medium and coarse prominent olive yellow (2.5Y 6/8) mottles; massive; very friable, nonsticky, nonplastic; few very fine and fine roots between peds; few very fine and fine tubular pores; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog; clear wavy boundary. (Lab sample # 92P0586). Quartz vein running through C 1-4".

C3--185 to 203 centimeters; multicolored sandy loam saprolite; massive; very friable, nonsticky, nonplastic; very fine and fine roots between peds; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog; clear irregular boundary. (Lab sample # 92P0587). Quartz vein running through C 1-4".

Cr--203 to 254 centimeters; multicolored weathered bedrock; very fine and fine roots between peds; 30 percent very coarse platy iron-manganese concretions; 11 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog. (Lab sample # 92P0588).

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled as : Hayesville ; Clayey, kaolinitic, mesic Typic Kanhapludult
Revised to correlated: Hayesville ; Fine, allitic, mesic Typic Kanhapludult

SSL - Project CP92NC019 MOUNTAIN SOILS - BUNCOMBE COUNTY
- Site ID 91NC021001 Lat: 35° 31' 45.00" north Long: 82° 34' 12.00" west MLRA: 130
- Pedon No. 92P0081
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
92P00580	Ap	AP	0-17				FSL	FSL
92P00581	BA	BA	17-30				CL	CL
92P00582	Bt1	BT1	30-44				C	C
92P00583	Bt2	BT2	44-72				C	C
92P00584	BC	BC	72-90				CL	SCL
92P00585	C1	C1	90-114				SL	FSL
92P00586	C2	C2	114-185				SL	LFS
92P00587	C3	C3	185-203				SL	LS
92P00588	Cr	CR	203-254					FSL
92P00589			114-185					

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0.14	(NA)
Clay, carbonate free, Weighted Average	43	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	32	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	43	% wt
LE, Whole Soil, Summed to 1m	1	cm/m

Weighted averages based on control section: 17-67 cm

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay (Total)	-2- Silt (Total)	-3- Sand (Total)	-4- Fine Clay (Clay)	-5- CO_3	-6- Fine Silt (Silt)	-7- Coarse Silt (Silt)	-8- VF Sand (Sand)	-9- F Sand (Sand)	-10- M Sand (Sand)	-11- C Sand (Sand)	-12- VC Sand (Sand)	-13- 2-5 (Rock Fragments (mm) Weight)	-14- 5-20 (Rock Fragments (mm) Weight)	-15- 20-75 (Rock Fragments (mm) Weight)	-16- .1-75 (Rock Fragments (mm) Weight)	-17- >2 mm wt % whole soil
				< .002	.002-.05	.05-2	< .0002	< .002	.002-.02	.02-.05	.05-.10	.10-.25	.25-.50	.5-1	1-2					
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1	3A1		3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
92P00580	0-17	Ap	S	19.2	25.1	55.7	7.3		16.4	8.7	16.1	28.2	8.5	1.8	1.1	3	6	--	45	9
92P00581	17-30	BA	S	39.0	17.9	43.1	17.7		12.9	5.0	10.6	23.0	7.8	1.2	0.5	tr	tr	--	33	
92P00582	30-44	Bt1	S	44.5	15.7	39.8	21.7		10.1	5.6	10.0	21.7	6.8	1.0	0.3	tr	tr	--	30	
92P00583	44-72	Bt2	S	43.4	13.5	43.1	22.1		7.9	5.6	9.8	21.8	8.4	2.1	1.0	tr	tr	--	33	
92P00584	72-90	BC	S	23.3	13.9	62.8	13.5		6.9	7.0	17.0	32.6	12.0	1.1	0.1	tr	tr	--	46	
92P00585	90-114	C1	S	15.7	16.9	67.4	8.8		8.0	8.9	17.6	36.7	10.7	1.4	1.0	2	8	--	55	10
92P00586	114-185	C2	S	3.9	14.9	81.2	2.5		7.3	7.6	19.9	38.5	15.9	4.8	2.1	1	tr	--	62	1
92P00587	185-203	C3	S	7.7	13.7	78.6	3.5		6.5	7.2	14.5	32.9	18.3	9.2	3.7	9	14	--	73	23
92P00588	203-254	Cr	S	6.7	20.8	72.5	3.6		10.7	10.1	18.9	24.2	13.7	9.7	6.0	3	3	17	64	23
92P00589	114-185		S													--	--	--		

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa	-2- Oven Dry	-3- Cole Whole Soil	-4- (Water Content) 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- (Ratio/Clay) CEC7	-13- (Ratio/Clay) 1500 kPa
				(g cm^{-3})			(% of < 2mm)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a		4B5	4C1		8D1	8D1
92P00580	0-17	Ap	S	1.54	1.58	0.008			16.4	8.3		1.008	0.12		0.31	0.43
92P00581	17-30	BA	S	1.51	1.55	0.009			20.2	14.2		1.011	0.09		0.14	0.36
92P00582	30-44	Bt1	S	1.31	1.38	0.017			27.9	18.0		1.014	0.13		0.14	0.40
92P00583	44-72	Bt2	S	1.27	1.35	0.021			29.1	18.7		1.014	0.13		0.14	0.43
92P00584	72-90	BC	S	1.50	1.52	0.004			22.9	13.3		1.010	0.14		0.21	0.57
92P00585	90-114	C1	S	1.52	1.52	--			17.8	10.6		1.009	0.10		0.29	0.68
92P00586	114-185	C2	S	1.62	1.62	--			11.4	4.8		1.009	0.11		1.64	1.23
92P00587	185-203	C3	S	1.80	1.80	--			7.1	5.4		1.010	0.03		0.71	0.70
92P00588	203-254	Cr	S	1.40	1.40	--			16.0	7.2		1.011	0.11		0.97	1.07
92P00589	114-185		S							6.3						

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (Atterberg Limits) LL pct <0.4mm	-2- (Atterberg Limits) PI	-3- (Bulk Density) Field (g cm^{-3})	-4- (Bulk Density) Recon 33 kPa (g cm^{-3})	-5- (Bulk Density) Recon Oven Dry (g cm^{-3})	-6- (Water Content) Field (% of < 2mm)	-7- (Water Content) Recon 33 kPa (% of < 2mm)	-8- (Water Content) Sieved Samples 6 kPa (% of < 2mm)	-9- (Water Content) Sieved Samples 10 kPa (% of < 2mm)	-10- (Water Content) Sieved Samples 33 kPa (% of < 2mm)	-11- (Water Content) Sieved Samples 100 kPa (% of < 2mm)	-12- (Water Content) Sieved Samples 200 kPa (% of < 2mm)	-13- (Water Content) Sieved Samples 500 kPa (% of < 2mm)
															4B1a	
92P00580	0-17	Ap	S												11.7	
92P00581	17-30	BA	S												17.4	
92P00582	30-44	Bt1	S												19.2	
92P00583	44-72	Bt2	S												21.3	
92P00584	72-90	BC	S												15.6	
92P00585	90-114	C1	S												12.4	
92P00586	114-185	C2	S												7.3	
92P00587	185-203	C3	S												6.8	
92P00588	203-254	Cr	S												10.6	

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (Total) C (% of <2 mm)	-2- (Total) N (% of <2 mm)	-3- (Total) S (% of <2 mm)	-4- Org C (% of <2 mm)	-5- C/N Ratio	-6- (Dith-Cit Ext) Fe (% of < 2mm)	-7- (Dith-Cit Ext) Al (% of < 2mm)	-8- (Dith-Cit Ext) Mn (% of < 2mm)	-9- (Ammonium Oxalate Extraction) Al+½Fe (% of < 2mm)	-10- (Ammonium Oxalate Extraction) ODOE (% of < 2mm)	-11- (Ammonium Oxalate Extraction) Fe (% of < 2mm)	-12- (Ammonium Oxalate Extraction) Al (% of < 2mm)	-13- (Ammonium Oxalate Extraction) Si (% of < 2mm)	-14- (Ammonium Oxalate Extraction) Mn (mg kg^{-1})	-15- (Na Pyro-Phosphate) C (% of < 2mm)	-16- (Na Pyro-Phosphate) Fe (% of < 2mm)	-17- (Na Pyro-Phosphate) Al (% of < 2mm)	-18- (Na Pyro-Phosphate) Mn (% of < 2mm)
					6B3a		6A1c		6C2b	6G7a	6D2a		8J	6C9b	6G12b	6V2b	6D5b				
92P00580	0-17	Ap	S		0.091		1.13		2.7	0.4	tr	0.24	0.04	0.15	0.16	0.04	240.0				
92P00581	17-30	BA	S		0.035		0.37		5.8	0.6	tr	0.32	0.04	0.26	0.19	0.06	28.4				
92P00582	30-44	Bt1	S		0.030		0.29		5.2	0.7	--	0.40	0.05	0.36	0.22	0.07	--				
92P00583	44-72	Bt2	S		0.026		0.26		5.1	0.7	tr	0.37	0.04	0.36	0.19	0.06	--				
92P00584	72-90	BC	S				0.08		4.5	0.4	tr	0.25	0.04	0.28	0.11	0.06	17.8				
92P00585	90-114	C1	S				0.03		4.0	0.3	tr	0.19	0.03	0.22	0.08	0.05	65.7				
92P00586	114-185	C2	S				0.02		2.7	0.2	tr	0.10	0.03	0.14	0.03	0.04	198.3				
92P00587	185-203	C3	S				0.05		2.1	0.2	tr	0.12	0.03	0.14	0.06	0.05	317.7				
92P00588	203-254	Cr	S				0.02		3.2	0.3	0.1	0.20	0.05	0.22	0.09	0.06	723.8				
92P00589	114-185		S						1.9	0.2	0.2										

*** Primary Characterization Data ***

Pedon ID: 91NC021001 — (Buncombe, North Carolina) — Print Date: May 1 2011 9:18AM

Sampled As : Hayesville — Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)													
				(- cmol(+) kg^{-1} -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a	6G9c	6D3b	5A3a	5A8b	5A3b	5G1	5C3	5C1
92P00580	0-17	Ap	S	2.1	0.6	0.1	--	2.8	3.7	0.1	1.0	6.5	5.9	2.9	3	43	47
92P00581	17-30	BA	S	2.4	0.9	0.1	--	3.4	2.2			5.6	5.4			61	63
92P00582	30-44	Bt1	S	3.0	0.9	0.1	--	4.0	3.5			7.5	6.3			53	63
92P00583	44-72	Bt2	S	2.7	0.9	0.1	--	3.7	4.7			8.4	6.2			44	60
92P00584	72-90	BC	S	1.2	0.5	0.1	--	1.8	5.2			7.0	4.8			26	38
92P00585	90-114	C1	S	0.5	0.4	tr	1.2	2.1	0.9			3.0	4.6			70	46
92P00586	114-185	C2	S	tr	0.1	tr	0.7	0.8	2.6			3.4	6.4			24	13
92P00587	185-203	C3	S	tr	0.1	tr	tr	0.1	3.8			3.9	5.5			3	2
92P00588	203-254	Cr	S	tr	0.2	tr	tr	0.2	2.4			2.6	6.5			8	3

Salt

Water Extracted From Saturated Paste: -1- to -15-; Ca, Mg, Na, K in mmol(+) L^{-1}; CO_3 through NO_3 in mmol(-) L^{-1}; H_2O and Total Salts in %; Elec Cond and Pred Elec Cond in dS m^{-1}; Exch Na in %.

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
																						5D2	
92P00580	0-17	Ap	S																			2	
92P00581	17-30	BA	S																			2	
92P00582	30-44	Bt1	S																			2	
92P00583	44-72	Bt2	S																			2	
92P00584	72-90	BC	S																			2	
92P00585	90-114	C1	S																			--	
92P00586	114-185	C2	S																			--	
92P00587	185-203	C3	S																			--	
92P00588	203-254	Cr	S																			--	

*** Primary Characterization Data ***

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Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

pH & Carbonates

Layer	Depth (cm)	Horz	Prep	-1- KCl 8C1g	-2- $CaCl_2$ 0.01M 1:2 4C1a2a	-3- H_2O 1:1 4C1a2a	-4- Sat Paste	-5- Sulf	-6- NaF	-7- Carbonate As $CaCO_3$ <2mm	-8- Carbonate As $CaCO_3$ <20mm	-9- Gypsum As $CaSO_4*2H_2O$ <2mm	-10- Gypsum As $CaSO_4*2H_2O$ <20mm	-11- Resist ohms cm^{-1}
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - -)						(- - Carbonate - -)		(- - Gypsum - - -)		
										(- - - - - - - - - - - - % - - - - - - - - - - -)				
92P00580	0-17	Ap	S	4.5	4.9	5.5								
92P00581	17-30	BA	S	5.3	5.6	6.1								
92P00582	30-44	Bt1	S	5.6	6.7	7.6								
92P00583	44-72	Bt2	S	5.5	6.2	7.1								
92P00584	72-90	BC	S	5.3	5.6	5.9								
92P00585	90-114	C1	S	5.2	5.6	6.1								
92P00586	114-185	C2	S	4.4	5.4	5.6								
92P00587	185-203	C3	S	4.6	5.2	5.4								
92P00588	203-254	Cr	S	4.6	5.4	6.0								

*** Primary Characterization Data ***

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Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

Clay Mineralogy (<.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1- X-Ray 7A2i peak size	-2-	-3-	-4-	-5-	-6- Thermal 7A4b %	-7-	-8-	-9-	-10- Elemental 7C3 % SiO_2	-11- Al_2O_3	-12- Fe_2O_3	-13- MgO	-14- CaO	-15- K_2O	-16- Na_2O	-17- EGME Retn mg g^{-1}	-18- Interpretation
92P00580	0-17	Ap	tcly	GI 4	KK 3	VR 2	GE 2	HE 1			KK 33	GI 24		27	11.2			0.3			
92P00581	17-30	BA	tcly	GI 5	KK 3	VR 2	GE 2	HE 2						34	14.3			0.3			
92P00582	30-44	Bt1	tcly	GI 4	KK 3	VR 2	GE 2	HE 2			KK 32	GI 30		34	14.3			0.2			
92P00583	44-72	Bt2	tcly	GI 4	KK 3	VR 2	GE 2	HE 2			GI 29	KK 27		35	15.7			0.2			
92P00584	72-90	BC	tcly	GI 3	KK 2	GE 2	VR 1	HE 1			GI 29	KK 28		35	17.2			0.4			
92P00587	185-203	C3	tcly	GI 2	KK 1						GI 21	KK 19		24	14.3			0.2			

FRACTION INTERPRETATION:

tcly - Total Clay, <0.002 mm

MINERAL INTERPRETATION:

GE - Goethite GI - Gibbsite HE - Hematite KK - Kaolinite VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: 91NC021001 (Buncombe, North Carolina) Print Date: May 1 2011 9:18AM

Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a					tion
Layer	(cm)	Horz	ion	(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - % - - - - - - - - - -)				(- % - - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00587	185-203	C3	fs										51	QZ 50	BT 36	OT 9	MS 4	OP 1	CA tr		

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite CA - Calcite MS - Muscovite OP - Opaques OT - Other

QZ - Quartz

*** Primary Characterization Data ***

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Sampled As : Hayesville Clayey, kaolinitic, mesic Typic Kanhapludult

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0081

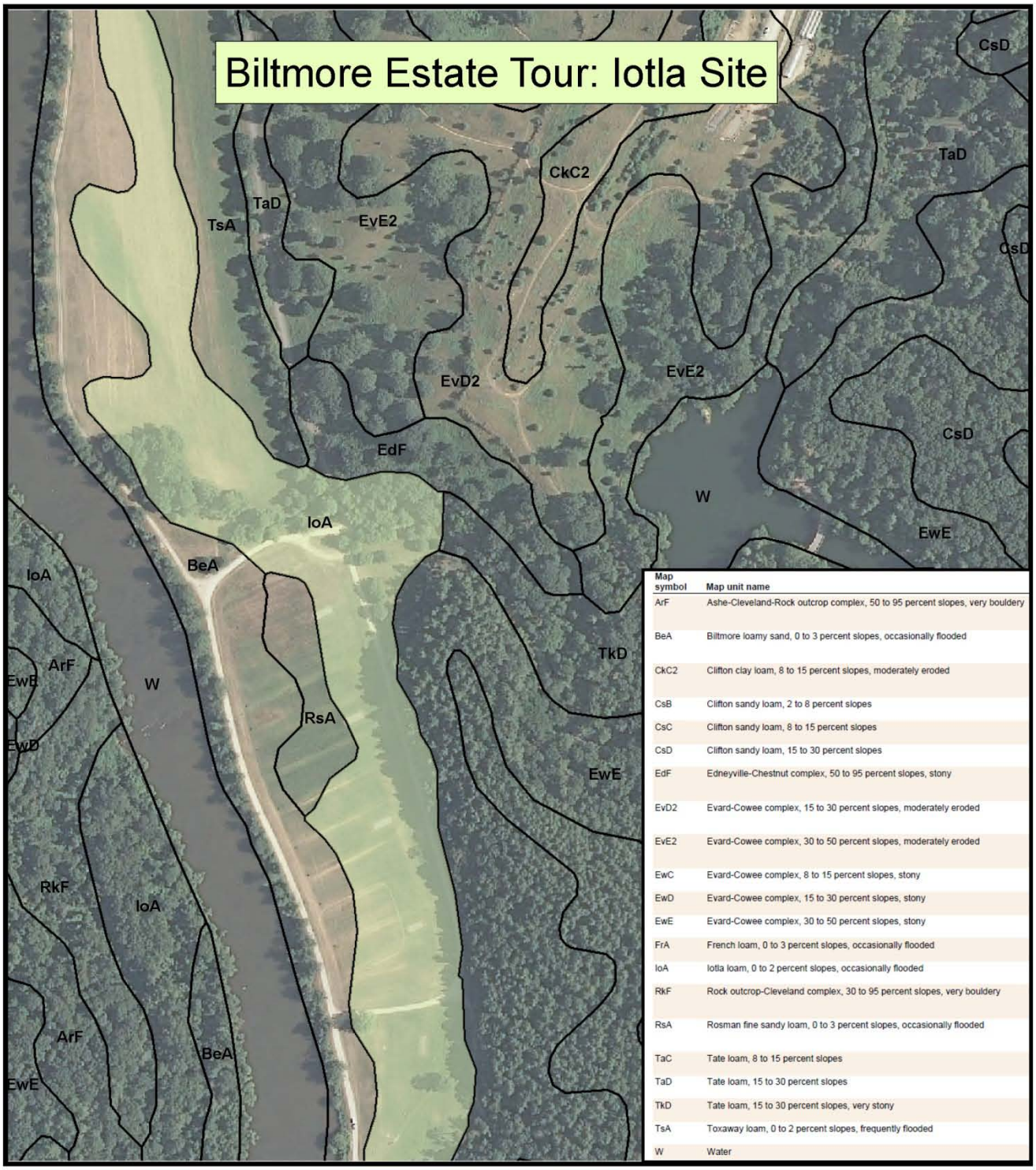
Fine Earth Mineralogy (<2.0 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Elemental				EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract																	7D2	tion
Layer	(cm)	Horz	ion	(- - - - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00580	0-17	Ap	feth																	9.0	
92P00581	17-30	BA	feth																	18.0	
92P00582	30-44	Bt1	feth																	22.0	
92P00583	44-72	Bt2	feth																	22.0	
92P00584	72-90	BC	feth																	14.0	
92P00585	90-114	C1	feth																	11.0	
92P00586	114-185	C2	feth																	9.0	
92P00587	185-203	C3	feth																	7.0	
92P00588	203-254	Cr	feth																	9.0	

FRACTION INTERPRETATION:

feth - Fine Earth, <2 mm

MINERAL INTERPRETATION:

eg - Surface Area



Map symbol	Map unit name
ArF	Ashe-Cleveland-Rock outcrop complex, 50 to 95 percent slopes, very bouldery
BeA	Biltmore loamy sand, 0 to 3 percent slopes, occasionally flooded
CkC2	Clifton clay loam, 8 to 15 percent slopes, moderately eroded
CsB	Clifton sandy loam, 2 to 8 percent slopes
CsC	Clifton sandy loam, 8 to 15 percent slopes
CsD	Clifton sandy loam, 15 to 30 percent slopes
EdF	Edneyville-Chestnut complex, 50 to 95 percent slopes, stony
EvD2	Evard-Cowee complex, 15 to 30 percent slopes, moderately eroded
EvE2	Evard-Cowee complex, 30 to 50 percent slopes, moderately eroded
EwC	Evard-Cowee complex, 8 to 15 percent slopes, stony
EwD	Evard-Cowee complex, 15 to 30 percent slopes, stony
EwE	Evard-Cowee complex, 30 to 50 percent slopes, stony
FrA	French loam, 0 to 3 percent slopes, occasionally flooded
IoA	Iotla loam, 0 to 2 percent slopes, occasionally flooded
RkF	Rock outcrop-Cleveland complex, 30 to 95 percent slopes, very bouldery
RsA	Rosman fine sandy loam, 0 to 3 percent slopes, occasionally flooded
TaC	Tate loam, 8 to 15 percent slopes
TaD	Tate loam, 15 to 30 percent slopes
TkD	Tate loam, 15 to 30 percent slopes, very stony
TsA	Toxaway loam, 0 to 2 percent slopes, frequently flooded
W	Water

N

0 0.02 0.04 0.08 0.12 0.16 Miles

NRCS Natural Resources Conservation Service

BILTMORE PEDON DESCRIPTION – NATURAL LEVEE ON FLOOD PLAIN

Print Date: 04/26/2011
Description Date: 10/1/1991
Describer: Milton Martinez, Chip Smith, Mark Hudson
Site ID: 91NC021004
Soil Name as Described/Sampled: Biltmore
Soil Name as Correlated:
Particle Size Control Section: 25 to 99 cm.
Description origin: Converted from SSL-CMS data
Diagnostic Features: ochric epipedon 0 to 20 cm.

Country:
State: North Carolina
County: Buncombe
MLRA: 130 -- Blue Ridge
Latitude: 35 degrees 31 minutes 49.00 seconds north
Longitude: 82 degrees 33 minutes 31.00 seconds west
Surface Fragments: 0.0 percent
Description database: NSSL

Ap--0 to 20 centimeters; dark yellowish brown (10YR 4/4) loamy sand; 1 percent medium distinct brownish yellow (10YR 6/6) mottles; weak fine granular structure; very friable, nonsticky, nonplastic; many very fine, fine and medium roots throughout; few fine interstitial pores; 11 percent very fine and fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; abrupt smooth boundary. (Lab sample # 92P0610).

C1--20 to 41 centimeters; brownish yellow (10YR 6/6) sand; 1 percent medium distinct very pale brown (10YR 7/3) mottles; single grain; loose, nonsticky, nonplastic; few fine interstitial and tubular pores; 1 percent very fine and fine platy mica flakes, unspecified; charcoal stains; slightly acid, pH 6.5, Hellige-Truog; clear smooth boundary. (Lab sample # 92P0611).

C2--41 to 58 centimeters; yellowish brown (10YR 5/6) sand; 1 percent medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose, nonsticky, nonplastic; few fine interstitial and tubular pores; 1 percent very fine and fine platy mica flakes, unspecified; charcoal stains; slightly acid, pH 6.5, Hellige-Truog; clear smooth boundary. (Lab sample # 92P0612).

C3--58 to 66 centimeters; light yellowish brown (10YR 6/4) sand; single grain; loose, nonsticky, nonplastic; few fine interstitial and tubular pores; 1 percent very fine and fine platy mica flakes, unspecified; moderately acid, pH 6.0, Hellige-Truog; abrupt smooth boundary. (Lab sample # 92P0613).

C4--66 to 107 centimeters; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) and light yellowish brown (10YR 6/4) sand; 1 percent fine faint brown (10YR 5/3) mottles; single grain; loose, nonsticky, nonplastic; 1 percent very fine and fine platy mica flakes, unspecified; moderately acid, pH 6.0, Hellige-Truog; clear smooth boundary. (Lab sample # 92P0614).

C5--107 to 122 centimeters; dark yellowish brown (10YR 4/6) loamy sand; 1 percent medium distinct light yellowish brown (10YR 6/4) and 1 percent fine prominent strong brown (7.5YR 5/6) mottles; single grain; loose, nonsticky, nonplastic; 1 percent very fine and fine platy mica flakes, unspecified; slightly acid, pH 6.5, Hellige-Truog; clear smooth boundary. (Lab sample # 92P0615). C5 has an increase in charcoal.

C6--122 to 137 centimeters; dark yellowish brown (10YR 4/6) and light yellowish brown (10YR 6/4) and strong brown (7.5YR 5/6) loamy sand; single grain; loose, nonsticky, nonplastic; 1 percent very fine and fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog; clear smooth boundary. (Lab sample# 92P0616).

C7--137 to 178 centimeters; dark yellowish brown (10YR 4/4) and brown (10YR 5/3) loamy sand; 1 percent fine distinct strong brown (7.5YR 4/6) mottles; single grain; loose, nonsticky, nonplastic; 11 percent very fine and fine platy mica flakes, unspecified; neutral, pH 7.0, Hellige-Truog. (Lab sample # 92P0617).

*** Primary Characterization Data ***

Pedon ID: 91NC021004 (Buncombe, North Carolina) Print Date: May 1 2011 9:30AM

Sampled as : Biltmore ; Mixed, mesic Typic Udipsamment
Revised to correlated: Biltmore ; Mixed, mesic Typic Udipsamment

SSL - Project CP92NC019 MOUNTAIN SOILS - BUNCOMBE COUNTY
- Site ID 91NC021004 Lat: 35° 31' 49.00" north Long: 82° 33' 31.00" west MLRA: 130
- Pedon No. 92P0084
- General Methods 1B1A, 2A1, 2B

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
92P00610	Ap	AP	0-20				LS	S
92P00611	C1	C1	20-40				S	S
92P00612	C2	C2	40-58				S	S
92P00613	C3	C3	58-65				S	S
92P00614	C4	C4	65-105				S	FS
92P00615	C5	C5	105-120				LS	FS
92P00616	C6	C6	120-135				LS	S
92P00617	C7	C7	135-175				LS	FS

Pedon Calculations

Calculation Name	Result	Units of Measure
CEC Activity, CEC7/Clay, Weighted Average	0	(NA)
Clay, carbonate free, Weighted Average	0	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	84	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	0	% wt

Weighted averages based on control section: 25-100 cm

*** Primary Characterization Data ***

Pedon ID: 91NC021004 (Buncombe, North Carolina) Print Date: May 1 2011 9:30AM

Sampled As : Biltmore Mixed, mesic Typic Udipsamment

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0084

PSDA & Rock Fragments

Layer	Depth (cm)	Horz	Prep	-1- Clay (Total)	-2- Silt (Total)	-3- Sand (Total)	-4- Fine Clay (Clay)	-5- CO_3 (Clay)	-6- Fine Silt (Silt)	-7- Coarse Silt (Silt)	-8- VF Sand (Sand)	-9- F Sand (Sand)	-10- M Sand (Sand)	-11- C Sand (Sand)	-12- VC Sand (Sand)	-13- 2-5 (Rock Fragments Weight)	-14- 5-20 (Rock Fragments Weight)	-15- 20-75 (Rock Fragments Weight)	-16- .1-75 (Rock Fragments Weight)	-17- >2 mm wt % whole soil
				< .002	.002 -.05	.05 -2	< .0002	< .002	.002 -.02	.02 -.05	.05 -.10	.10 -.25	.25 -.50	.5 -1	1 -2					
				% of <2mm Mineral Soil												% of <75mm				
				3A1	3A1	3A1			3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
92P00610	0-20	Ap	S	--	8.9	91.1			4.0	4.9	14.3	46.4	28.5	1.9	tr	--	tr	--	77	
92P00611	20-40	C1	S	--	6.1	93.9			2.5	3.6	14.2	48.2	29.8	1.7	tr	--	--	--	80	
92P00612	40-58	C2	S	--	4.3	95.7			1.4	2.9	9.9	39.9	42.8	3.0	0.1	--	--	--	86	
92P00613	58-65	C3	S	--	5.5	94.5			1.7	3.8	11.6	47.5	32.4	2.9	0.1	--	--	--	83	
92P00614	65-105	C4	S	--	5.1	94.9			1.9	3.2	10.8	51.1	30.4	2.6	tr	--	--	--	84	
92P00615	105-120	C5	S	0.4	5.2	94.4			2.3	2.9	15.7	52.0	24.4	2.3	tr	--	--	--	79	
92P00616	120-135	C6	S	1.1	7.5	91.4			2.7	4.8	16.4	49.6	23.3	2.1	tr	--	--	--	75	
92P00617	135-175	C7	S	2.1	5.9	92.0			1.8	4.1	15.4	52.9	22.2	1.4	0.1	--	--	--	77	

Bulk Density & Moisture

Layer	Depth (cm)	Horz	Prep	-1- (Bulk Density) 33 kPa	-2- Oven Dry	-3- Cole Whole Soil	-4- (Water Content) 6 kPa	-5- 10 kPa	-6- 33 kPa	-7- 1500 kPa	-8- 1500 kPa Moist	-9- Ratio AD/OD	-10- WRD Whole Soil	-11- Aggst Stabl 2-0.5mm	-12- (Ratio/Clay) CEC7	-13- 1500 kPa
				(g cm^{-3})			(% of < 2mm)						cm^3 cm^{-3}	%		
				4A1d	4A1h			4B1c	4B1c	4B2a		4B5	4C1		8D1	8D1
92P00610	0-20	Ap	S	1.63	1.63	--		17.3	7.9	1.8		1.003	0.10			
92P00611	20-40	C1	S							1.3		1.002				
92P00612	40-58	C2	S							1.2		1.002				
92P00613	58-65	C3	S							1.3		1.003				
92P00614	65-105	C4	S							1.4		1.003				
92P00615	105-120	C5	S							1.8		1.003				
92P00616	120-135	C6	S							1.8		1.002			1.82	1.64
92P00617	135-175	C7	S							1.9		1.003			1.14	0.90

*** Primary Characterization Data ***

Pedon ID: 91NC021004 (Buncombe, North Carolina) Print Date: May 1 2011 9:30AM

Sampled As : Biltmore Mixed, mesic Typic Udipsamment

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0084

Water Content

Layer	Depth (cm)	Horz	Prep	-1- (Atterberg Limits) LL	-2- (Atterberg Limits) PI	-3- (Bulk Density) Field	-4- (Bulk Density) Recon 33 kPa	-5- (Bulk Density) Recon Oven Dry	-6- (Water Content) Field	-7- (Water Content) Recon 33 kPa	-8- (Sieved Samples) 6 kPa	-9- (Sieved Samples) 10 kPa	-10- (Sieved Samples) 33 kPa	-11- (Sieved Samples) 100 kPa	-12- (Sieved Samples) 200 kPa	-13- (Sieved Samples) 500 kPa
				pct <0.4mm		(g cm^{-3}) 4A1a			(% of < 2mm) 4B4							
92P00610	0-20	Ap	CLODDB			1.32			0.4							
92P00611	20-40	C1	CLODDB			1.36			0.3							
92P00612	40-58	C2	CLODDB			1.14			0.3							
92P00614	65-105	C4	CLODDB			1.27			1.0							
92P00615	105-120	C5	CLODDB			1.15			8.4							
92P00616	120-135	C6	CLODDB			1.34			19.2							
92P00617	135-175	C7	CLODDB			1.30			16.0							

Carbon & Extractions

Layer	Depth (cm)	Horz	Prep	-1- (Total) C	-2- (Total) N	-3- (Total) S	-4- Org C	-5- C/N Ratio	-6- (Dith-Cit Ext) Fe	-7- (Dith-Cit Ext) Al	-8- (Dith-Cit Ext) Mn	-9- (Ammonium Oxalate Extraction) Al+½Fe	-10- (Ammonium Oxalate Extraction) ODOE	-11- (Ammonium Oxalate Extraction) Fe	-12- (Ammonium Oxalate Extraction) Al	-13- (Ammonium Oxalate Extraction) Si	-14- (Ammonium Oxalate Extraction) Mn	-15- (Na Pyro-Phosphate) C	-16- (Na Pyro-Phosphate) Fe	-17- (Na Pyro-Phosphate) Al	-18- (Na Pyro-Phosphate) Mn
				(% of <2 mm)					(% of < 2mm)								(mg kg^{-1})	(% of < 2mm)			
					6B3a		6A1c														
92P00610	0-20	Ap	S		0.026		0.41														
92P00611	20-40	C1	S		0.010		0.14														
92P00612	40-58	C2	S		0.008		0.12														
92P00613	58-65	C3	S		0.141		0.14														
92P00614	65-105	C4	S				0.19														
92P00615	105-120	C5	S				0.22														
92P00616	120-135	C6	S				0.20														
92P00617	135-175	C7	S				0.16														

*** Primary Characterization Data ***

Pedon ID: 91NC021004 (Buncombe, North Carolina) Print Date: May 1 2011 9:30AM

Sampled As : Biltmore Mixed, mesic Typic Udipsamment

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0084

CEC & Bases

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- Sum Bases	-6- Acid-ity	-7- Extr Al	-8- KCl Mn	-9- CEC8 Sum Cats	-10- CEC7 NH_4 OAC	-11- ECEC Bases +Al	-12- Al Sat	-13- Base Saturation Sum	-14- Base Saturation NH_4OAC
				(- - - - - - NH_4OAC Extractable Bases - - - - -)												(- - - - Base - - - -)	
				(- - - - - - - - - - - - - - - - - - cmol(+) kg^{-1} - - - - - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - - -)			(- - - - - - - - % - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H5a			5A3a	5A8b			5C3	5C1
92P00610	0-20	Ap	S	1.3	0.5	--	0.1	1.9	2.4			4.3	2.2			44	86
92P00611	20-40	C1	S	0.3	0.2	--	tr	0.5	1.6			2.1	1.4			24	36
92P00612	40-58	C2	S	0.2	0.1	tr	tr	0.3	2.2			2.5	1.1			12	27
92P00613	58-65	C3	S	0.4	0.2	0.1	tr	0.7	1.8			2.5	1.8			28	39
92P00614	65-105	C4	S	0.5	0.2	0.1	0.1	0.9	1.4			2.3	1.8			39	50
92P00615	105-120	C5	S	0.7	0.3	0.1	0.1	1.2	1.2			2.4	2.0			50	60
92P00616	120-135	C6	S	0.5	0.1	0.1	0.2	0.9	1.1			2.0	2.0			45	45
92P00617	135-175	C7	S	0.7	0.1	0.1	0.2	1.1	1.4			2.5	2.4			44	46

Salt

Layer	Depth (cm)	Horz	Prep	-1- Ca	-2- Mg	-3- Na	-4- K	-5- CO_3	-6- HCO_3	-7- F	-8- Cl	-9- PO_4	-10- Br	-11- OAC	-12- SO_4	-13- NO_2	-14- NO_3	-15- H_2O	-16- Total Salts	-17- Elec Cond	-18- Pred Elec Cond	-19- Exch Na	-20- SAR
				(- Water Extracted From Saturated Paste -)																			
				(- - - - - mmol(+) L^{-1} - - - (- mmol(-) L^{-1} -)													(- - - - % - - - (- - dS m^{-1} - -)				
																						5D2	
92P00610	0-20	Ap	S																			--	
92P00611	20-40	C1	S																			--	
92P00612	40-58	C2	S																			--	
92P00613	58-65	C3	S																			6	
92P00614	65-105	C4	S																			6	
92P00615	105-120	C5	S																			5	
92P00616	120-135	C6	S																			5	
92P00617	135-175	C7	S																			4	

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - - -)						(- - Carbonate - -)		(- - Gypsum - - -)		
					$CaCl_2$					As $CaCO_3$		As $CaSO_4$*$2H_2O$		Resist
	Depth				0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - - - - - - - - - % - - - - - - - - - - - -)				cm^{-1}
				8C1g	4C1a2a	4C1a2a								
92P00610	0-20	Ap	S	5.3	5.6	6.3								
92P00611	20-40	C1	S	4.8	5.4	6.2								
92P00612	40-58	C2	S	4.9	5.4	6.2								
92P00613	58-65	C3	S	5.0	5.4	6.1								
92P00614	65-105	C4	S	5.1	5.5	6.2								
92P00615	105-120	C5	S	5.2	5.6	6.2								
92P00616	120-135	C6	S	5.0	5.5	6.2								
92P00617	135-175	C7	S	5.2	5.7	6.3								

*** Primary Characterization Data ***

Pedon ID: 91NC021004 (Buncombe, North Carolina) Print Date: May 1 2011 9:30AM

Sampled As : Biltmore Mixed, mesic Typic Udipsamment

USDA-NRCS-NSSC-Soil Survey Laboratory ; Pedon No. 92P0084

Sand - Silt Mineralogy (2.0-0.002 mm)

Layer	Depth (cm)	Horz	Fraction	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal		Tot Re			Optical Grain Count 7B1a				EGME Retn	Interpretation
				(- - - - - - - - peak size - - - - - - - - -)					(- - - - - - - - % - - - - - - - - - -)				(- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - -)							mg g^{-1}	
92P00610	0-20	Ap	fs										66	QZ 65	FK 16	BT 7	MS 6	PR 2	OT 2		
														OP 1	HN 1	GN tr	ZR tr	CA tr	TM tr		
92P00611	20-40	C1	fs										62	QZ 61	FK 21	MS 7	BT 7	PR 2	OT 1		
														OP 1	ZR tr	CA tr	HN tr				
92P00612	40-58	C2	fs										57	QZ 55	FK 20	BT 12	MS 6	PR 3	OT 2		
														ZR 1	OP 1	HN tr	CA tr	GN tr	CL tr		
														TM tr							
92P00614	65-105	C4	fs										64	QZ 61	FK 19	MS 8	BT 6	OP 2	PR 2		
														OT 1	HN 1	ZR 1	TM tr	CA tr	GN tr		
92P00617	135-175	C7	fs										56	QZ 56	FK 19	BT 13	MS 9	PR 1	HN 1		
														OT 1	ZR tr	OP tr	TM tr	CA tr	GN tr		

FRACTION INTERPRETATION:

fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:

BT - Biotite
CA - Calcite
CL - Chlorite
FK - Potassium Feldspar
GN - Garnet
HN - Hornblende
MS - Muscovite
OP - Opaques
OT – Other
PR - Pyroxene
QZ - Quartz
TM - Tourmaline
ZR - Zircon

IOTLA SERIES – FLOOD PLAIN

The Iotla series consists of very deep, somewhat poorly drained, moderately permeable soils on nearly level flood plains of the southern Blue Ridge (MLRA 130B). They formed in recently deposited, loamy alluvial materials. The mean annual temperature is 56 degrees F. and the average annual rainfall is 52 inches near the type location. Slope ranges from 0 to 3 percent.

TAXONOMIC CLASS: Coarse-loamy, mixed, active, mesic Fluvaquentic Dystrudepts

TYPICAL PEDON: Iotla loam, on a 2 percent flood plain, at an elevation of 2,090 feet--cultivated field. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 8 inches; brown (10YR 4/3) loam; weak medium granular structure; very friable; many fine and very fine roots; common fine pores; common fine and medium flakes of mica; slightly acid; abrupt smooth boundary. (6 to 12 inches thick)

Bw1--8 to 19 inches; dark yellowish brown (10YR 4/4) sandy loam; few medium faint brown (10YR 5/3) and few medium distinct brownish yellow (10YR 6/6) mottles; weak medium subangular blocky structure; friable; common fine and medium roots; common fine and medium pores; common fine and medium flakes of mica; slightly acid; clear smooth boundary.

Bw2--19 to 31 inches; brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; few fine distinct reddish yellow (7.5YR 6/6) irregularly shaped masses iron accumulation and common medium distinct dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) irregularly shaped iron depletions; few fine roots; few fine pores; common fine and medium flakes of mica; moderately acid; clear wavy boundary. (Combined thickness of the Bw horizon is 9 to 30 inches)

Bwg--31 to 47 inches; dark grayish brown (10YR 4/2) sandy loam; many medium distinct yellowish brown (10YR 5/4) mottles; weak medium subangular structure; friable; few fine roots; few fine pores; common fine and medium flakes of mica; strongly acid; abrupt wavy boundary. (4 to 8 inches thick)

Cg--47 to 53 inches; grayish brown (10YR 5/2) loamy sand; few light gray (10YR 7/1) mottles; massive; loose; 2 percent by volume rounded quartz gravel; common fine and medium flakes of mica; moderately acid; abrupt wavy boundary.

2Cg--53 to 67 inches; grayish brown (10YR 5/2) very gravelly sand; single grain; loose; few sand strata 1 to 3 inches thick; 40 percent by volume rounded quartz gravel and 5 percent rounded quartz cobbles; common fine and medium flakes of mica; moderately acid.

TYPE LOCATION: from Asheville, 2.1 miles south on U.S. Highway 25 (Biltmore Avenue) to Biltmore Village, 5.2 miles south on U.S. Highway 25-A, 4.1 miles southeast on Secondary Road 3116 (Mills Gap Road) to intersection of Secondary Road 1336 (Cane Creek Road) and Secondary Road 3116 (Mills Gap Road), 650 feet east southeast of intersection and 450 feet North of Cane Creek in a cultivated field; USGS Fruitland Topographic Quadrangle; latitude 35 degrees, 27 minutes, 8.23 seconds N. and longitude 82 degrees, 28 minutes, 33.67 seconds W.; NAD 27

REMARKS: Diagnostic horizons and feature recognized in this pedon are:

Ochric epipedon - the zone from the surface to 8 inches (Ap horizon)
Cambic horizon - the zone from 8 to 37 inches below the surface (Bw horizon)
Fluvaquentic feature - an irregular decrease in organic carbon from a depth of 10 inches to a depth of 50 inches below the surface; redox depletions within 24 inches from the soil surface; and a slope of less than 25 percent.

Biltmore's Vineyards

Our estate vineyard is in a valley near the French Broad River. We enjoy a favorable climate for grape cultivation. Our varieties include Chardonnay, Riesling, Viognier, Cabernet Franc, Cabernet Sauvignon, and Merlot. All grapes are picked by hand, with a harvest averaging 250 tons of grapes annually.

A Day In The Life:

Harvesting vinifera grapes for award-winning wines

Vineyard Director Dennis Wynne honored as 2008 N.C. Winegrower of Excellence

Dennis has worked for 28 years to help our vineyards produce the best grapes for the best wines possible. He recently received the "Winegrower of Excellence for 2008" award from the N.C. Winegrower's Association. "I was shocked and honored," he said. "But the award should go to my entire crew. They're the ones who do it; they make my job so much easier."

Dennis and his seven-member vineyard crew lovingly tend 94 acres yielding six varieties of grapes. It's not for the faint of heart, he warns.

"It's all a gamble. We have to be vigilant about pest control, watering, erosion control and keeping deer, turkey, and geese away from the grapes," he said. "And we are constantly checking the weather; that's the biggest risk factor."

Weather is the big factor that makes or breaks a successful harvest. Too much rain keeps Dennis and his crew on constant alert fighting diseases caused by wetness. Although North Carolina grapes withstand temperature shifts unlike anything seen in California, sudden drops below freezing wreak havoc on the vines and their fruit, despite the crew's best efforts.

Tending the vineyards is a year-round job. The team hand prunes more than 57,000 vines and ties the vines during the winter. From April through summer, they spray, mow, train the vines, pull suckers, spread leaves, and check for pests and fungal disease.

About this time each year, Biltmore Winemaker Bernard Delille samples grapes once or twice a week. "Bernard is a great winemaker," Dennis said. "He comes out and inspects frequently, and then decides when we should pick the grapes."

In mid-August, 60–70 people are hired for the harvest, which begins around Labor Day and continues through October. White varietals are harvested first; Cabernet Sauvignon grapes are the last picked.

"Although viticulture is a gamble and hard work, it's very rewarding," said Dennis. "And with our climate, we're pushing the limits on growing vinifera. It's great to know our wines, with all these challenges, are winning competitions in California and France."

One recent award bears this out: the Biltmore Estate® 2008 Viognier, crafted from North Carolina grapes, captured a gold medal at the San Diego International Wine Competition. Try this award-winner along with our other fine wines, at your next visit to the Winery.

Biltmore Receives Top Honors

Biltmore Reserve Cabernet Rated 92 Points

Our Biltmore® Reserve Cabernet Sauvignon – Alexander Valley was rated 92 points by the Beverage Testing Institute accompanied by the following tasting notes: "Garnet-violet color. Bold, fresh-picked raspberry and sour cherry jam aromas with a silky fruity-yet-dry medium-to-full body with burnt sugar, nut, and root vegetable accented finish. An excellent fruit-forward table wine with excellent balance and structure."

Biltmore Wines Bring Home Gold in Dallas

We're thrilled to receive a gold medal from the prestigious 2011 *Dallas Morning News* Wine Competition—the largest commercial wine competition outside of California, open to wines from all wine regions in the world.
Biltmore® Reserve Pinot Noir – Russian River Valley

Biltmore Wines Shine in San Francisco

At the 2011 San Francisco Chronicle Wine Competition, the largest competition of American wines in the world, Biltmore was awarded Best of Class in 3 categories out of more than 5,000 wines! Plus, a gold medal for our North Carolina Chardonnay.
Biltmore Estate® Sparkling Blanc de Blancs
Biltmore® Sauvignon Blanc
Biltmore® Century Red
Biltmore® Reserve Chardonnay – North Carolina

Biltmore Wines Bucks the Competition in Houston

At the 2011 Houston Livestock Show & Rodeo International Wine Competition, an event like none other, once again Biltmore takes home 2 Class Championships!
Biltmore® Reserve Pinot Noir – Russian River Valley
Biltmore® Century White

As Seen on the Today show

Biltmore® Century Rosé was featured as one of *The Best Wines in America*.

Top 2010 Accolades

White Wines

Biltmore® Reserve Chardonnay – Napa Valley
GOLD: Consumer Wine Awards
GOLD: Monterey Wine Competition
87 POINTS: Wine Enthusiast

Biltmore® Limited Release Chenin Blanc
GOLD: National Women's Wine Competition

Biltmore Pinot Grigio
87 POINTS & BEST BUY: Beverage Tasting Institute World Wine Championships

Biltmore® Sauvignon Blanc
87 POINTS & BEST BUY: Beverage Tasting Institute World Wine Championships

Red Wines

Antler Hill™ Cabernet Sauvignon – Napa Valley
DOUBLE GOLD: North Carolina State Fair Wine Competition
GOLD: San Francisco Chronicle Wine Competition

Biltmore® Reserve Cabernet Sauvignon – North Carolina
90 POINTS: Jane Garvey, Atlanta Wine School

Biltmore® Reserve Cabernet Sauvignon – Alexander Valley
GOLD: San Diego International Wine Competition
GOLD: American Wine Society Competition

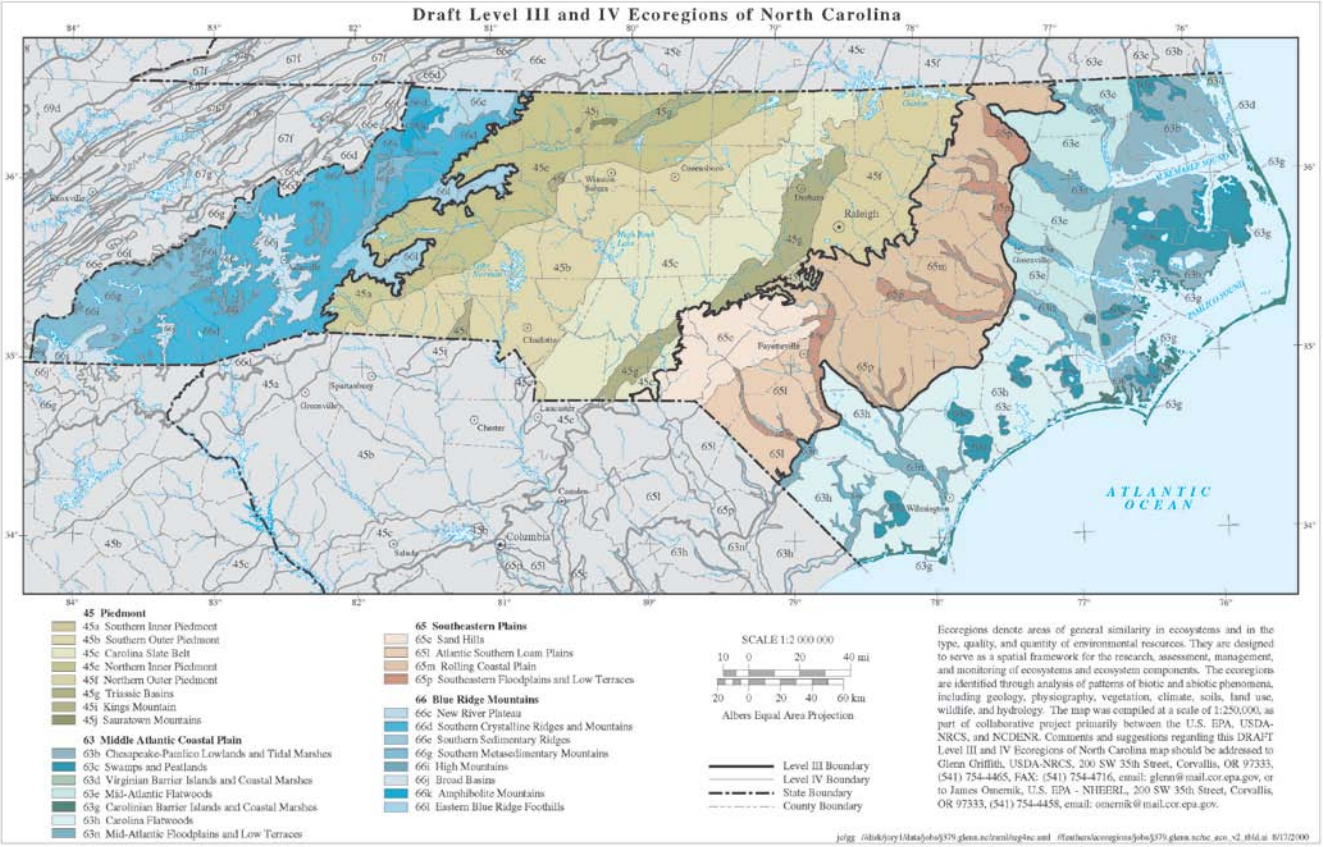
Biltmore® Reserve Pinot Noir – Russian River Valley
UNANIMOUS GOLD: Riverside International Wine Competition

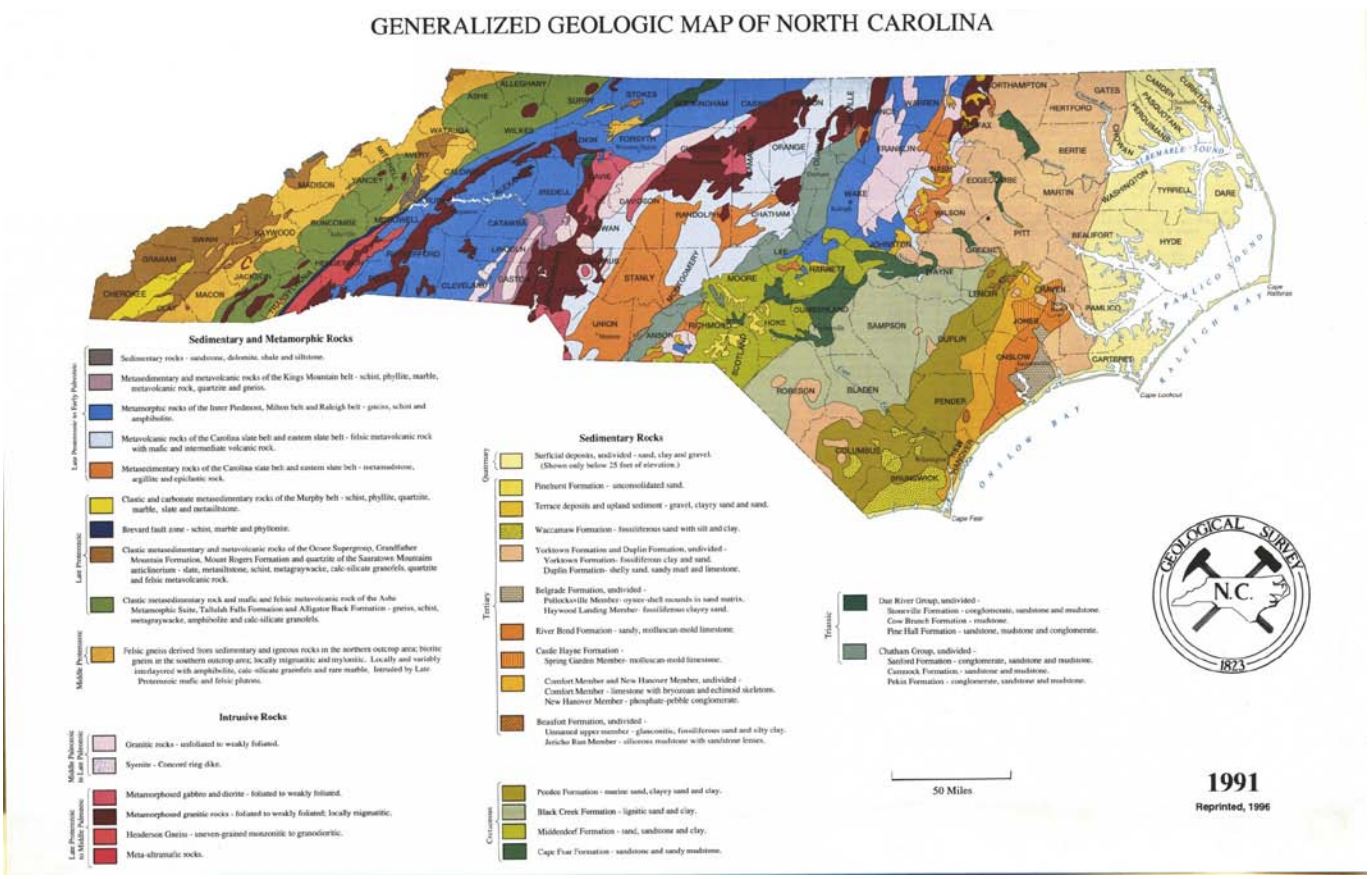
Biltmore® Century Red
DOUBLE GOLD: North Carolina State Fair Wine Competition

Biltmore® Syrah
GOLD: Consumer Wine Awards

Sparkling Wines

Biltmore Estate® Sparkling Blanc de Blancs
DOUBLE GOLD: North Carolina State Fair Wine Competition


Draft Level III and IV Ecoregions of North Carolina
ATLANTIC OCEAN
45 Piedmont
45a Southern Inner Piedmont
45b Southern Outer Piedmont
45c Carolina Slate Belt
45e Northern Inner Piedmont
45f Northern Outer Piedmont
45g Triassic Basins
45i Kings Mountain
45j Sauratown Mountains
63 Middle Atlantic Coastal Plain
63b Chesapeake-Pamlico Lowlands and Tidal Marshes
63c Swamps and Peatlands
63d Virginian Barrier Islands and Coastal Marshes
63e Mid-Atlantic Flatwoods
63g Carolinian Barrier Islands and Coastal Marshes
63h Carolina Flatwoods
63n Mid-Atlantic Floodplains and Low Terraces
65 Southeastern Plains
65e Sand Hills
65l Atlantic Southern Loam Plains
65m Rolling Coastal Plain
65p Southeastern Floodplains and Low Terraces
66 Blue Ridge Mountains
66c New River Plateau
66d Southern Crystalline Ridges and Mountains
66e Southern Sedimentary Ridges
66g Southern Metasedimentary Mountains
66i High Mountains
66j Broad Basins
66k Amphibolite Mountains
66l Eastern Blue Ridge Foothills
SCALE 1:2 000 000
10 0 20 40 mi
20 0 20 40 60 km
Albers Equal Area Projection
Level III Boundary
Level IV Boundary
State Boundary
County Boundary
Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. The ecoregions are identified through analysis of patterns of biotic and abiotic phenomena, including geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology. The map was compiled at a scale of 1:250,000, as part of collaborative project primarily between the U.S. EPA, USDA-NRCS, and NCDENR. Comments and suggestions regarding this DRAFT Level III and IV Ecoregions of North Carolina map should be addressed to Glenn Griffith, USDA-NRCS, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4465, FAX: (541) 754-4716, email: glenn@mail.cor.epa.gov, or to James Omernik, U.S. EPA - NHEERL, 200 SW 35th Street, Corvallis, OR 97333, (541) 754-4458, email: omernik@mail.cor.epa.gov.


GENERALIZED GEOLOGIC MAP OF NORTH CAROLINA
Sedimentary and Metamorphic Rocks
Sedimentary Rocks
Intrusive Rocks
50 Miles
GEOLOGICAL SURVEY
N.C.
1823
1991
Reprinted, 1996

In 2005, the North Carolina General Assembly passed legislation making the Fraser Fir the official Christmas tree of North Carolina.

Roughly 50 million Fraser Firs, to be more specific, are grown on approximately 35,000 acres in North Carolina. Of all of the Christmas trees grown in the state, ninety-percent are Fraser Firs. According to the NC Dept of Agriculture, in 2009 Christmas trees brought an estimated $100 million economic impact to the state of NC. In 2006 North Carolina was number one in Christmas trees production in the US with sales of $134,000.

Formation of Soils in North Carolina

S.W. Buol

WNR Professor of Soil Science, North Carolina State University

Soils in North Carolina can trace their ancestry to the formation of planet earth. As the molten magma cooled that portion of the earth's surface that was destined to be politically designated as North Carolina acquired a chemical composition that determined the proportion of chemical elements available within the material that we now call soil. The basic ingredients that formed most of the soils in North Carolina were acid igneous rocks. By earth-wide standards these rocks are rich in silicon and aluminum but poor in the life essential elements of phosphorus, calcium and magnesium. Geologic ages before the land surface acquired any similarity to that of the present, the cooling crusts were twisted and turned to reshape portions of the original granitic rock structure into metamorphosed masses of gneiss. Melting and solidifying processes concentrated certain elements into potassium-rich mica schists, silica-rich quartz dikes, and iron- and magnesium-rich mafic dikes within the crustal lithosphere.

Additions were made via volcanic activity that spread ash and molten flows over some of the gneiss and granites. These materials were eroded, redeposited and compressed into shales, slates and limestones. The surface plates of the earth continued to shift and what is now the western part of the state was thrust upward to form the Appalachian mountains. Wide basins were formed to the east of the mountains and sediment from eroding surfaces settled into them forming the Triassic Basins. Tectonic upheaval subsided, and erosion became the major influence shaping the land surface of what was to become North Carolina. Over the millennia, soil materials eroded off the piedmont and mountains. The Blue Ridge formed the highest point in the eastern part of the United States. Erosion to the west of the Blue Ridge was carried toward the Mississippi basin. To the east of the Blue Ridge eroded sediments were deposited to form the continental shelf of the North American continent. As the relative elevation of land continued to rise, the position of the Atlantic Ocean receded to the east, and broad nearly level areas of sediment became exposed as land surface, now known as the coastal plain. Sea level fluctuated over 400 feet in the last 5 million years creating seven levels of sediment surfaces, separated by scarps (escarpments) that are markers of the former coast line within the coastal plain.

The most significant aspect of geologic history on soil formation within North Carolina is a legacy of material that is chemically poor with respect to chemicals such as phosphorous, calcium and magnesium needed to support life. Most of the limestones which contained the calcium- and phosphorus-rich materials of dead organisms were thrust westward into what is now Tennessee or eroded and deposited deep within the sediments under the coastal plain. The slates, granites, and gneiss exposed on the eroding slopes of the piedmont and mountains are acidic and contain only small amounts of phosphorus, calcium and magnesium, with potassium being in relatively good supply.

North Carolina was untouched by the massive continental glaciers that pulverized the limestones and granites of what is now Canada. With the aid of flowing waters and dusty winds, that fertile silty material was deposited over vast areas in the Midwest of the United States. The

materials on the coastal plain, most of which were chemically poor at their origin, were exposed to further chemical depletion as they were eroded and transported to their present location. Only the relatively basic sediments in the Triassic Basins and basic gabbro and diorite rock exposures can be considered chemically fertile soil forming material.

Graced with appropriate temperature and moisture North Carolina has climatic conditions that are amenable to many plant species and ample water is available during the long frost-free season. Paleoclimatic evidence does not indicate extreme differences within the recent past. Although cooler climatic conditions have been present no glacial activity has been detected in North Carolina.

Most of the state averages about 45 inches of precipitation each year. Average precipitation is slightly higher near the coast, decreases to about 35 inches in the Asheville basin and reaches about 80 inches in some of the mountains in the southwest part of the state. Temperatures over most of the piedmont and coastal plain dictate evapotranspiration requirements of about 30 inches of water each year. Cooler temperatures in the mountains dictate somewhat less evapotranspiration. Although yearly weather conditions fluctuate around these averages there is an average annual surplus of about 15 inches of water if all the precipitation infiltrates into the soil. Most of this surplus water comes during the winter months, percolates through the soil and recharges the ground water.

Change with time is intrinsic to the concept of soil formation. If soil composition could not be changed in response to ambient conditions all soils would have only properties of the geologic material from which they form. Several soil properties are dictated by the composition of the parent material and several soil characteristics common in other areas of the world cannot develop in North Carolina simply because the ingredients necessary for their development are not present. For example, the redistribution of carbonate to form calcic horizons is a significant feature of soils formed in material that contains abundant amounts of carbonate. Calcic horizons are not found in North Carolina.

Base Saturation Patterns

The interaction of water and plants redistributes chemical elements within the soil profile in addition to both adding and removing some elements. Plants obtain hydrogen and oxygen from water. Almost all other chemicals in plant tissue, except carbon, are taken up through their roots.

Carbon enters the plant as CO_2 through the stomata of the leaves and combines with nitrogen, phosphorus, calcium, magnesium, iron, copper, zinc, sulfur, boron, etc. extracted from the soil to form organic compounds of these elements in the plant tissues. Potassium, extracted from the soil, does not form organic compounds but is retained in the cytoplasm and vacuoles of the plant cells. Plants combine these inorganic elements from the soil with the CO_2 from the air to form organic compounds in their roots and above ground parts.

Most of these organic compounds are deposited as organic litter on the soil surface not to the total soil volume from which the plant roots extracted the essential elements. Potassium quickly leaches from the dead plant cells as an inorganic ion. As microbes consume the plant tissues and respire the carbon as CO_2 the other essential elements are released from their organic compounds as inorganic ions. The result of this "biocycling" is a concentration of life essential elements in topsoil despite the leaching effect of the percolating water.

When biocycling and leaching processes are imposed on infertile parent materials soil profiles are formed within which exchangeable base cation contents decrease with depth develops, i.e. Ultisols. When these processes are applied with equal vigor to fertile parent material a vertical pattern of decreasing, then increasing, base saturation with depth develops, i.e. Alfisols. In North Carolina, major examples of these processes in identical climatic, topographic, vegetative and age settings are the formation of Ultisols such as Cecil soils formed in acid parent materials and Alfisols, such as White Store soils formed in basic Triassic Basin parent material.

Clay Movement

Vertical water movement patterns within soil offer an explanation for the formation of subsoil clay accumulation, i.e. Bt, argillic and kandic horizons. Most rainfall events are of a limited duration during which water passes rapidly through the larger pores in the uppermost layers of the soil. After rainfall ceases the velocity of the percolating water slows and eventually ceases as it is drawn by capillary action into the smaller (less than 0.01mm diameter) voids. It is from voids with diameters between 0.01 and 0.0002 mm that plant roots extract water between rainfall events. Water held in pores less than 0.0002 mm in diameter retain water at such great tensions that it cannot be extracted by plants. The energy of the rapidly moving water as it percolates through the surface horizons has the ability to suspend clay-sized particles and carry them downward. As plants extract water the suspended clay does not pass into the root and is concentrated into the smallest pores where subsequent water flow rates of high velocity cannot again suspend it.

In most soils the amount of clay suspended in each rain event is extremely small, but over several years, perhaps centuries, enough clay is translocated from the upper part of the soil to form argillic or kandic (Bt) horizons. If the clay translocation process (lessivage) is rapid, visible coatings of oriented clay (clay skins) are formed on root channels and ped faces in subsoil horizons. If lessivage is slow, as when little clay is present in the surface horizons, mixing (pedoturbation) processes destroy the fragile clay skin structures, and the clay is mixed into the matrix, but the greater clay content of the subsoil remains.

Clay depletion in the surface horizons and accumulation in the subsoil is a feature common to almost all soils formed on stable landscape positions in North Carolina. It has been hypothesized that this should not occur in poorly drained soils, but it does. The reason appears to be that even if the water table is within the Bt horizon for much of the year there are periods of time during most years, usually during the summer, when subsoils are not saturated and conditions are present for the lessivage process to take place.

Soils with thick sandy surfaces, primarily the Typic and Arenic Kandiudults of the coastal plain, have almost no clay skins within the upper Bt horizons. It is probable that the lessivage process is slow because surface horizons lack both clay and weatherable minerals from which clay can form. In sandy, quartz-rich materials like those is the Sandhills region little clay is accumulated in the subsoil. The lessivage process is slow and soils on rapidly eroding surfaces, like the slopes in the mountains, do not accumulate enough clay to form argillic horizons although clay skins are often present in Bw or cambic horizons.

Soil Organic Matter Distribution

The content and distribution of organic matter in soils results from the interaction of plants, water and temperature. Since there is no organic carbon in geologic rock, except that derived from plants and buried by sedimentation, the organic carbon we find in soil owes its existence to carbon dioxide extraction from the air via plants. Organic carbon is usually the only element determined to estimate organic matter content of soil. Soil organic matter is also the major source of nitrogen in the soil.

Nitrogen, like carbon also comes from the air. Although 78 percent of the air is nitrogen it is present as N_2 and not directly available to plants. Plants secure almost all the nitrogen they need as nitrate (NO_3^-) or ammonium (NH_4^+) from the soil. Small amounts of nitrogen are converted from N_2 by electrical discharges, lightning, and added to the soil in rainwater. Nonsymbiotic microorganisms living in the soil are capable of converting N_2 and incorporating it into their cells. As these microbes die and their bodies decompose the nitrogen they contain is released into the soil solution mainly as nitrate. Precipitation and nonsymbiotic microbial fixation together contribute approximately 20 pounds of nitrogen per acre to the soil each year. Leguminous plants have a symbiotic relationship with nitrogen fixing microbes (Rhizobium) that "fix" N_2 and pass it along to the legume plant. Plants readily consume nitrogen, and it becomes a component of their tissue subsequently to be released as that dead tissue is decomposed. Nitrogen, released as organic tissue decomposes, moves as nitrate (NO_3^-) in oxidized water but is reduced in anaerobic soil water and returns to air as N_2 and other nitrogen gases.

Organic matter in soils is transient. Microbes in the soil consume the organic carbon of the dead plant and animal tissue. Of the carbon consumed, about 25 percent is incorporated into microbial cells, and about 75 percent is released as CO_2, which escapes the soil and returns to the air. Individual microbes have a short life expectancy and with each generation the 75 percent conversion of organic carbon to CO_2 takes place as a new generation of microbes decomposes the cells of the dead microbes. The only new supply of organic carbon is the cells of plants that extract carbon from the air, or of animals which have eaten plants to obtain carbon and other nutrients for their cells. Organic carbon decomposition releases the mineral nutrients that the plants have taken from their total rooting volume and concentrates them in the surface layers of the soil. This results in the spatial association of fertility (N, P, K, etc.) and organic matter in the topsoil horizons.

Temperature and moisture conditions are satisfactory to produce abundant plant growth in all parts of North Carolina. Therefore the availability of organic carbon via plant litter appears not to be limited. To explain the different soil organic carbon contents we find among soils we need to examine those factors that control the rate at which organic carbon is destroyed and returned to the air as CO_2. Soil microbes use O_2 to decompose soil organic carbon. In soils that are saturated with water for much of the year O_2 within the soil is often in short supply. In poorly drained soils, much higher contents of organic carbon are maintained than in well-drained, better-aerated soils.

There are over a million acres of organic soils (Histosols) in the state. They are formed where during recent geologic time organic production has exceeded organic matter decomposition and a thick layer of almost pure organic matter overlies the mineral substrate. We have to say "almost pure" because trees, partially rooted in mineral substrata have been uprooted by wind and mixed mineral material upward into the organic layer and some deposition of mineral dust has occurred. Histosols form when saturated and anaerobic conditions are present throughout most of the year and organic carbon oxidation is slow and nitrate reduction

is rapid. As a result much of the organic material in the uncultivated Histosols in North Carolina has carbon:nitrogen ratios well above the 32:1 ratio considered necessary to allow plant available nitrogen to be released during slow decomposition.

Soil microbes respire more slowly when cool, and therefore, it takes longer for each generation of microbes to decompose the plant tissue and organic remains of the past microbial generation. The residence time of each organic carbon atom in the soil is thus longer, and organic carbon contents in cool soils are greater than in warm soils. In the cooler soils of the high mountains, organic carbon contents are greater than in the warmer areas of the state. Soils on the south-facing slopes in the mountains contain less organic carbon than soils on the north-facing slopes because they receive direct sunlight and surface horizons become warmer for longer periods of time each cloudless day.

The temperature to which a given amount of radiation will heat soil depends upon the heat capacity of the soil. Heat capacity is the number of calories needed to raise the temperature of a substance 1°C. Water has a much higher heat capacity than air, thus water content in the soil is the major determinant of a soils heat capacity. Dry soil has a lower heat capacity than moist soil; therefore maximum daytime temperatures near the soil surface are higher than those in moist soil. Sandy soils retain less water than finer textured soils when dried to the point that plants begin to wilt. Therefore, they warm to higher surface temperatures and organic carbon contents are lower than in finer textured soils. Lower maximum temperatures are also present in the surface horizons of more poorly drained soils where higher water contents keep their maximum temperatures below those of surface horizons in adjacent well-drained soils.

Farming operations cause daily maximum surface soil temperatures to increase. Simply removing the shade and surface litter present under native tree vegetation reduces soil organic carbon contents about 30 percent after only a few years. Where drainage has been installed to lower the seasonal high stand of the water table even greater organic carbon content reductions are experienced. Extreme reduction in soil organic carbon content has resulted in parts of the eastern North Carolina "Blacklands." Since European settlement, drainage and fires have combined to oxidize some of the organic soils (Histosols) and expose the mineral substrate where farming is now conducted.

Erosion and Sedimentation

Natural geologic erosion and deposition processes have shaped the characteristics of most soils in the state. Over geologic time the surface of the land (soil) is not stable. The surface of the land at any given site is either rising in response to deposition or lowering in response to erosion and dissolution of the mineral materials. From measurements of the constituents dissolved and suspended in the major rivers of the Atlantic coast it is estimated the land surface is lowering at a rate of 1.6 inches per 1000 years. Approximately 55 percent of the materials are lost by dissolution of minerals and 45 percent as suspended load in the rivers.

Average rates are extremely misleading because the erosion and deposition processes are localized both in space and time. The spatial arrangement of these processes has created extreme contrasts in soil properties within North Carolina. Erosion is most intense on steep slopes and along major rivers where the kinetic energy of flowing water suspends and moves soil material. Dissolution losses have the most impact on soil properties where soil surfaces are stable and mineral alteration and lessivage have produced the thick, quartz-rich sandy surfaces

and kaolinite-rich kandic horizons of the upper coastal plain. On the steep slopes of the mountains, physical removal by surface erosion and physical displacement via landslides change the absolute position of the soil surface so rapidly that the impact of lessivage is minimal with only Bw or cambic horizons being formed in the soils. Argillic and kandic horizons are present only in areas of stable landscape. In the piedmont, with lesser slope gradients, the rate of erosion is less than in the mountains. The soil surfaces are being lowered at a slower rate, and argillic (Bt) horizons are present in all soils except those on the most erosive sites. The level upland surfaces in the coastal plain experience little erosion and are sites for the thickest soils with the most contrasting "textural" profiles, i.e. Kandiudults and Paleudults.

Alternating erosion and sedimentation has created extreme spatial contrast of soil properties in the flood plains and low terraces of the major river systems within the coastal plain. These alluvial areas are subjected to extreme contrasts of erosive energy as floodwater reshapes the channels by cutting new channels while filling old channels with sediment. Floodwater velocities differ greatly both in time and space. Therefore the texture of the deposited sediment contrasts greatly within small distances. Long-term deepening of the major river channels has left former floodplains as stable terraces upon which soils with argillic (Bt) horizons have formed. However, spatial variations in texture, a result of the past sedimentation and stream bank erosion processes experienced during the time the terrace was in a flood plain landscape position, remain. As the river channels deepened, the water tables under the adjacent terraces deepened. Differential settling of the contrasting textures has resulted in the formation of small depressions, often called "potholes," of more poorly drained soils interspersed within the well-drained soils of the terraces. The intimate spatial mixture of textures and depths to water tables force even detailed soil surveys to represent these areas with map units that have high percentages of included contrasting soils.

Erosion processes remove more than surface soil material. In the mountains, landslides scour linear slopes and pile colluvium at the base of slopes. Landslides and the slow creep of soil material down the slopes result in the formation of shallow soils, and often rock outcrops, near the crest of the ridges and deep soils on the lower part of the slope. Except along major rivers, little deposition remains in the flood plains irregularly eroded in flash floods. On the coastal plain, where river gradients decrease, broad flood plains are present. The piedmont has intermediate flood plain width.

Mineralogy and Particle Size

Most soils in North Carolina contain less silt than soils in the glaciated areas of the Midwest of the United States. Low silt content has profound influence on the available water holding capacity of soils. When silt-sized particles are packed together in soil, pores ranging from 0.0002 to 0.01 mm in diameter are formed. Pores of this size are responsible for retaining water for plant use between rain events during the growing season. Low silt content soils in North Carolina retain approximately 0.1 inch of available water per inch of soil depth. Silty soil in the Midwest retain double that amount.

The granitic nature of most rock, and sediment derived from that rock, precludes high silt content in the soils of North Carolina. The major component of the granitic rock is quartz that weathers by dissolution. Dissolution rate per unit weight of quartz is dependent upon the surface area of the individual particles. Sand-size particles dissolve very slowly while silt- and clay-size particles of quartz dissolve at a relatively rapid rate. Almost no quartz of clay size is present in soil.

Silt contents are greatest in the slate belt and the northeastern part of the coastal plain but seldom exceed 50 percent. Soils formed in the Midwest commonly exceed 60 percent silt, the abundance of silt-size particles resulting from physical crushing by glacial ice and concentration by wind, i.e. loess.

Most soils in the coastal plain are Siliceous. The sand and silt in Siliceous soils is 90 percent or more quartz (SiO_2) and less than 10 percent weatherable minerals. A distinct boundary between Mixed and Siliceous mineralogy exists at the Suffolk scarp at an elevation of 20 feet. To the east and below the Suffolk scarp the soils contain more than 10 percent weatherable minerals and are recognized as having Mixed mineralogy. The weatherable minerals are thought to be derived from sediment originating from material dislodged from areas to the north by glaciation during the last ice age and deposited when the ocean edge was at the Suffolk scarp.

The mineralogical composition of soils within the flood plains in the coastal plain depends upon the area being eroded by the watershed of individual rivers. The flood plains of rivers with headwaters in the piedmont usually have Mixed mineralogy resulting from saprolite material eroded from some areas within the piedmont. The flood plains along rivers in the coastal plain that have headwaters only within the coastal plain usually have Siliceous mineralogy.

Granitic and gneissic rocks form a large portion of the piedmont and mountain areas of the state. Quartz is the most abundant mineral. The second most common minerals are feldspars and micas. Feldspars weather by rearrangement of the silica and aluminum into clay minerals such as gibbsite and kaolinite. On the more stable slopes in the piedmont this alteration takes place at the contact of the saprolite and bedrock, usually well below the soil profile. The upward sequence of alteration within the saprolite is from feldspar to gibbsite, gibbsite to halloysite, then halloysite to kaolinite very near the bottom of the argillic horizons. Gibbsite and halloysite are usually found only within a few inches of the hard rock. The gibbsite appears to rapidly acquire silica, from percolating water to form the halloysite. The halloysite appears unstable when subjected to drying and alters to plate-like-shaped kaolinite in the upper part of the saprolite.

In the mountains where there is a rapid exposure of feldspar minerals by the erosive action of creep and landslides considerable feldspar of sand size is often incorporated into the soil. Gibbsite, apparently forming directly from feldspar weathering, is a significant component of both the silt and clay fractions in cambic horizons. Kaolinite is the dominant clay in most soils in the mountains. Kaolinite forms from both feldspar and biotite. Alteration of sand-size biotite to sand-size kaolinite, with both minerals being present in the same particle, has been observed. Sand-size kaolinite is rigid and easily fractures to smaller silt- and clay-size particles.

In the acid soil environment of almost all soils in North Carolina aluminum ions are abundant. This leads to the formation of a secondary mineral known by several names: soil chlorite; hydroxy interlayered vermiculite (HIV); pedogenic chlorite; with hydroxy interlayered mineral (HIM) being the preferred designation. In its formation Al^{3+} and OH^- ions precipitate as $Al(OH)_3$ and AlOOH in the interlayers of 2:1 minerals like montmorillonite and vermiculite forming a very stable 1.4 nm (14 A^o) mineral. HIM is a minor, but consistent, clay-sized component of nearly all soils in North Carolina.

The basic materials of the Triassic Basins and smaller bodies of gabbro, metagabbro and diorite alter to montmorillonite when exposed to weathering in and below the soil. In the Triassic Basins the montmorillonite may have been formed prior to deposition. The presence of appreciable quantities of montmorillonite in clay textured subsoils renders these horizons quite impermeable when wet. The shrink-and-swell characteristics of montmorillonite produces physical movement as the soil wets and dries creating angular blocky structure with slickenside features on the ped faces. Base saturation percentage in and below these horizons is usually much higher than horizons formed from acid igneous rock and many of these soils are Alfisols.

Soil Color

Most soil colors are related to the distribution and composition of iron and organic carbon compounds in the soil. Iron is a constituent of most initial materials in North Carolina, and its movement in response to site specific conditions often differentiates soils within the state. Most often iron is present in silicate minerals but can occur as iron oxides. Iron oxides are particularly visible in soil because of their red and yellow color. Organic carbon is visible as black color in soil material. Most silicate minerals, quartz and kaolinite being the most common in North Carolina, are gray or nearly white in color. Most micas and feldspars are also gray except iron-bearing biotite mica that can be brown to black in color and some pink feldspars.

As previously discussed, organic carbon is derived from the air and after a brief sojourn darkening the surface A horizons of the soil, most but not all returns to the air as carbon dioxide. Organic carbon can also translocate within soil and leach to surface waters especially in sandy materials. Iron, however, is translocated both vertically within the soil profile and laterally among soils on the landscape. To be translocated iron must first be free of its silicate parent mineral. This requires dissolution of silica. Iron silicates are most abundant in basic rocks such as gabbro and diorite. Biotite is a common iron-bearing mineral in gneiss. Under warm conditions, percolating water dissolves silicates more rapidly than under cold conditions. During the eons of time that iron-bearing minerals in North Carolina have been exposed to percolating water considerable iron has been released from the iron bearing silicates of the geologic material. If the environment into which the iron is released contains O_2, the iron forms a ferric (Fe^{3+}) oxide of red or yellow color. Particles of oxide precipitate on the gray-colored quartz and kaolinite minerals. Small amounts of iron oxide, acting as paint, impart a red or yellow color to the soil.

In an absence of O_2, iron is reduced to a ferrous (Fe^{2+}) form which is soluble in water and thus able to move with the water. Water exposed to air contains dissolved O_2. For water to lose its dissolved O_2, microbes need to be actively respiring. Under the deciduous vegetation that once covered North Carolina, the leaves deposited each autumn blanketed the soil surface. Coarse texture surface horizons overlying more clayey and less permeable subsoils of well-drained soils may become saturated for short periods of time mainly in the winter when plants are not transpiring. During warm winter days, the sun warms the surface, and the sugars, carbohydrates and starches of the decomposing organic litter provide an ample source of available carbon to microbes. Respiration is rapid; oxygen is consumed; and nitrate, manganese and iron are reduced as long as the soil is saturated. The nitrate is liberated as N_2 and other gasses. The manganese and iron are reduced to soluble ferrous and manganous forms and free to move as water percolates deeper into the soil with each subsequent rainfall. After each rainfall event some water drains from the soil, the larger pores empty of water and fill with air. Oxygen from the air filled pores diffuses into the reduced water, and the ferrous iron oxidizes to a ferric iron. Red ferric iron is mainly hematite, and yellow ferric iron is geothite. Most soils have

a mixture of the two. Manganese, being less readily oxidized than iron, is often observed as black ped face coatings somewhat below the main horizon of iron accumulation.

This process is sporadic and suitable conditions for iron reduction in the surface horizons may occur only a few days each year, or be lacking in many years. The result is low iron content and gray-colored E horizons near the surface of most of the well-drained soils and yellow- to red-colored B horizons. The gray color of the iron poor surface horizons seldom extends to the surface because organic carbon of decomposing plant material added to the surface forms dark colored A horizons.

Plinthite

Of particular interest is the behavior of iron within landscapes on the coastal plain. Sediments on the coastal plain contain relatively few iron bearing silicates because of silicate weathering prior to erosion and movement from the piedmont. Depositional environments are anaerobic so most iron oxides were reduced and removed at the time the sediments were deposited. Most soils in the coastal plain have relatively low iron oxide contents. However, continued desilication of the few remaining iron silicates in the sediments releases some iron, and perhaps some iron is imported as aerosol dust.

Centers of the broad, nearly level interstream divides are saturated for long periods of time each year, some for the entire year. Abundant plant litter supplies fresh carbon each year. There is an inadequate O_2 supply for microbes to quickly decompose the annual additions of plant litter so organic carbon contents are high, and oxygenated rain water is quickly reduced after it enters these poorly drained soils. As the reduced water near the top of the water table moves toward the river valleys between rainfall events, plant roots extract some water from the top of the water table. As air replaces that water in the soil pores ferrous iron oxidizes and precipitates as red or yellow ferric oxide. The result is a "rim" of moderately drained to well-drained soils with yellow- to red-colored, iron-enriched subsoil horizons at the edges of the interstream divides and gray-colored, iron-depleted poorly drained soils in the interstream centers.

Often the subsoils near the edge of the interstream divides that have been stable for long periods of time acquire rather high amounts of iron oxides that partially cement the other soil particles forming a feature called plinthite. Once substantial masses of iron cemented material have formed they restrict water movement and are not easily dissolved by future reduction. To a lesser extent these same features are observable in the piedmont, but the more rapidly changing landform associated with ongoing geologic erosion of the steeper slopes probably precludes complete plinthite formation. Only "red and gray reticulate mottling" is observed in the lower B and upper Cr horizons of soils formed on the lower side slopes.

Spodic Horizons

Some of the organic compounds added as plant litter or formed as the litter is decomposed are soluble or suspendable and move with water in the soil. Such organic compounds are not easily decomposed by microbes, and most seem to be organo-mineral complexes containing short-range-order (amorphous) aluminum oxides. It is probable that such complexes move out of the surface horizons in all soils, but they appear to be retained and decomposed by microbial activity in the Bt horizons of soils that have appreciable amounts of clay.

In sandy soils, especially those with water tables near the surface, a high concentration of these organo-mineral complexes move to surrounding streams and rivers imparting a black or "coffee" color and acidity to the water. Some of the mineral-organic complexes are retained in a subsoil horizon at the upper surface of the seasonally fluctuating water table to form Bh or spodic horizons. A layer or horizon that is repeatedly saturated and aerated for extended periods of time during the year seems to be necessary for these features to form. Spodic horizons seldom occur in well-drained or excessively drained sands but may be extremely thick in some locations with large water table depth fluctuations. Iron oxides are associated with spodic horizons in some soils that have an abundant supply of weatherable iron silicates, but the Spodosols in North Carolina are in iron-poor sandy sediments of the coastal plain and most contain little iron oxide.

Dispersive Soil Material

Sodium-rich soil material is uncommon in humid areas. Sodium is a hydrated ion and when present in sufficient quantity causes soil material to disperse. Sodium is quite mobile in soil, and with appreciable amounts of leaching water, the sodium released upon feldspar weathering is usually removed, ending up in the oceans. Sodium-rich feldspars (plagioclase) are a component of several geologic materials, but little exchangeable Na^+ is present in most soils in North Carolina. Some mafic materials present in the Triassic Basins, diabase and other mafic rocks release Na^+ and Mg^{2+} upon weathering in the saprolite. When sodium-rich saprolite material is weathering below slowly permeable Bt horizons and on convex portions of the landscape, it is protected from leaching, and exchangeable Na percentages approach the 15 percent usually considered necessary for dispersion. In the very low salinity soil water in North Carolina it has been found that exchangeable Na^+ saturation as low as 5 percent, if accompanied by about 15 percent exchangeable Mg^{2+}, is sufficient to induce dispersion if this material is used in earthen dams. Only rare occurrences of this material have been found where all of the above conditions are present.

Sulfur Rich Soil Material

Prolonged contact of sulfur and iron in a reduced environment can produce insoluble iron sulfides. Such conditions occur in clay textured materials saturated with brackish water which are also receiving ferrous iron from fresh water sources. When these materials are drained and become oxidized sulfuric acid is produced. The resulting material is extremely acid, often too acid for the growth of plants. Commonly known as "Cat Clays" or "Acid Sulfate Soils," they are identified as Sulfaquents in soil taxonomy. Only very limited areas of such soils are known to exist in North Carolina. Most are on islands and clayey beaches near the mouth of the Cape Fear River where fresh waters of the river enter the Atlantic Ocean. Apparently because the other major rivers from the state enter sounds within which the salt concentration is much lower than in the ocean, occurrence of sulfuric horizons in North Carolina is rare compared to occurrences in South Carolina and Maryland.

Human Influence

Intensity of human habitation has increased greatly since European settlement started about 300 years ago. Human evaluation of the soils in North Carolina was well expressed by Professor Mitchell in 1822 when he said:

The soil of this State is pronounced, by those who have traveled extensively on both Continents, to be of a middling quality. It is of that kind which seems most to demand the employment of science and skill in its cultivation, and to promise that they shall not be employed in vain. Our grounds are neither so fertile that they will produce spontaneously what is necessary to the sustenance and comfort of our citizens, not so sterile that we have reason to abandon them in despair.[1]

With few exceptions all the soils in North Carolina are composed of mineral material derived from acid igneous rock containing scant quantities of the life essential elements calcium and phosphorus. Blessed with near ideal temperature and moisture for abundant plant growth, the limited supply of these and other life essential elements that plants must obtain from minerals were concentrated in the surface horizons of the soils, but even the richest of surface horizons contain very limited amounts. These amounts were quickly removed and transported from the fields in food and fiber crops grown and sold to urban areas.

The first European settlers practiced what is now known as "slash-and-burn" agriculture. After the trees were cut and burned, the land was cultivated for a few years harvesting the stores of essential nutrients contained in the ashes. The organic carbon in the soil rapidly oxidized in response to the removal of the cooling shade further releasing essential elements. As these stores of organically bound elements became exhausted, land was abandoned, and the farmers moved to clear yet uncultivated lands. In the words of Professor Mitchell (*ibid*),

But, in the process of time, as this system goes on, the planter will look down from the barren ridges he is tilling, upon the grounds from which his fathers reaped their rich harvest, but which are now desolate and abandoned and enquire whether he can restore them to their ancient fertility at a less expense than he can cultivate those lands of an inferior quality with which he is now engaged.

Fortunately natural concentrations of phosphorus and calcium were available and could be mined from some near surface sediments in the coastal plain. As farming intensified and spread across the state, resupplies of essential nutrients via fertilizer and lime became available. Over the history of farming in North Carolina, considerable amounts of lime and phosphate have been added to the soils that were cultivated, and today the cultivated soils are more fertile for the production of food and fiber crops than they were in their natural condition.

Calcium and magnesium from the liming materials have moved downward in the soil and replaced some of the natural acidity in the subsoil. This enables the roots of crop plants to extend to greater depths in subsoils, naturally too acid and calcium poor to permit their elongation, and extract more available water during rainless periods in the growing season. Phosphorus contents of the plowed surface horizons have been increased, but being insolublized by iron and aluminum, phosphorus has not migrated downward in most agricultural soils and subsoil contents are very low. Potassium supplies have been maintained by fertilization.

Annual supplements of nitrogen are placed on cropland and pasture to bolster the amounts naturally extracted from the air by rain and N-fixing bacteria. Liming and fertilization have taken place for approximately 200 years in many parts of the state. This is but a short time in the formation of the soils in North Carolina. However, these practices have significantly

improved the soil's ability to produce crop yields per acre that are now approximately three to four times greater than obtained by the first cultivators.

As farming became more mechanized, many areas—primarily those of steeper slopes—were no longer cultivated and have been occupied by forest. Even land abandoned by early slash-and-burn farmers as infertile still has enough fertility to support the growth of pine and hardwood trees, which have a much slower rate of nutrient uptake from the soil than food crops. Forest regrowth occurs naturally on abandoned cropland in the state, but landowners wanting high rates of tree growth often find it profitable to add lime and fertilizer.

Summary

Soil is what soil does. At the interface between the lithosphere and atmosphere on the land mass of planet earth, soil directs the exchange of water and heat, supplies most of the essential elements of life, and holds plants upright so they can utilize the energy of the sun to produce organic compounds necessary to all life on the planet. Soil becomes a mixture of organic and mineral materials within which the organic and inorganic chemistries interact with a multitude of life forms. Each soil is located at a site where a unique array of environmental and human activities combine to create features and functions that identify that soil as different from all other soils. No two soils are exactly alike. People have attempted to group soils of similar function and form thereby facilitating human understanding. Within North Carolina, over 300 kinds of soil have been identified by these human efforts, but in reality each identified kind of soil encompasses many soils, each somewhat unique and different.

Many known species of soil are not represented in North Carolina. Limited by the composition of the geologic materials from which they form and moderate climatic differences, soils in North Carolina may be considered monotonously similar. Most have features and functions that only slightly differ. Although soil differences in North Carolina may be small when compared to the total spectra of soils on earth, many of these differences are critical to human uses. Science is required to understand these soil differences. Skill is required in the application of science to assure continued formation and function of soils in North Carolina.

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[1]Quote from a speech by Professor Mitchell to the North Carolina Agricultural Society in 1822 and printed in the North Carolina Department of Agriculture Monthly Bulletin No. 15, 1882.

Notes on Kandic Properties

Dr. Stanley W. Buol

During the South Regional Work Planning Conference in Savannah, Georgia (June 3–6, 2002), the kandic horizon and its place in Soil Taxonomy was a topic of discussion. A committee was formed to look into how it can be better applied to landforms in the Southeast. Dr. Stan Buol, North Carolina State University, who was involved early in the development of the concept, was not in attendance. Responding to a request by Marc Crouch, however, he did provide the following history as he knows it.

It is hot and dry in Raleigh, and I am getting ready to catch and eat walleyes and northerns next week in Canada, so this morning I am nostalgic about the kandic horizon. Evidently, the apparent CEC7/kg clay is the issue. That issue goes back to about 1966, when all the present Udults were Ochrults (7th Approximation) and became Normudults (1964 draft changes to the 7th). At a southern regional soil classification workshop in Ft. Worth, the issue was up for discussion and the proposals were for splitting the Normudults into Hapludults and Tropudults. McCracken was concerned that no provisions were made to separate coastal plain Udults from piedmont Udults, so he asked me to look into the issue. He had become department head, and I had arrived from Arizona with a total lack of experience in Ultisols. Dr. Roy Simonson had forcefully, and correctly, pointed out that criteria for classification had to be from within the pedon classified and could not be based on properties below the soil, i.e., 2 m. Within the proposed Tropudults (iso soil temperature regime criteria), but not in the Hapludults, an Oxic subgroup had been proposed and defined as not having “more than 24 meq/100g clay in the major part of the argillic horizon” (Second Supplement, October 1966).

Armed with all the data I could find and with McCracken’s blessing, I set off for Ft. Worth to propose the following:
1) Pedons that did not have a clay content decrease of more than 20%, relative to maximum clay content of the argillic, within 150 cm of the surface would be Pachyudults (thick Udults), and those with a clay decrease of more than 20% within 150 cm would be Hapludults.
2) All Udults would have Oxic subgroups if they had CEC7/100 g clay less than 24 meq.
The first proposal met with resounding success, but the name Pachyudults was changed to Paleudults to reflect a bias toward genesis (old soils on the older coastal plain surfaces rather than “Pachy,” from “pachyderm,” meaning thick). The data I had showed that this would separate most Udults on coastal plains from Udults on the piedmont without having to have weatherable mineral data. The state soil scientists liked it because it required less lab data and because the clay content with depth could be determined in the field. As a sidelight Bartelli sent me to my room in the middle of the afternoon to clean up a few sentences in my proposal, by 5 p.m. the group accepted the proposal, and at happy hour the concept of “Pale” based on clay content decrease with depth was being touted for Alfisols, Mollisols, and even Aridisols. The second proposal, Oxic subgroups in all Udults, was soundly shouted down by the group. It required too much lab data, and available data indicated that it would affect a large number of existing series in the Southern region. When the proposal reached Guy Smith, he liked both the “Pale” and the

“Oxic” proposals, but the state soil scientists were strongly against the “Oxic” subgroups, so it remained only in the Tropudults and thus was not of concern in most of the Southern region.

After Guy retired and was in Venezuela, the question of “Oxic” subgroups continued to arise. We were then in the beginnings of the ICOM’s with the International Committee on Low Activity Clays. The most pressing issue was the volume of clay skins needed (>1%) to distinguish an argillic horizon from an oxic horizon and seemed to be an insoluble problem. In soils that have few weatherable minerals from which to form “new” clay, few clay skins are present (Rebertus and Buol, 1985. Intermittency of illuviation in Dystrochrepts and Hapludults from the piedmont and Blue Ridge provinces of North Carolina. Geoderma 36: 277- 291). During the time Guy was in Venezuela, we had several exchanges of letters relative to Ultisols. I well remember and retain those letters, in which Guy was so convinced that the Southern States would not accept the low clay CEC criteria that he wanted to retain the Tropudults, based only on the iso STR criteria, and recognize Oxic subgroups only in “Trop” great groups so as not to upset the Southern region. I wanted to abandon “Trop” as a great group because it was redundant to the family criteria, and I argued, “Low CEC was low CEC regardless of whether it was in the tropics or in the temperate zone.” In one exchange of letters, I sent Guy a postage stamp from the U.S. that outlined the tropics, temperate, and boreal latitudes and asked the very pointed question of whether he thought we should use a great group formative element on criteria that could be mapped on a postage stamp. Feeling a bit guilty about being so abrupt with an elder I so respected, I was hesitant when his letter arrived a couple of weeks later. To my surprise his first sentences were, “Now I am going to surprise you. I agree with you.” Guy’s concern for low activity clay criteria in the Southern region is shown on page 240 of the Guy Smith interviews.

The work of ICOMLAC was in full swing, and the clay skin issue would not go away. Frank Moormann did not want to violate the mandate to ICOMLAC to study low activity clay in Ultisols and Alfisols. Both orders required an argillic horizon, but clearly it was often impossible to find clay skins in argillic horizons with low activity clay. A new diagnostic horizon seemed the best way to address the problem, and in 1979, I introduced the “finer textured subsurface horizon (FTSH)” (page 122 in the Excerpts from the Circular Letters of ICOMLAC). After some editing, Frank and I proposed the “finer textured subsoil horizon” that was like the argillic horizon but had low apparent clay CEC and no clay skin requirements (page 125 in the Excerpts from ICOMLAC). Of course, we had to have a better name for the FTSH horizon, and as an aside I proposed “Impic horizon,” derived from “impotent,” but more scientific heads prevailed, and I think Hari Eswaran proposed “Kandic,” derived from kandite, the family name for kaolinites. (I still find that students are more likely to remember what is defined if it is referred to as impotent “Impudults” rather than “Kandiudults.”)

That ended the search for clay skins in argillic-like horizons of low activity clay, but there remained two fundamental questions on how this new diagnostic horizon should be used. First, there was the separation of coastal plains from piedmont areas in the Southern region. I firmly believed that distinction had to be retained and thus saw the necessity of the dual great group name—“Kanhap” for the thinner kandic horizons, mostly in the piedmont, and “Kandi,” i.e., “Pale,” for the thicker kandic horizons of the coastal plain. The second question was more difficult and was a major point of disagreement between Frank and myself. Apparently, the same issue is now in debate. Should the CEC criteria be 16 cmol/kg clay or 24 cmol/kg clay when CEC is determined at pH 7? Frank wanted 24 because it better defined the low activity clay areas in West Africa. I wanted 16 because it better fit the criteria we had been using to separate clayey kaolinitic and clayey mixed families in the Ultisols of the U.S. I also argued that the 16 cmol/kg clay was equivalent to the Oxic horizon and thus the separation of Oxisols from Inceptisols. In some obscure hotel room, Frank and I consumed the mollifying contents of a bottle of Scotch and decided on the phrase “apparent clay CEC at pH 7 of 16 or less OR apparent ECEC of the clay of 12 or less.” By that time we had a number of data sets that determined that an ECEC of 12 cmol/kg clay was nearly equal to an apparent CEC of 20 cmol/kg clay at pH 7. Thus, it would be a compromise between the 24 he wanted and the 16 I wanted, and we would both save face. (Saving face is very necessary in Asian culture, and Frank had spent many years in Viet Nam and Thailand.)

The ICOMLAC proposal went to John Witty in that form. John held a small meeting in Washington to review the proposal. Frank could not attend, but I did. I was armed with a study of existing data and a map made by Joe Nichols showing that if the higher pH 7 CEC value of 24 cmol/kg clay were accepted, it would move the “kandi” to include parts of Tennessee, Kentucky, and Mississippi, but I do not have the exact map Joe prepared. Anyhow, at that meeting it was argued that the dual criteria of 16 cmol/kg clay or less at pH 7 OR an ECEC of 12 cmol/kg clay or less would require two lab analyses of each sample and it would be better if we settled on one criterion. Thus, the wording was change to AND. The data available clearly showed that if a sample had an apparent CEC of 16 cmol/kg clay at pH 7, it would always meet the 12 or less cmol/kg clay ECEC criterion. I personally feel that the confusion created by including both values in the definition should be eliminated by stating only the apparent CEC

at pH 7 criterion, but at the time everyone was more concerned with adhering to the words of the ICOMLAC proposal, even though the application of the criteria had been changed by using AND rather than OR in the definition. Although I clearly favored AND, I refused to vote on the decision out of respect for Frank, who was not able to present his case. After Frank saw the final outcome, he thought I had unduly influenced John. Later, when I visited Frank in the Netherlands, we had dinner and a good bottle of wine, and as I explained what had happened, he forgave me and we parted good and respected friends.

It appears that the 16 vs. 24 apparent clay CEC at pH 7 is again up for debate. From the work Joe Nichols did with data existing at that time, all that changing the kandic limit to 24 cmol/kg clay would do is put the borderline pedons in a different place throughout the Southern region. With introduction of the clay activity family classes, a small range of soils fit as subactive families between “kandi” and 24 cmol/kg clay. One could argue that there is no need to have a 0.16 to 0.24 CEC7 to % clay ratio subactive activity family class and have the semiactive activity class range from 0.40 down to 0.16 as defined by the kandic.

There are three reasons I personally would not like to see the kandic horizon criteria raised to less than 24 cmol/kg clay. First, my most selfish reason is that the rules for identifying soils with expansive clays for the purpose of permitting standard septic systems is in the process of being defined at 16 cmol/kg apparent clay CEC determined at pH 7 in North Carolina. This is what I have been doing for about 30 years when septic system questions and samples with more than 35% clay come to my lab. I have tested this criterion against x-ray traces of the clay and believe that it more clearly defines the limit of more or less than 10% 2:1 clay minerals in a sample than I can obtain from x-ray (Kimble, Buol, and Witty. 1993. Rationale for using ECEC and CEC in defining the Oxic and Kandic horizons. Soil Survey Horizons. 34: 39-44). It is a lot easier to do, more easily reproduced, and looks better than x-ray traces in a courtroom when decisions of the Health Department and consultants come up for litigation.

Joe Kleiss (1994. Relationship between geomorphic surfaces and low activity clay on the North Carolina coastal plain. Soil Science 157: 373- 378) has helped to establish a geomorphic relationship that can be used, at least in North Carolina, to define the extent of the kandic horizon on the coastal plain. We have not formally tested limits in the piedmont, but in working with sanitarians and consultants, we have found a good relationship between the 16 limit and other morphological features of the pedons that these people can recognize in the field and use to make their septic system recommendations.

There always is a gray area at the “on ground” boundary between any taxonomic criteria definition of any natural entity. Soils are no more problematic in this respect than rocks or minerals. Within a limited geographic area, it is usually possible to find some taxonomic criterion that fits a geographic boundary, but as that geographic area is expanded and more pedons are examined, we always find that there is no taxonomic criterion that satisfactorily “fits” with “natural” geographic boundaries of soils in all areas.

I was personally very concerned when the kandic criterion was established because I knew the line would be difficult to establish within “my own backyard,” but we do the best we can. If the limit is increased, it will only push the decisions to another “backyard,” i.e., younger geomorphic surfaces and more poorly drained soils on the coastal plains (see the Kleiss reference) and soils with greater inclusions of basic parent material and/or loess in other areas. Secondly, we should remember that Soil Taxonomy attempts to classify all soils in the world. In the Southern region we are on the “fringe” of the kandic horizon and do not find the extremely low CEC soils defined as the Acrudoxic Kandiudults (ECEC of 1.5 cmol/kg clay or less) and the various “Acr” great groups of Oxisols. Increasing the “kandic” limit will enlarge the range of clay activity identified by the kandic horizon and needs to be tested in many other places, especially where “Kandi” Ultisols and Alfisols are in geographic association with Oxisols.

Finally, I like 16 cmol/kg clay limit for the kandic horizon because apparent CEC7 of the clay is most often spatially related to parent material. Having one limit that separates Oxisols and “Kandi” great groups from Inceptisols and “nonkandic” great groups is desirable when map units (often associations of great groups) are named on small-scale generalized maps. I think it is desirable to have some degree of uniformity within Soil Taxonomy. As Guy Smith once said, “Have sympathy for the students.” If we identify low activity clay at 16 for the oxic horizon and 24 for the kandic horizon, persons looking at the description of these diagnostic horizons in Soil Taxonomy (on page 43 of the 2nd edition, we say the kandic CEC is comparable to that of Oxisols) may wonder if soil scientists really know what they mean by low activity clay.

History of Soil Survey in North Carolina

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Abstract

The Raleigh to New Bern survey, published in 1900, at a scale of 1 inch per mile is the oldest known soil survey in North Carolina. Milton Whitney, then chief of the Bureau of Soils, had been the first superintendent of the research farm in West Raleigh before being appointed to the Federal position. In 1909, W. E. Hearn completed a unique soil survey of approximately 50,000 acres in Lake Mattamuskeet while it was under water, later to be pump drained in the 1920s only to become a lake again in 1933-34 when the pumping was abandoned. Hugh H. Bennett entered the soil survey of his native state in 1903, became an inspector in 1910, and spearheaded the formation of the Soil Erosion Service in 1933. Of the 100 counties in the state, 98 have published soil surveys, and the remainder have completed surveys awaiting publication. Fifty-six counties have two published soil surveys and five have three published surveys. Tales of 'bacca spittin', moonshin', and "ya'll can't get there from here" have contributed to the soil surveys of the "Old North State."

Introduction

Perhaps it would be a bit presumptuous to claim that North Carolina was where soil survey in the United States started, but it is a fact that in 1886, Dr. Milton Whitney was appointed the first superintendent of the research farm in West Raleigh. While the research farm was to become North Carolina State University, Dr. Whitney was to become the first Chief of the Bureau of Soils in the USDA and establish the soil survey program and the first systematic classification of soils in the United States (McCracken 1989).

Whitney was well known for his ever present cigar and his allegations that he could determine the kind of soil in which a tobacco was grown by the aroma of the smoke (Simonson 1986). His contention that the content of sand, silt, and clay had more to do with soil productivity than the soil's nutrient status or fertility put him at odds with the chemists and soil fertility specialists of that day (McCracken 1989). Also, oral history indicates that not all of his associates shared his enthusiasm for cigars.

Early Soil Survey Program in North Carolina

North Carolina became one of the first six states to begin a program of systematic classification and mapping its soils, with accompanying interpretations of use potentials. The USDA soil survey program began as a cooperative effort with the North Carolina Agricultural Experiment Station (now North Carolina State University) and the State Board of Agriculture (now the North Carolina Department of Agriculture). The first soil survey in North Carolina was the "Raleigh to New Bern Area," started in 1900 (Lee 1984). The survey was to be used as the basis for systematic investigation of the fertilizer requirements of different crops through a series of substations to be established on some of the principal soil types. The first surveyor was William C. Smith, a USDA employee. With the U.S. Geological Survey base maps previously prepared along the railway right-of-way, he mapped 1000 square miles in eight months. This is a rate of 5.6 square miles per day traveling by foot, horse- or mule-back, cart, buggy, or train. The cost of the survey was $1.10 per square mile.

In 1901, a second soil survey was started in the Statesville area. This survey was in one of the most eroded areas in the state. The report stated that farming practices resulted in "washing and small gullies . . . with many fields

having gullies with a depth of greater than 40 feet" (Lee 1984). The remedy suggested was that "gullied fields in a few years would be entirely reclaimed by a judicious use of ditch and terraces and the filling in of the larger gullies by means of pine boughs and logs" (Lee 1984). The fast-growing area around Cary was surveyed in one summer month in 1901. The survey area covered 63 square miles and included the present site of N.C. State University. The Mt. Mitchell area was mapped to find soils suitable for apple orchards in 1903. Other area soil surveys are listed in Table 1.

Table 1. Soil Surveys by area

Year Published	Name of Survey
1900	Raleigh to New Bern area
1901	Statesville area
1901	Cary area
1902	Mt. Mitchell area
1902	Hickory
1903	Craven
1903	Asheville
1904	Greenville
1909	Lake Mattamuskeet
1977	Outer Banks [1" = 1000 feet]

Alamance County was selected, because it was alphabetically first among the counties, for a survey in 1901. Duplin County was surveyed to consider land suitable for vegetable and grape production. Chowan County soil survey marked the first State Department of Agriculture employee, G. M. MacNider, to join with USDA soil scientist W. Edward Hearn. These two men also mapped Transylvania County at the same time. The state contributed $188.10 to the Chowan County survey and $737.80 to the Transylvania County survey. From 1900 to 1910, the base maps were 1-inch-per-mile U.S. Geological Survey (USGS) maps, many of which were 15 to 25 years old and out of date due to new roads, etc. Soil surveyors were geologists or chemists with little training in agriculture (Lee 1984).

In 1904, Hugh Hammond Bennett joined the North Carolina soil survey, became an inspector in 1910, and in 1933 formed the Soil Erosion Service, later to become the Soil Conservation Service and the Natural Resources Conservation Service.

In 1910, Professor Curtis Marbut was placed in charge of the Bureau of Soils, USDA. Base maps were then made with a plane table (15- x 15-inch board) equipped with compass and mounted on a tripod. An alidade was used to sight and measure. Transportation was by mule- or horse-drawn carts. An odometer fastened to the front wheel served to measure distances along roads. Churches, schools, cemeteries, and dwellings along the road were carefully identified on the base maps. About 1905, a 36- to 42-inch-long screw auger became the standard tool to examine soils.

In 1917, S. F. Davidson became the first college-trained soil scientist to join the soil survey, followed in 1918 by W. A. Davis. In 1918, the automobile entered the survey to transport the soil surveyor and his plane table.

The first airplane entered the survey in North Carolina in 1920. W. B. Cobb, a World War I pilot, assisted by W. A. Davis, flew over the swamps of Tyrrell County to locate points later to be traversed on foot. A few photos from the plane were used to aid the ground work, but total photo coverage was not used at that time. Complete aerial photo coverage was not used for soil survey in North Carolina until 1934 (Lee 1984).

A Few Statistics

North Carolina contains 100 counties. In recent years, soil surveys have been made and published by county or, in some cases, two counties.

As of this writing (June 1998), 182 county soil surveys in North Carolina have been published (Table 2). These surveys cover all 100 counties. More than half of the counties have two published soil surveys, and seven have three published surveys (Table 3).

By 1911, B. W. Kilgore had written *A preliminary report of mountain soils* based on soil surveys and field experiments. In 1915, C. B. Williams wrote a report on the piedmont soils, and in 1918,

Table 2. Number of soil surveys published in each decade (USDA-NRCS 1995)

Decade	No. Published
1900-1909	22
1910-1919	33
1920-1929	31
1930-1939	10
1940-1949	8
1950-1959	11
1960-1969	4
1970-1979	14
1980-1989	26
1990-1997	23
total	182

Table 3. Coverage of the 100 counties in North Carolina
[excluding the area surveys listed in Table 1].

No. Times Published	No. Counties
1	31
2	62
3	7

Three North Carolina Agricultural Experiment Station bulletins have been published that have summarized the soil survey data for the entire state (Williams and others 1934, Lee 1955, Daniels 1984).

The estimated cost for conducting soil survey field work in North Carolina is $1.50 per acre (September 1995). In 1995, 14 counties were contributing a total of more than 1.6 million dollars in cost-sharing funds for soil surveys. Most county cost-share agreements call for the county to contribute one-third of the survey cost for the privately owned land in the county. For their cost-share support, local governments receive both a published and a digital version of the modern soil survey. It should be noted that this support is perhaps strongest in, but not limited to, some of the least wealthy counties in the mountains of the state. Twelve counties in the sparsely settled mountain area have cost-shared surveys at a scale of 1:12,000. At first glance, the need for increased resolution in mountainous areas may not appear justified. However, soil suitable for home sites, horticultural crops such as Christmas trees, apples, ginseng, and tobacco are often in very small units that are not possible to delineate on smaller scale maps. This is but one indication that the soil survey program in North Carolina has been, and is still, serving the people.

In addition to the support from the North Carolina Agricultural Research Service at North Carolina State University and North Carolina A&T University at Greensboro, the state of North Carolina presently supports nine N.C. Department of Environment and Natural Resources soil scientists active in field mapping. This support has been ongoing since about 1975 and several of the state supported soil scientists are party leaders in our present

surveys. Although they receive their paychecks from the State of North Carolina, they work side by side with federally funded soil scientists of the Natural Resources Conservation Service and the Forest Service.

In 1994, a major reorganization in the USDA resulted in the formation of a Major Land Resource Area (MLRA) office in Raleigh. This office is responsible for providing assistance to nine states, which include parts of North Carolina, New York, Alabama, Georgia, Florida, New Jersey, Delaware, Maryland, and all of South Carolina.

There is a professional bond among the soil scientists in North Carolina that is strengthened by almost universal membership in the Soil Science Society of North Carolina, which meets annually. With strong leadership from among the soil scientists that work in the National Cooperative Soil Survey, a North Carolina Registry of Certified Professionals in Soils was formed and recently has succeeded in their efforts to establish State licensing of soil scientists in North Carolina.

Some Unusual Surveys

Perhaps the most unusual soil survey was conducted in North Carolina. In 1909, some wealthy individuals had the bright idea that a shallow body of water known as Lake Mattamuskeet could be drained with the aid of pumps, and the lake bed could be used to produce crops. The lake was approximately 1 to 5 feet deep and covered about 50,000 acres. The surface of the lake was only 30 inches above sea level and is located approximately 10 miles from Pamlico Sound. A base map at a scale of 1 inch per mile was compiled by the Office of Experiment Stations and the USDA. Mr. W. Edward Hearn, one of the most experienced soil surveyors, was placed in charge of surveying the lake and surrounding area for a total of 112,640 acres.

To keep located during the survey of the lake, the surveyors first ran guide strings across and then followed the strings in wide, flat-bottomed boats to make the auger borings. Obtaining auger samples from under water was a severe problem. A 60-inch auger was used. The auger was inserted in a bicycle inner tube that had been severed at the valve. This "waterproof" casing was carefully fastened to the auger in such manner that the soil samples could be drawn and retained from any depth to 3 feet below the lake bottom.

Although the survey was completed and published in 1909, it was not until the 1920s that a definite attempt was made to drain the lake completely. This was done with huge pumps and the digging of a network of canals and ditches. Extensive tracts were cultivated with large machinery and used to grow corn, soybeans, and oats. Smaller areas were used for white potatoes and some vegetables. According to observers, yields were "fair" but despite the rather sandy nature of most lake bottom soils, they apparently did not achieve uniform drainage, and some sections of crops often "drowned out" rains. By 1933-34, the owners decided that it was not possible to crop the area of the former lake; the pumps were removed; nature took its course; and today Lake Mattamuskeet contains some fine bass fishing and hosts vast flocks of migratory waterfowl (Lee 1984).

As development of beach homes and a boom in recreation demand greatly increased population and waste disposal problems on the Outer Banks of North Carolina, there was an urgent request for a special soil survey. With strong support from all cooperators, mapping the soils of the coastal strip from Virginia to South Carolina was completed in 1977. A special report for each of the seven counties that have land on the Outer Banks was released to provide information on soil suitability and limitations for development. The map scale was 1 inch per 1000 feet (1:12,000) with many of the published sheets containing more water than land.

In 1984, the U.S. Environmental Protection Agency initiated a multi-level research project to address concerns regarding potential soil and water acidification by atmospheric deposition. During this study, 13 watersheds covering 53,000 acres were surveyed by North Carolina soil scientists. In addition to mapping, pedon data were collected on 80 statistically selected transects and complete laboratory characterization was provided on 54 pedons. The work provided several unique experiences such as helicopter transport of samples from remote mountaintop locations.

All in a Day's Work

W.D. Lee (1984) reported that in the early days, dogs, bulls, wild boars and snakes occasionally objected to a soil surveyor's passage. However, the most disturbing incidents occurred when an irate farmer appeared with a

pitchfork or shot gun and vehemently proclaimed he "didn't want no gov'm't men messing on his land" and "get the blankety-blank outer here."

In the early days when soil surveys were being made with a plane table and alidade base map, there was a soil surveyor by the name of Red Stryker. Red was able to take care of himself and was known for punching out any farmer who challenged him for crossing the farm. Because soil surveyors had to move frequently in those, they would rent a room in a house and take their breakfast and supper in the local restaurant. Seems Red ate a lot of bran flakes washed down with prune juice and had to relieve himself at frequent intervals. He had the practice of picking up napkins at breakfast. In one place, one of the waitresses caught on to what he was doing. One morning she asked Red why he always was taking napkins with him, to which he replied that they were to wipe his alidade. The waitress laughed and said she had never heard it called that before. During the rest of the stay, she would routinely ask if he was able to keep his alidade clean—shouldn't he take more napkins?

Then there was the legendary Billy Ligon. Billy was the principal correlator while the surveys were being made of the mountain counties of the state. If any comment was made about his driving on inspection trips, he would slam on the brakes and turn over the driving to the individual making the comment. One soon learned not to sit in the back seat on the same side of the car where Billy was driving on a hot day because tobacco juice frequently drenched that position.

While making reviews of the area, the review parties usually stayed in Waynesville, N.C. In Waynesville, there was one exceptionally good restaurant for breakfast each morning. In this restaurant worked an exceptional waitress. This lady would never take a note and was able to remember and correctly return with several orders. Billy, like all of us, was greatly impressed with her ability. Upon returning a year after one of these reviews, he inquired if they would eat at the same restaurant and remarked how he remembered the waitress. Billy always ordered eggs over easy, grits, and biscuits for breakfast. Louie Aull, party chief and outstanding joker, make it a point to catch the waitress before she took the order from the several soil scientists at their table. Being duly armed with Louies coaching, she approached the table and received the verbal order from each, leaving Billy until last at which time she declared, "Oh, I remember you . . . you always order eggs over easy, grits, and biscuits," leaving Billy with his mouth open in amazement at her ability.

Ralph McCracken reports his personal account of a rather frequent scenario experienced by soil surveyors in the mountains of North Carolina. One day when Ralph was walking down a dirt path in the woods, a person stepped out from behind a tree and asked where he was "started for"? Being astute and acquainted with the locale, Ralph concluded immediately that he was a representative of the local moonshin' industry. Seizing the opportunity to teach a potential student, he carefully explained how he was surveying the soils and making a map. Upon receiving Ralphs excellent lecture, the fella' replied, "I'll save you some trouble . . . ain't no soils down this way so you can turn about and go back." Being a firm believer in the wisdom of indigenous people, Ralph accepted the help and, to this day, there is a map unit delineation in North Carolina entitled "Ain't No Soil."

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1979-1999: Two Decades of Progress in Western North Carolina Soil Surveys

Michael Sherrill

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Historically, the first soil surveys in western North Carolina were cooperative endeavors to classify soils according to their characteristics, both internal and external, with special emphasis on the features that influence the production of crop plants, grasses and trees (Goldston 1948). The United States Department of Agriculture in cooperation with the North Carolina Agricultural Experiment Station and the Tennessee Valley Authority conducted most of the initial soil surveys in the 1940s and 1950s. Most of these soil surveys were published at a 1:48,000 scale (Perkins 1947). The soil classification system of this era had a strong agricultural bias, and most of the soil scientists field time and effort were spent classifying, mapping, and interpreting the agricultural soils in valleys and along the major streams in western North Carolina.

Modern soil surveys, beginning in 1981, are very different documents from soil surveys produced in the 1940s and 1950s. The major areas of difference are kind of photography, scale of photography, in-depth study of geology and geologic behavior, shading phenomena, new series creation, and innovative soil map unit design.

Soil maps in western North Carolina are being produced on 1:12,000-scale ortho photos. These maps are true to scale and are compatible with the soil-digitizing product that most soil survey users are requesting. The 1:12,000 scale allows the field soil scientist to delineate significant areas, as small as one acre. Small areas of landscape features, such as prime farmland, hydric soils, and rock outcrops, can be accurately located on 1:12,000-scale soil maps. In addition, the 1:12,000-scale ortho photos allow field soil scientists to delineate narrow ridgetops. Top of ridges are common sites for roads and are desirable areas for home sites. Some ridgetop delineations are covered with old-growth forests that have little commercial value but which are quite valuable to groups wanting to preserve old-growth forests. Ridgetop delineations also help map users orient themselves correctly on the map (Figure 1).

In-depth studies of common geological formations in western North Carolina are part of the modern soil surveys. Three major separations based on the type of rock are made in most new soil surveys. These geologic groups are crystalline rocks high in mica content, crystalline rocks low in mica content, and metasedimentary rocks.

Crystalline rocks, such as mica schist and mica gneiss, are high in mica content. This rock tends to produce soils and saprolite high in mica content. Soils and underlying saprolite erode easily and are difficult to compact when used as earthen foundation material. Soils such as Fannin and Chandler have a high mica content and are poor as engineering materials (Figure 2). Micaceous rock tends to weather deeply. Most micaceous saprolite commonly extends tens of feet below the soil surface.

The relationship of soils to metasedimentary rock formations in western North Carolina is difficult to interpret. Metasedimentary rocks generally are composed of thin beds that dip at some angle from the horizontal. When slopes parallel the bedding dip, soils are very susceptible to landslides. Some thin beds contain sulfur compounds and produce a yellowish leachate during road building. This leachate is very acid (Figure 3). When this leachate enters nearby streams, fish kills and other aquatic damage commonly occur. The map unit descriptions in modern soil surveys discuss this soil/geologic problem and discuss possible solutions.

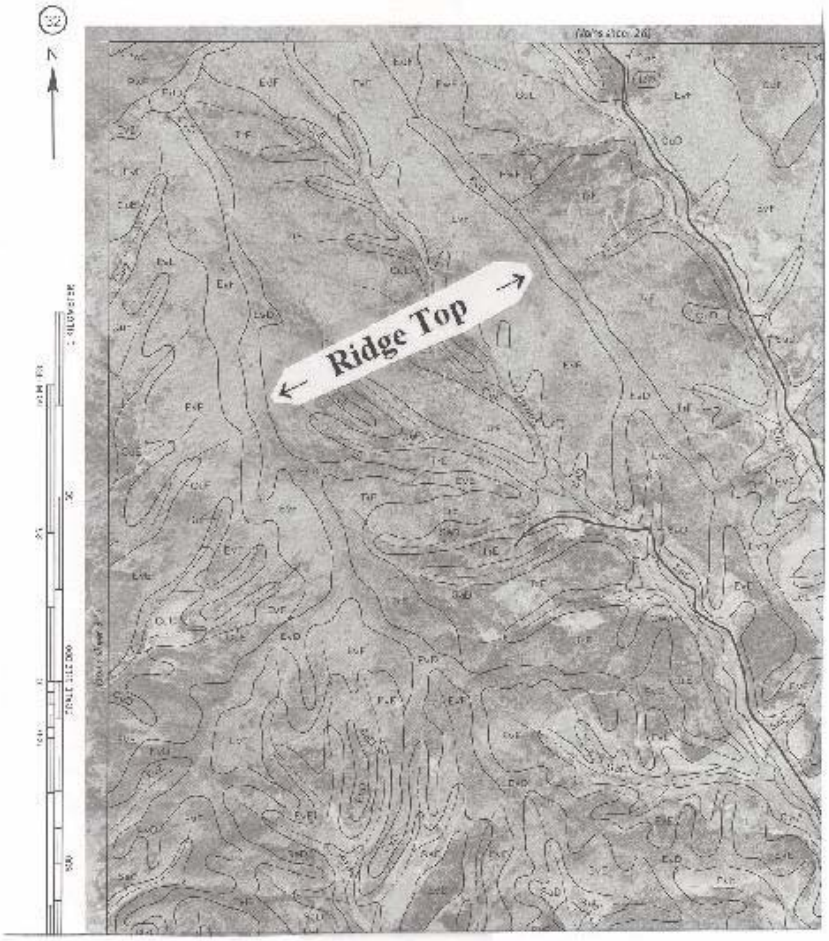

Figure 1. Section of soil map 32, Jackson County, North Carolina, June 1997.

Figure 2. Roads built of micaceous soil material are subject to landslides.

Figure 3. Acid leachate stains of metasedimentary rock.

Generally in western North Carolina, soils on south- to west-facing slopes have surface layers that are lighter in color and contain less organic matter than north- to east-facing slopes. In certain areas, the phenomenon of shading occurs when a higher mountain to the west casts a shadow on mountains of lower elevation to the east (Figure 4). Shading from the direct rays of the afternoon sun on south- to west-facing slopes of lower mountains lowers the maximum daily soil temperature, slows biological activity and causes more organic matter to accumulate. These shaded areas have tree species and productivity similar to north- to east-facing slopes. This is important information to foresters in timber management and road building. Roads on unshaded south- to west-facing cut slopes are more difficult to vegetate and expensive to maintain due to the frequent freeze-thaw cycles during the winter. Shaded south- to west-facing slopes are not as frequently subjected to freeze-thaw cycles and are less difficult to vegetate and maintain.

Modern soil surveys conducted from 1983 through 1990 established 50 new soil series in an attempt to classify, map, and interpret soils encountered in western North Carolina. Soils such as Nikwasi and Hemphill in the floodplains near toeslopes are subject to wetland preservation regulations. Ellijay soils are formed from an ultramafic rock that is very high in magnesium content. Ellijay soils have a calcium-magnesium imbalance and are difficult to manage for crops. In the high mountains, the Wayah soil series was accurately classified as an Inceptisol. However, its high content of organic matter in the surface layer also gives this soil properties shared with Andisols. The taxonomic establishment of new soil series, along with old established soil series, gives the soil scientist in western North Carolina the basic information needed to develop soil map unit names, descriptions, and other interpretive materials.

Soil map unit designation can be a challenging task in some areas of western North Carolina. Soil scientists quickly observed that in some areas of the same soil series, trees of commercial value grew, though in other areas the timber is of very poor quality. This contrast is related to meteorological events. The west side and ridgetops of north-south- trending mountains are barriers to the prevailing westerly wind. During the winter season, trees on these sites experience tremendous ice damage and wind shear. A map unit modifier, "windswept," has been established for the west side and ridgetops of prominent north-south trending mountains where tree growth is severely affected by wind and ice (Figure 5).

The "windswept" map unit helps foresters identify noncommercial forest areas. Summer home owners quickly learn that ice and wind shear also remove shingles from rooftops as well as tree limbs.

Soil survey work in the mountains is not yet complete. In 1998, a memorandum of understanding was signed by the National Park Service and the Natural Resources Conservation Service to produce a detailed soil survey of the Great Smoky Mountains National Park at a 1:24,000 scale. Many of our established series will be used in the park, but we also know that this 550,000-acre piece of real estate also contains soils that will require establishing additional soil series and some unique map unit designs. We have learned that some high mountain areas burned repeatedly in the early 1900s did not revegetate with forest cover. These areas, known as "balds," lack the thick dark surface layers common in nonburned areas. Burned areas are easily identified on color infrared aerial photography as pale green (Figure 6). To accurately identify these areas, and thus enhance the value of our soil maps to National Park managers whose primary interest is vegetation, we may need the soil map unit modifier "burned" added to our growing list of map unit modifiers.

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Figure 4. Shading effect of higher mountains

Figure 5. Trees severely damaged by wind and ice

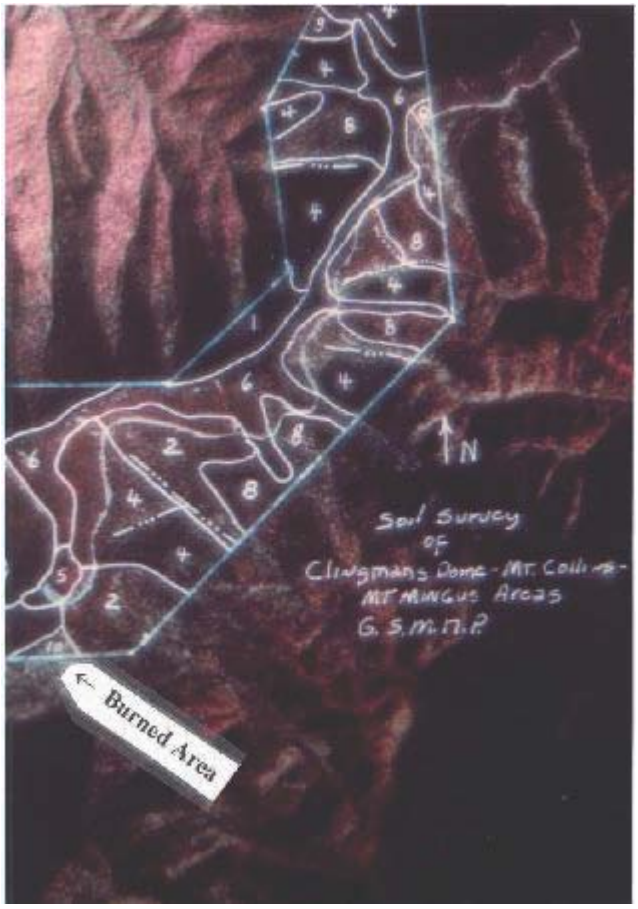

Figure 6. Burned area near Clingman's Dome

Soil Survey from Raleigh to Newbern, N.C.[1]

William G. Smith

Introduction

The area mapped extends from Raleigh to Newbern, along the line of the Southern and the Atlantic and North Carolina railways, a distance of 105 miles, about 9 miles wide, and contains approximately 1,000 square miles, or 640,000 acres (Figure 1).

The State Department of Agriculture paid all the field expenses of the survey party, as well as all expenses incident to the making of a good base map showing wagon roads, railroads, houses, towns, and streams, and proposes to follow up the survey and locate test farms on the more important soil types revealed by the soil survey, the object being to study further the fertilizer problems as well as the cultural methods and crops adapted to the different soil types. Two test farms are already located, one at Tarboro, in Edgecombe County, and the other at Red Springs, in Robeson County. The farm at Tarboro was visited by the survey party and its soil correlated with a similar soil type of the area surveyed.

Credit is due the State geological survey for aid furnished through the State Department of Agriculture in securing competent traverse men to make the base map.

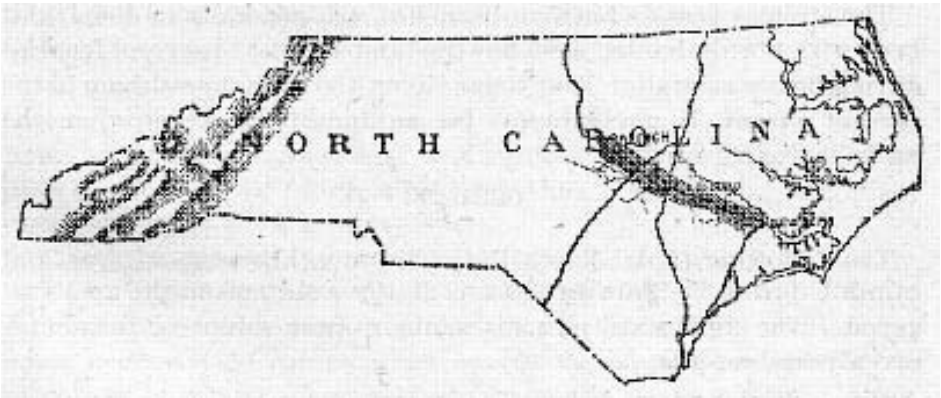

Figure 1. Sketch map of North Carolina, showing area surveyed

Topography

From Raleigh to Newbern there is a gradual change from the rolling uplands of the Piedmont Plateau to the low, level country of the Coastal Plain region. Raleigh is situated near the eastern edge of the Piedmont Plateau, so the greater portion of the area surveyed lies within the Coastal Plain.

The Piedmont Plateau extends about 25 miles east of Raleigh, and is characterized by rough, hilly country, with narrow stream valleys in which the streams have considerable fall. The greatest development of the Piedmont Plateau lies west of Raleigh, extending to the foot of the mountains. In the vicinity of Raleigh the elevation above sea level is about 300 feet, and a few miles southeast, at Garner Station, on the Southern Railroad, the elevation is 383 feet. From Garner eastward there is a fall of about 7 feet per mile to Selma, where the elevation is 175 feet and where all trace of the plateau region is lost and the flat or gently rolling Coastal Plain area proper begins. The fall from Selma to Newbern, which has in elevation of 16 feet, averages about 2 feet per mile. From Selma to Newbern the country is generally low and flat and in the eastern portion are swamps. The largest swamp is located about Dover and is known as the Dover Pocoson, while the next largest is near Newbern. They are depressions of from 2 to 10 feet below the surrounding, generally flat land, and represent about 200 square miles in extent. The elevation at Dover is 65 feet, making an average of less than 2 feet fall eastward to Newbern.

The streams possess but few branches, are generally in deeply cut beds with abrupt banks, slow flowing, and subject to several feet rise during heavy rainfall. The Neuse River, the largest occurring in the present survey, is navigable as far as Smithfield except when the water is excessively low.

Climate

The following table[1] shows the mean monthly temperatures and rainfall during the growing seasons at three stations in the area surveyed. The figures are normals made up from seventeen to twenty-seven years records.

Mean monthly temperature and rainfall

Month	Raleigh		Goldsboro		Newbern	
	Temperature *(°F)*	Rainfall *(inches)*	Temperature *(°F)*	Rainfall *(inches)*	Temperature *(°F)*	Rainfall *(inches)*
April	59.1	3.22	60.6	4.76	59.6	3.72
May	68.2	5.45	69.6	4.99	68.4	4.44
June	75.7	4.32	77.2	5.18	75.9	4.75
July	78.0	6.44	79.8	6.08	78.9	7.07
August	76.4	6.24	78.3	7.27	77.3	8.08
September	71.1	3.22	72.8	4.80	72.9	5.45
Annual	59.6	50.21	61.5	53.56	61.3	56.08

[1]*Climate Conditions Affecting Water Power in North Carolina, 1899, by C.F. Von Hermann.*

The average temperature and rainfall for the Coastal Plain section for the seasons are as follows:

Average seasonal temperature and rainfall

Season	Temperature *(°F)*	Rainfall *(inches)*
Spring	59	12.85
Summer	77	17.04
Autumn	62	13.10
Winter	45	12.24
Year	60.8	55.23

Conditions of Agriculture

From Raleigh eastward to Newbern there is a gradual increase in the size of the farms. In the hilly regions east of Raleigh the farms contain about 110 acres; in the middle portion of the area surveyed the farms contain on an average about 140 acres, while in the level country about Newbern there are many large plantations of more than 1,000 acres, and the average farm contains 225 acres.

The improvements on these farms vary greatly in the different sections of the area. Usually they possess a dwelling house, barns for stable purposes, and wagon sheds, and in the tobacco area curing sheds are always found. The tenant houses for the colored laborers form a part of the farm equipment, especially on the larger plantations. Fences are maintained at a minimum expense, for the stock laws in most of the counties are such that protection against stray cattle and other stock is unnecessary.

There are several systems of cultivating the farms. Where the farms are small they are usually farmed by their owners, but where they are larger the owners may manage the entire farm and employ labor necessary to carry on the operation. Again, portions of the farm may be rented for a cash rent or on the share system. A favorite system is to rent portions of a large farm to a tenant on shares provided he buys his provisions, etc., from the plantation owner, who conducts a large general store. In the entire area the labor is both white and colored, and frequently both kinds are employed on the larger farms. For such crops as cotton and tobacco, the negro labor is as capable as white labor. Figure 2 shows a typical cabin of a negro family in this section.

As the area surveyed follows so closely the railroad throughout the entire distance, transportation by rail is very good, and some of the industries, as, for example, the trucking industry, have been made possible by the advantage which comes from rapid transportation. In the eastern part of the area water transportation is available and has been utilized to a considerable extent in developing the resources of the country. The wagon roads of the area are not good. While some of the roads have been constructed at considerable expense and can be easily traveled, by far the larger number of roads have received no attention whatever, and are consequently in poor condition for either light or heavy hauling.

The principal crops are corn, cotton, tobacco, and truck. Corn has always been one of the staple crops of the entire area and occupies a prominent place in the various crop rotations used in the different sections of the area. Cotton is also one of the important crops grown, and the yield per acre shows the beneficial results of improved methods of culture and of the attention given to fertilizers. The effort, is being made to manufacture the crop where it is grown, and in this way an important industry is being developed which has a far-reaching influence on the economic development of the State.

Since the introduction of bright tobacco in the eastern part of the State it has achieved remarkable success, and large districts of the area surveyed produce a fine type of lemon-yellow tobacco. In addition to the crops grown the development of the truck industry in the eastern portion of the area has made valuable large tracts of land which were formerly not desirable for agricultural purposes. Nearly all classes of early truck and early fruits are grown, and handsome profits are realized by successful farmers. The largest shipments of truck are from Goldsboro, Newbern, Kinston, and Lagrange.

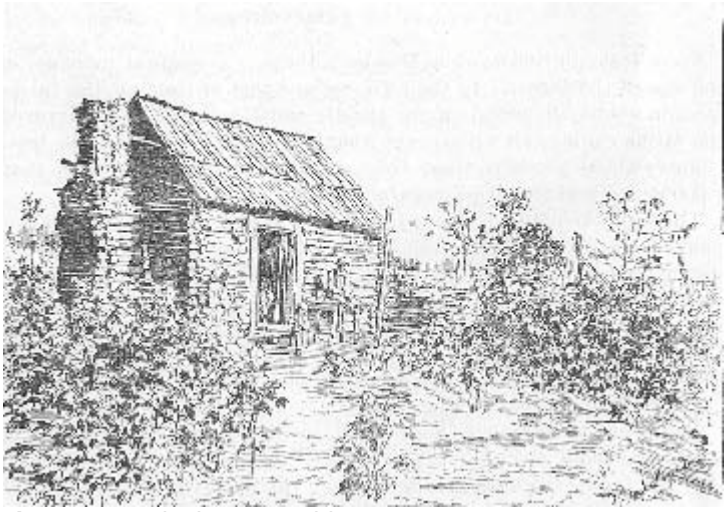

Figure 2. Typical negro cabin.

Figure 3. Cotton Field.

Figure 4. Hauling cotton to market.

Figure 5. Cotton platform at Kinston.

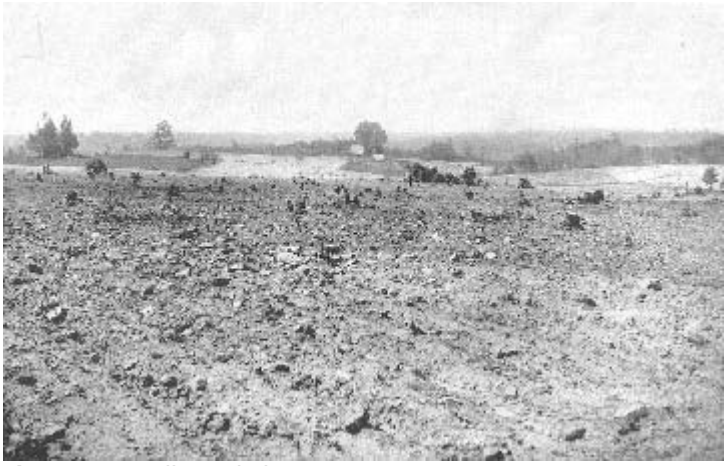

Figure 6. Cecil sandy loam.

SOILS: Cecil Clay

The Cecil clay is a red clay soil, with sharp quartz sand intermixed, 6 inches deep, containing from 10 to 30 per cent of quartz and rock fragments in both soil and subsoil. It is underlaid by a tenacious red clay subsoil, which is reached by ordinary plowing. This soil is locally known as red clay land.

The soil is derived from the decomposition of granite, gneiss, and other crystalline rocks. The quartz fragments are derived from the quartz intrusions of the original rocks. While the presence of these fragments makes the soil and subsoil more friable and facilitates drainage, they obstruct plowing a great deal and are wearing on all soil implements.

The red clay subsoil possesses a peculiar coherency sufficient to make well curbing unnecessary; yet it is sufficiently porous to absorb rainfall and to allow a steady percolation of water through it into wells and streams. The red clay subsoil of the Cecil clay is very important, as it forms also the subsoil of sandy deposits in the Raleigh and Durham areas.

It is a fertile soil, well suited to cotton, grain, and grass. The yield of cotton ranges from three-fourths of a bale to 1 bale per acre, depending on the cultural methods employed.

The following table shows the mechanical analyses of the upper 6 inches and the underlying tenacious red clay subsoil. While distinctively a clay soil, the surface shows an infusion of sand that makes it more friable than the material beneath, which has nearly double the amount of clay possessed by the surface soil. It must be borne in mind that the quartz and rock fragments, which are not included in the table and vary from one-half inch to 4 inches in diameter, tend also to make the soil more friable. They vary in amounts from 10 to 30 per cent.

Mechanical analyses of Cecil clay (%) [Fine Earth]

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5219	2 miles S. of Raleigh	Dull red sandy clay loam, 0 to 6 in.	6.34	9.10	10.89	7.48	14.61	6.85	21.37	22.42
5220	Subsoil of 5219	Stiff red clay, 6 to 36 in.	8.03	6.04	7.88	4.78	8.68	4.59	19.90	39.80

SOILS: Cecil Sandy Loam

Cecil sandy loam is a brown sandy loam soil from 6 to 10 inches deep, containing from 10 to 30 per cent of quartz and rock fragments. It is underlaid by a red clay, containing quartz and rock fragments similar to the subsoil of the Cecil clay. It is locally known as brown land.

Cecil sandy loam differs from Cecil clay in possessing a much larger percentage of sand in the soil. It is more friable than Cecil clay and more easily tilled, though the quartz and rock fragments have a wearing effect on plows and other soil implements.

This type of soil is found in large areas in the vicinity of Raleigh and in smaller areas at Clayton and Wilsons Mills. There are some large and gently rolling fields of this soil, but generally it is quite hilly.

Cotton, small grain, and corn do well on this soil, the cotton production averaging from one-half to three-fourths of a bale per acre where fertilizer is used. Bright tobacco is grown to some extent on this soil. Because of the moist, retentive character of the subsoil this type of soil withstands drought quite well. The forest growth is like that common to the plateau section, differing from the Coastal Plain forest growth in that it possesses a larger proportion of hardwood than pine.

The following mechanical analyses of the soil and subsoil of the Cecil sandy loam show a large and uniformly proportioned infusion of sand in the soil, while the red clay subsoil analysis is almost identical with that of the Cecil clay subsoil:

Mechanical analyses of Cecil sandy loam (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5223	2.5 miles S. of Raleigh	Brown sandy loam, 6 to 10 in.	3.58	6.03	18.14	12.76	26.73	10.49	12.20	9.35
5224	Subsoil of 5223	Stiff red clay, 16 to 30 in.	7.63	4.94	8.40	5.77	11.36	3.94	19.37	37.92

SOILS: Durham Sandy Loam

Durham sandy loam consists of a gray, rather coarse sandy soil from 12 to 15 inches deep, generally overlying a yellow clay subsoil. Like the two preceding types, quartz and rock fragments are found to the extent of from 10 to 30 per cent in both soil and subsoil. The quartz and rock fragments seem to have been derived from the Piedmont formation, since the Durham sandy loam is always found in or close to the plateau area. The soil is easily tilled except for the presence of the fragments, which have the same wearing effect on soil implements noted in the two preceding types.

The origin of the subsoil is in part sedimentary, as is shown by the occasional presence of gravel and in part residual.

The largest development of Durham sandy loam is found south of Raleigh, and from here on to its eastern limit it occurs in small and irregular patches. Like, the two preceding soils it ceases to appear beyond Wilsons Mills in the area surveyed. It also partakes of the hilly surface characteristic of the Piedmont Plateau.

The Durham sandy loam is better adapted to corn, bright tobacco, and truck than it is to cotton or small grain. However, with sufficient application of fertilizers, about one-half of a bale of cotton per acre may be grown. Because of its sandy character and low per cent of clay, this soil is more subject to leaching and drought than the preceding soils.

The following mechanical analyses show a larger proportion of sand and less of clay in both soil and subsoil than are found in the preceding types. It may be mentioned in passing that the analysis of the soil of the Durham sandy loam would not suggest the marked difference between it and the Cecil sandy loam that is evident in the field. The former is rather loose and leachy, while the latter is moist, retentive, and spongy, because of the slightly larger proportion of clay.

Mechanical analyses of Durham sandy loam (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5225	3.5 miles S. of Raleigh	Gray stony sandy loam, 12 to 15 in.	3.12	7.33	12.21	11.22	33.30	13.70	12.86	5.51
5226	Subsoil of 5225	Yellow or red clay, stony, 12 to 36 in.	6.51	3.92	8.74	6.69	18.88	6.44	23.96	24.00

SOILS: Norfolk Sandy Soil

The Norfolk sandy loam varies from a coarse, sharp, gray, sandy soil to a gray, sandy loam, 10 to 20 inches deep, overlying a yellow clay. It is sedimentary in origin. No rock or quartz fragments are present in either the soil or subsoil, but occasionally gravel is found in the subsoil. The soil is easily tilled, the natural drainage is good, and, because of the clay subsoil, it withstands drought fairly well. It is found to a large extent east and south of Raleigh, as well as in the vicinity of Clayton and Wilsons Mills and to the north of Princeton.

The surface of the Norfolk sandy soil is more level and the areas larger and more uniform than any of the preceding soils, yet when it occurs near streams it is hilly. About 5 miles north of Clayton, along the Neuse River, this soil occurs as a rather thin deposit (4 to 8 inches), which is eroded in places, exposing the yellow clay subsoil. In this locality when the plow strikes the subsoil, a soil of a somewhat heavier character is formed.

This soil is well suited to bright tobacco, corn, and truck, and to some extent to cotton.

The following analyses show some striking resemblances in the proportion of sand, silt, and clay to that of the Durham sandy loam, but since it contains no rock fragments or gravel it has a field characteristic quite different from any of the preceding soils. The lower percentage of organic matter (only 1 per cent, as against 3 per cent in the preceding soils) accounts for the gray, bleached appearance that marks this soil in the field as compared with the dull color of the other types.

Mechanical analyses of Norfolk sandy soil (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5229	4 miles S. of Raleigh	Gray sandy loam, 0 to 15 in.	0.76	8.56	22.23	12.13	33.73	10.88	9.08	3.30
5230	Subsoil of 5229	Stiff yellow clay, 15 to 36 in.	4.68	8.90	12.38	5.39	15.10	8.08	15.67	29.81
5231	4 miles N. of Princeton	Gray sandy loam, 0 to 15 in.	1.18	2.74	27.22	20.28	24.18	9.40	10.12	4.88

SOILS: Susquehanna Gravel

Susquehanna gravel is a deposit of gray sandy soil from 12 to 15 inches deep, overlying a yellow clay subsoil. From 10 to 25 per cent of gravel of a diameter of from one-fourth of an inch to 2 inches is found in the soil and often a like amount is also found in the subsoil. If the gravel were eliminated this soil type would be identical with the Norfolk sandy soil, which it resembles in possessing a sharp, bleached-looking sand as well as having a similar sedimentary origin. The gravel in some places obstructs tillage very much, and is quite wearing on soil implements.

The crops suited to this soil are the same as are adapted to the Norfolk sandy soil bright tobacco, corn, and truck and cotton to some extent. This soil is slightly given to leaching, but because of the clay subsoil it holds fertilizers and withstands drought quite well. The distribution of this soil is limited to a few small areas in the vicinity of Clayton and Auburn, amounting to about 3 square miles.

The following analysis of the fine earth portion of the Susquehanna gravel shows it to be similar in texture to the Norfolk sandy soil, the principal difference as before noted being the gravel content of from 10 to 25 per cent. No analysis of the yellow clay subsoil was deemed necessary, as it is so similar to the Norfolk sandy soil.

Mechanical analyses of Susquehanna gravel (%) [Fine earth]

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5233	10 miles S. of Raleigh	Gray sandy soil, 0 to 15 in.	1.57	12.70	17.76	12.62	26.17	15.22	9.64	4.73

SOILS: Garner Stony Loam

Garner stony loam is a sandy loam containing from 40 to 60 per cent of rock fragments and gravel. At a depth of from 6 to 15 inches it overlies a red tenacious brick-clay subsoil, which often contains a trace of sand, rock fragments, and gravel. This type is found along streams and doubtless owes its origin to the extraction of clay and silt during a period of the rapid flow of the streams which it generally borders. It is found north of Clayton along the Neuse River and south along Crabtree Creek. This type packs firmly over the clay substratum, affording to all the roads that traverse it a firm roadbed almost equal to macadam.

Tillage is almost impossible, but in cases where cotton is once rooted good crops are secured because of the clay subsoil. These areas, however, are generally given to the growing of commercial pine and to cattle and hog pasture runs.

The following table shows the mechanical analyses of the soil and subsoil. The soil would be a good friable sandy loam were it not for the presence of the large amount of rock fragments and gravel that makes this soil almost useless for tillage purposes.

Mechanical analyses of Garner stony loam (%) [Fine Earth]

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5234	3 miles S. of Clayton	Stony, gravelly soil, 0 to 15 in.	4.03	17.04	13.72	7.86	17.86	17.80	14.07	7.39
5235	Subsoil of 5234	Stiff, yellow and red clay, 15 to 40 in.	6.62	3.65	4.30	2.35	5.77	8.76	22.37	45.91

SOILS: Selma Silt Loam

This is a gray silty loam mixed with fine sand 18 inches deep, overlying a mottled yellow clay subsoil, which sometimes contains fine sand and small gravel. It is a large and important area, found in its greatest extent in the vicinity of Selma and Princeton and to a lesser extent about Goldsboro. The surface is gently rolling, the natural drainage is good, only a small portion possessing rather poor natural drainage; artificial drainage is possible in nearly all such cases.

The Selma silt loam area is characterized by numerous fine sandy knolls and ridges from 2 to 6 feet high and from 5 to 40 acres each in extent. With their silty clay subsoils at a depth of 18 inches these ridges and knolls are especially suited to the growing of bright tobacco, corn, or truck, while the lower-lying more silty portion is well suited to cotton, which it yields at the rate of from three-fourths of a bale to one bale per acre. Both the sandy knolls and the lower-lying portions, however, admit of being used for cotton, corn, tobacco, or truck, and are so used. Both phases of this type are choice soils, easily tilled, and respond well to fertilizers.

The clay subsoil, while possessing some sand and occasionally gravel the size of beans, is sufficiently coherent to make the use of well curbing unnecessary. Wells from 20 to 40 feet deep are commonly found here, as in the other areas discussed. There is, however, a movement toward the use of drive pumps, which furnish water freer from contamination. In this area a water-bearing sandy stratum underlying the yellow silty clay is reached by drive pumps at a depth of from 30 to 60 feet.

The forest growth consists largely of pine, oak, and gum. Several small wild fruits are found; while of the domestic fruits the peach and cider apple are common. Many domestic varieties of grapes, such as the Delaware, Concord, and Scuppernong are grown.

The following table shows the analyses of the soil and subsoil of the Selma silt loam.

Mechanical analyses of Selma silt loam (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5237	1 miles W. of Princeton	Gray silt loam, 0 to 18 in.	1.52	8.72	23.92	12.82	26.62	11.90	13.25	3.72
5238	Subsoil of 5237	Mottled, yellow clay with base of fine sand and gravel, 18 to 40 in.	2.65	10.21	14.66	11.62	17.70	9.68	11.57	21.26

SOILS: Selma Heavy Silt Loam

This is a rather heavy gray silty loam, from 10 to 20 inches deep, overlying a stiff mottled clay. It is often spoken of as stiff land or clay land. Like the preceding soil, it is of sedimentary origin and represents a large and important area. It is found as large flat areas in the vicinity of Selma, Princeton, and to the north of Dover. There is no sharp line of demarcation between the soil and subsoil, one gradually merging into the other. The subsoil is, however, much stiffer than the soil.

The knolls and ridges spoken of in the preceding soil type very seldom occur in the Selma heavy silt loam. Natural drainage is poor; artificial drainage is possible and nearly always necessary, to insure a good crop. Fertilizers are well retained. This soil is suited to cotton, which it yields at the rate of from three-fourths of a bale to little more than one bale per acre. Under good drainage conditions, however, corn, vegetables, and small fruits are successfully grown.

The following analyses of three soils and two subsoils show the heavier character of this soil as compared with the immediately preceding type. The marked difference between the soil and subsoil is in accord with the observations in the field. No. 5242, representing the heavier phase of this area, is locally known as clay soil. Nos. 5240 and 5244 represent the area of largest extent.

Mechanical analyses of Selma heavy silt loam (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5240	2 miles NE. of Kinston	Heavy gray silt loam, 0 to 10 in.	3.82	2.01	4.16	4.40	37.80	21.40	22.29	4.26
5241	Subsoil of 5240	Stiff gray mottled clay, 10 to 36 in.	2.33	1.22	3.38	3.92	29.97	21.38	21.56	15.94
5242	3 miles N. of Tuscarora	Stiff mottled gray clay loam, 0 to 10 in.	2.16	1.74	4.76	5.30	35.84	9.49	23.04	17.30
5243	Subsoil of 5242	Stiff gray mottled clay, 10 to 36 in.	3.17	1.88	4.17	3.92	23.24	6.38	19.90	37.31
5244	0.25 mile SW. of Selma	Heavy gray silt loam, 0 to 8 in.	1.86	0.52	1.56	1.79	13.34	34.96	37.44	7.96
5245	Subsoil of 5244	Yellow silty clay, 8 to 36 in.	3.14	6.38	11.02	8.62	21.44	11.48	11.39	26.46

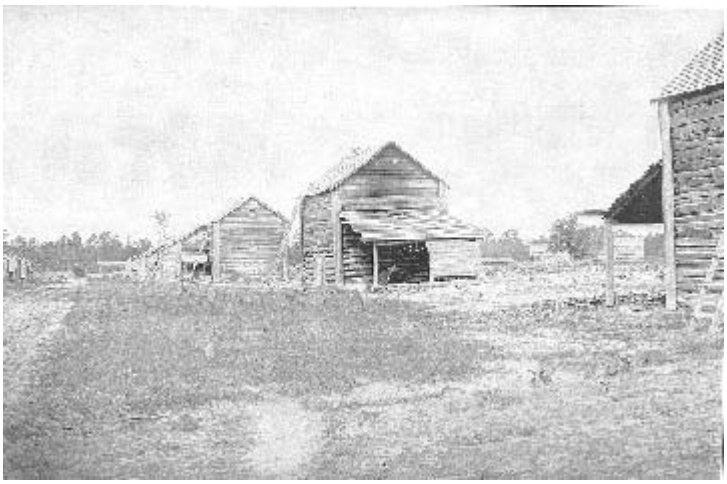

Figure 7. Group of Bright tobacco barns where tobacco is cured by artificial heat.

Figure 8. Bright tobacco being sold on warehouse floor in Goldsboro.

SOILS: Goldsboro Compact Sandy Loam

This is a soil type which comprises several variations in texture, all consisting, however, of gray, ashy, sharp, generally compact sand. Usually it has no distinctive subsoil, though it often grades gradually into a sandy clay substratum. It is a sedimentary soil varying in color from a bleached gray to black, the color being due to organic stains. This type is generally found in lower lying flat areas along the Neuse River at Kinston and extending into and around the Dover Pocoson area. The lower lying portions, containing the black sandy features, were once subjected to swamp conditions. When these are drained and an application of lime used, good crops of cotton and corn are secured.

The gray or bleached phase lies somewhat higher, but it generally requires considerable artificial drainage. In the gray phase occur compact spots from 5 to 20 acres or more in extent, which, on account of their compactness, suggest the possible presence of some cementing material. These spots are undesirable and are locally known as stiff gray land, which when partially dry can scarcely be plowed. Instances are noted where a good application of barnyard manure seems to have made, these compact or seemingly cemented areas more friable.

Cotton and corn are generally grown with fair success on all the variations of this soil type where drainage is practiced and suitable cultural methods are employed.

The following table of analyses is given to show the peculiar sandy-clay character of both soils and subsoil. No. 5250 represents the coarse phase, while the other three (soils) represent the finer phase.

Mechanical analyses of Goldsboro compact sandy loam (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5246	2.25 miles E. of Cove post office	Fine gray compact, sandy loam, 0 to 15 in.	1.29	0.94	2.50	1.70	12.98	37.39	31.76	11.27
5247	Subsoil of 5246	Yellow-mottled clay, with fine sand, 15 to 40 in.	2.09	0.68	1.74	1.18	9.92	26.35	31.57	26.20
5248	0.75 mile SW. of Kinston	Fine gray compact, sandy loam, 0 to 20 in.	3.76	11.22	17.18	15.30	18.94	5.90	10.19	16.80
5249	3 miles N. of Lagrange	Gray, very compact loam, 0 to 16 in.	1.38	7.26	14.46	11.14	20.56	14.22	19.25	10.77
5250	1 mile E. of Goldsboro	Coarse, compact, sandy loam, 0 to 20 in.	3.09	31.68	23.38	7.22	9.22	4.22	11.65	9.37

SOILS: Norfolk Sand

The Norfolk sand is a deep sandy soil 3 to 6 feet or more in depth. Often the first 6 inches is gray or bleached in color, while the underlying portion is a brown or yellow sand of the same texture. In different localities it varies from a fine sandy soil to a coarse sandy soil, all the variations having, however, the same general character as regards the production of crops.

The Norfolk sand is an extensive and important type. It is a truck soil, suited to the early maturity of crops because of its warm, dry nature. It occurs to a large extent along the Neuse River at Lagrange, Kinston, and Newbern, and also in some places 2 or 3 miles from the river. Immediately south and southwest of Lagrange is found a large area of the coarse phase, at Newbern occurs the medium phase, and 3 miles south of Lagrange, bordering the Neuse River, is the fine sandy phase (soil 5251), on which cotton does well.

The surface of the Norfolk sand is generally flat or gently rolling, possessing good drainage. Occasionally spots are met which are often subject to drought because of the great depth to the water table.

The following table shows the mechanical analyses of two samples of the Norfolk sand:

Mechanical analyses of Norfolk sand (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5251	3 miles S. of Lagrange	Fine sandy soil, 0 to 10 in.	1.75	Tr.	1.84	8.90	72.86	8.95	2.43	2.52
5252	1.5 miles N. of Newbern	Brown, sandy soil, 0 to 40 in.	0.76	0.60	3.80	8.22	68.62	12.84	2.74	2.30

SOILS: Sandhill

The Sandhill soil is a gray, sharp, incoherent sand of considerable depth from 10 to 50 feet or more found usually in the form of high flat ridges or hills. The first 6 or 9 inches is generally bleached, while the underlying portion is of a brown or reddish color and of the same texture as the soil. Its origin appears to have been a sandbar deposited by coastal waters and modified by wind action.

In the area surveyed only a small margin of this extensive Sandhill soil of the Coastal Plain occurs about 2 miles south of Goldsboro. It was sufficient, however, to correlate it with the great sand ridge that extends from about this point southward through North and South Carolina, Georgia, Alabama, Mississippi, Louisiana, and terminating in Texas.

It is a dry, barren soil, as it lacks sufficient moisture for crops. In wet seasons or when irrigated, truck does well. The natural growth is pine and scrub oaks. Stone fruits and small fruits, such as peaches, apples, grapes, and the blackberry, which are able to extend their roots deep, do well if they get started and are well cared for.

From the foot of the Sandhill type, even during dry seasons, a constant flow of pure water generally comes. The roads, as a matter of course, that traverse this soil are very loose and sandy, except in wet weather, when they are more easily traveled.

The following table of analyses shows a similarity of this type to the soil of the Norfolk sand, which is in keeping with the field observation as to texture and origin. The low percent of organic matter and small clay content tallies also with the loose, leachy character of this soil noted in the field.

Mechanical analyses of Sandhill (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5255	2.5 miles SW. of Goldsboro	Gray, loose, incoherent, sandy soil, 0 to 40 in.	1.47	3.86	9.62	18.96	40.74	15.78	5.02	4.12
5256	3 miles W. of Goldsboro	Gray, loose, incoherent, sandy soil, 0 to 40 in.	1.78	2.16	32.22	28.30	23.90	4.66	4.06	2.75

SOILS: Norfolk Fine Sandy Loam

This type consists of a mellow, fine, sandy loam from 10 to 15 inches deep, overlying a yellow, rather stiff clay subsoil. The soil and subsoil are of sedimentary origin. This type represents a large and important area in the eastern part of North Carolina. In the present survey it occurs to a large extent at Kinston and from thereon to Newbern.

This soil is peculiarly adapted to a wide range of crops, being well suited to the growing of cotton, corn, truck, and bright tobacco. Cotton yields from one-half to three-fourths of a bale per acre. Fertilizers are retained and drought is withstood quite well because of the clay subsoil. Open wells 20 and 30 feet deep are quite common in this area; a water-bearing stratum of sand is reached by drive pumps at a depth of from 60 to 80 feet. The test farm at Tarboro, Edgecombe County, is located on this important soil type.

The following table of analyses shows the distinctive character of the Norfolk sandy soil, namely, a fine, rather mellow sandy soil underlaid with a rather stiff yellow-clay subsoil containing a trace of fine sand. No. 5253 represents a variation of this type where it grades into the Norfolk sand near Newbern, and where it is used largely as a truck soil. No. 5259 represents the heavier phase of this type, and Nos. 5257 and 5261 represent the lighter phase as well as the largest area. The subsoils for all the variations are rather stiff, except No. 5254 of the truck soil, which is sometimes quite sandy and incoherent.

Mechanical analyses of Norfolk fine sandy loam (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5253	2.25 miles W. of Newbern	Medium fine sandy loam, 0 to 15 in.	1.55	Tr.	3.18	4.24	46.56	21.15	6.91	16.00
5254	Subsoil of 5253	Yellow sandy clay, 15 to 40 in.	1.33	Tr.	2.70	5.38	54.86	17.16	4.81	13.13
5257	4 miles NE. of Kinston	Fine, sandy loam, light phase, 0 to 15 in.	2.03	1.14	4.36	7.28	43.30	26.52	11.91	3.32
5258	Subsoil of 5257	Yellow sandy clay, 15 to 36 in.	3.36	1.55	3.51	5.28	31.43	15.01	9.70	29.57
5259	2.67 miles W. of Newbern	Fine, sandy loam, heavier phase, 0 to 10 in.	2.40	0.64	9.32	21.10	16.92	7.94	27.77	13.75
5260	Subsoil of 5259	Stiff, mottled gray clay, 10 to 40 in.	3.57	Tr.	5.62	11.04	9.53	3.83	22.44	43.70
5261	3 miles W. of Tarboro (test farm)	Fine, sandy loam, lighter phase, 0 to 18 in.	0.90	0.00	Tr.	1.26	54.10	26.15	12.49	4.79
5262	Subsoil of 5261	Stiff, yellow clay with trace of sand, 18 to	2.81	Tr.	0.64	0.52	40.32	20.06	13.10	23.12

	40 in.

SOILS: Neuse Clay

The Neuse clay is a stiff silty or fine sandy loam, from 10 to 20 inches deep, gray in color, and underlaid to a great depth with a stiff, mottled-clay subsoil. In the present survey it occurs along the Neuse River near Kinston and in and around Tracy Swamp, about 2 miles north of Dover station. Along the Neuse River it is known locally as mud-bottom land, and is there subject to overflow; here it is generally left to a dense growth of cypress, gum, ash, alder, vines, and rank grass, and is used as a pasture run for hogs and cattle.

Tracy Swamp is subject to standing water to a depth of from 3 to 6 feet during periods of much rainfall. It is used in dry seasons as a pasture run. Attempts are being made to reclaim this area by ditching and draining it into the Neuse River, which, if successful, will open up some fine cotton land. The forest growth of cypress, gums, etc., is the same as that described for this type along the Neuse River.

To the north of Tracy Swamp, separated off on the map by a dotted line, lies a large area of Neuse clay elevated high enough not to be so much subject to standing water, making tillage to some extent possible. Here the area is quite flat, but drainage is possible by ditching. The forest growth is largely long-leaf pine. Cotton and corn do well when once rooted in this soil. On account of the soil becoming so dry and hard during droughty seasons that the plow can scarcely turn it, or so sticky in wet seasons that implements can barely move through it, this soil is generally difficult to till and does not possess a very good reputation among the local farmers. When loosened and dried out this soil dusts about under the feet like flour. The addition of barnyard manure or green crops plowed under would tend to make the soil more friable and productive.

The following table shows the mechanical analyses of the samples as follows: No. 5265 represents the large area of stiff-clay phase north of Tracy Swamp, near Dover station; Nos. 5266 and 5267 represent the lighter and friable phase found in Tracy Swamp and along the Neuse River, which areas are not much tilled at present on account of the poor natural drainage and frequent overflow.

Mechanical analyses of Neuse clay (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5265	5 miles N. of Dover	Very stiff, gray silty clay, 0 to 20 in.	2.54	0.32	2.46	2.26	12.68	10.60	41.46	26.12
5266	4.5 miles W. of Kinston	Stiff, mottled silty clay, 15 to 40 in.	9.51	0.00	1.38	4.30	13.36	7.52	35.04	28.84
5267	2 miles W. of Dover	Stiff, mottled gray clay, 0 to 20 in.	9.87	Tr.	2.72	3.35	20.16	14.46	37.80	10.80

SOILS: Savanna

The Savanna land is a type due to location instead of soil character. It is a flat area surrounding the Pocoson land near Newbern, subject to from 6 to 20 inches of standing water during rainfall, but artificial drainage is possible over most of this area. The natural forest growth consists mainly of long-leaf pine, gum, and oak. In this area occur numerous depressions, from 3 to 8 feet deep and from 100 to 300 feet or more in diameter, which generally contain standing water and a dense growth of water cypress. The openings left by the removal of the lumber pine support a dense growth of rank grass and shrubbery, which seems, to furnish good pasture nearly the entire year.

The soil is similar in texture to that of the Norfolk fine sandy soil at a depth of 8 or 12 inches, and is generally underlaid with a mottled, rather stiff yellow-clay subsoil. Where the Savanna land borders the truck soils, it possesses from 8 to 12 inches of rather loose, gray, sandy loam, which grades quickly into the stiff clay subsoil. Where the Savanna land is well drained it is very productive for cotton, corn, and grass crops.

The following, mechanical analyses of samples of soils and subsoils show the similarity in texture of this type to that of the Selma heavy silt loam (5268) and the Norfolk fine sandy soil (5270), both phases at a depth of from 8 or 12 inches, grading rapidly into a heavy clay subsoil.

Mechanical analyses of Savannah (%)

No.	Locality	Description	Organic matter and loss	Gravel, 2 to 1 mm	Coarse sand, 1 to 0.5 mm	Med. sand, 0.5 to 2.5 mm	Fine sand, 0.25 to 0.1 mm	Very fine sand 0.1 to 0.05 mm	Silt, 0.05 to 0.005 mm	Clay, 0.005 to 0.0001 mm
5268	3 miles W. of Newbern	Heavy, gray silt loam, 0 to 8 in.	2.76	1.30	1.48	2.18	32.54	20.38	27.42	11.53
5269	Subsoil of 5268	Stiff mottled gray clay, 8 to 36 in.	4.31	Tr.	0.72	0.72	11.76	11.11	22.80	48.24
5270	4.5 miles W. of Newbern	Loose gray sandy loam, 0 to 8 in.	4.24	0.34	4.13	8.35	42.45	13.21	19.27	7.07
5271	Subsoil of 5270	Yellow mottled clay, 8 to 36 in.	3.30	Tr.	1.71	5.95	28.68	8.91	16.50	34.25

Figure 9. Corn and cowpeas showing method of pulling fodder.

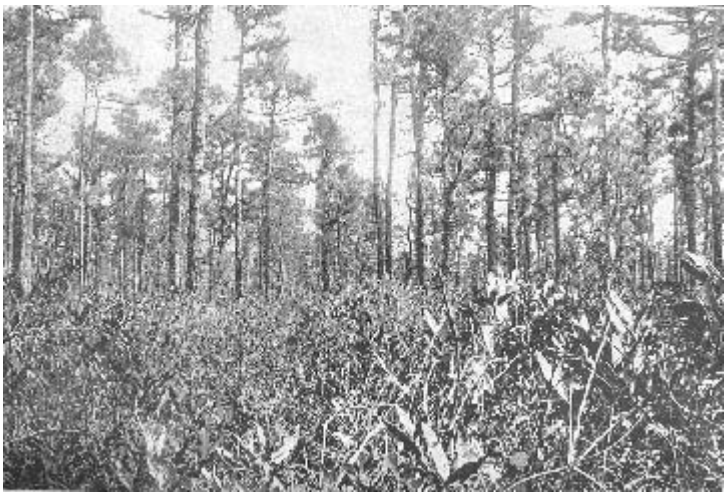

Figure 10. Characteristic growth on pocoson.

SOILS: Pocoson

The Pocoson area possesses a character distinctively incident to location. Generally speaking, it is a swampy area, depressed from 2 to 10 feet below the surface of the surrounding land. The typical Pocoson consists of a black, spongy, mucky soil, supporting a scattering growth of scrub pine, a dense undergrowth of gallberry shrubs, wire grass, and broom sedge, and all woven together with brier vines. During moderately dry seasons this affords a pasture run for cattle and hogs after they learn to get through the almost impassable matting. The scrub pines are 6 or 8 inches in diameter and from 20 to 30 feet high, and are useful for firewood, fence posts, and a poor grade of timber. During dry seasons these areas are sometimes subjected to fire, rendering them useless for a long time for cattle and hog runs because of the almost complete burning of the muck soil and the shrub and grass growth. Generally, however, these areas are subject to standing water, especially in the winter season.

Through these Pocoson lands extend extensive ridges and knolls, from 3 to 6 feet higher than the mucky area just described. These generally possess a soil similar in texture to that of the Goldsboro compact sandy loam, supporting a strong growth of commercial long-leaf pine. On the margin of these ridges often occur small spots of gum and cypress swamps and irregular strips of canebrakes. At a depth of from 10 to 15 inches the soil of these ridges generally grades into a sandy clay subsoil. When drained and tilled these ridges yield good crops of cotton, corn, and grass.

The Pocoson land of the present survey consists of a large tract between Dover and Cove post offices, known as the Dover Pocoson. There are also small areas of this land near Newbern, Goldsboro, Lagrange, and Kinston. About one-half of the Dover Pocoson consists of the knolls and ridges of the gray sandy loam above mentioned. At Goldsboro, Lagrange, and Kinston these areas have also a soil similar to these ridgesa gray sandy loam which is capable of tillage when drained. Three miles south of Lagrange, in the Pocoson area, there is about 2 square miles of the black spongy soil above mentioned, known locally as huckleberry soil. A portion of this soil is cultivated and yields well of corn, cotton, grass, and some vegetables when well ditched. All crops tend to a rank growth, because of the large amount of humus present in the soil.

SOILS: Muck

The muck soil consists of varying amounts of vegetable mould, mixed with fine sand and clay, generally underlaid at a depth of from 2 to 6 feet, with a substratum similar in character to the adjacent land. In the present survey it occurs generally along the upper courses of small slow-moving streams, which are usually headed in large flat areas. Where drained, some of these soils yield large crops of hay, as well as corn and truck. The natural growth consists of cypress in the very wet swampy phases and alderbush, gum, willow, broom sedge, and rank grass on the more elevated and tillable phases.

SOILS: Meadow

This term, as used in the present survey, stands for a low-lying flat, usually poorly drained, land along the larger streams. It figures mostly as a narrow margin along the Neuse River and its larger branches from Raleigh to Goldsboro, where it ceases to appear any more, because of the soil admitting of being classified with other types having a more specific texture. The meadow soil is a river deposit 3 feet or more deep, varying from a clay to a sandy loam. As used here, however, it generally consists of a rather deep, fine sandy or silty loam. It is a fertile soil, easily tilled, and adapted to grass and pasturage and occasionally to general farming where drainage is possible. The forest growth consists largely of willow, alderbush, and gum.

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[1]This article is a reprint of the original paper with renumbered figures: Smith WG. 1900. Soil survey from Raleigh to Newbern, N.C. In: Field operations of the Division of Soils. Washington (DC): U.S. Government Printing Office. p 187-205. [USDA report no. 64].

Hugh Hammond Bennett: the Father of Soil Conservation

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Hugh Hammond Bennett must be included among the elite of North Carolina's most illustrious native sons. Appropriately described as "the father of soil conservation," he was also affectionately known as "Chief" and "Big Hugh." Dr. Bennett's contributions to soil science and to humankind have been far reaching. In fact, the impacts of his vision and his achievements are continually being recognized today.

Dr. Bennett perhaps is best remembered for arousing a nation to the potential perilous effects of soil erosion, which he called "a national menace." His efforts did not end with the awakening though. They were just a part of his exciting career that culminated in the establishment of a national soil conservation program. More than 60 years later, the beneficial impacts of that conservation program as it has evolved are seen and experienced daily.

It is impossible to document the life and works of Hugh Hammond Bennett thoroughly in this brief article. Several writers have already undertaken this monumental task. The aim of this commentary is to highlight a few major periods in his life and to validate his greatness as an individual and a dedicated public servant.

The Formative Years

Hugh Hammond Bennett was born April 15, 1881, in Anson County, North Carolina. Hugh’s father operated a 1,200-acre plantation in the Carolinas. When he died in 1913, there was no indebtedness on the plantation he had directed since the Civil War. Hugh frequently cited this as an example of efficiency that characterized the management of many Southern cotton plantations at that time. This model of efficiency apparently made an indelible impression on him because efficiency was a trademark of Hugh Bennett in the various roles that he was destined to fill in the years that lay ahead.

Hugh remembers helping his father lay off terrace lines when he was about ten years old. A wooden 'horse' or bipod, later known as an A-frame, substituted for a transit and tripod in establishing level lines. Hugh's job was to dig small holes with a hoe to mark the successive points to form the plow line for turning up soil for terraces. Bennett recalled vividly asking his father why they were going to all that trouble. His father's answer seared deep into his memory: "To keep the land from washing away!"

There were nine children in the Bennett family. All nine had a fling at college, four going on to graduation. Hugh's early schooling was in Wadesboro. For seven years, accompanied by two brothers, he rode a mule to school using a fertilizer sack for a saddle. Sometimes when the mules were needed in the field, the brothers would walk to school and back, a distance of seven miles. At that he grew up with a sense of well being, for he was always well fed and well clothed. There were self respect and mutual respect, and security and close-knit family love and loyalty at home.

Hugh earned his university education the hard way. There were postponements and delays. He entered the University of North Carolina in the fall of 1897. By spring of 1899, funds were exhausted and he dropped out of college. He worked for two years in a pharmacy in Wadesboro to earn money to return to school. Later he would look back on those two years in the drug store as one of the most valuable parts of his education in that he learned much about human nature and some hard rules of business.

Bennett specialized in geology and chemistry at the university. A professor who influenced him greatly was Dr. Collier Cobb, who taught him geology. Hugh graduated from the University of North Carolina in the spring of 1903.

Bennett, the Scientist

Hugh Bennett had numerous job opportunities available to him as a result of his college degree and his pharmacy work experience. It was a sheer accident, so he said, that caused him to take a job with the old Bureau of Soils. While considering several offers, he saw an announcement of a Civil Service examination for chemist in the Bureau of Soils, U.S. Department of Agriculture. It was for a job that would pay one thousand dollars a year, and in those days that was considered good pay for a youngster fresh out of school. His grade on the examination was 89.10, a relatively high grade that earned him an appointment as chemist in the Bureau of Soils. However, the filling of the laboratory chemist position was delayed and Bennett was asked if he would object to a temporary assignment in soil survey field work. His quick response was, "No objection!"

The long and colorful career of Hugh Hammond Bennett began on July 1, 1903, in Davidson County, Tennessee. His assignment entailed the classification and mapping of soils by individual types, and observation of their productivity. He liked the work from the start, particularly because it was about 95 percent outdoor activity. He loved the land—the smell of it, the feel of it, its beauty, its variety. Soil surveying also afforded him an opportunity to learn the soils of this nation to an extent approached by few men before or since.

Unhurriedly and with infinite pains, he examined the flora and fauna as well as the soils of the United States from Maine to California. It was not an easy life, but it was a happy one filled with incidents, some profoundly significant. During his multiple careers, but especially that as a soil scientist, he worked in every state of the Union. In retrospect, the foundation of what was to come later in his life was laid in those early days as a soil scientist.

Bennett’s many observations of soil erosion, originating with his home place in Anson County, were beginning to mold deep impressions in his thinking. Years later he would write, "The damaging effects of soil erosion were in evidence to right and left through the rolling farm country encountered in North Carolina, Tennessee, and Virginia during my first two years of surveying, but it was not until 1905 that I began to understand just what was taking place on the land." Bennett was referring to his assignment to Louisa County, Virginia, in 1905 to conduct a soil survey with the assistance of W. E. McClendon. He liked to relate the Louisa County experience, which he regarded as sort of an epiphany, i.e., an awakening or revelation about the processes of erosion:

"Bill McClendon of Bishopville, South Carolina, and I were stirring through the woods down there in middle Virginia when we noticed two pieces of land, side by side but sharply different in their soil quality. The slope

of both areas was the same. The underlying rock was the same. There was indisputable evidence that the two pieces had been identical in soil makeup. But the soil of one piece was mellow, loamy, and moist enough even in dry weather to dig into with our bare hands. We noticed this area was wooded, well covered with forest litter, and had never been cultivated. The other area, right beside it, was clay, hard and almost like rock in dry weather. It had been cropped a long time. We figured both areas had been the same originally and that the clay of the cultivated area could have reached the surface only through the process of rainwash—that is, the gradual removal, with every heavy rain, of a thin sheet of topsoil. It was just so much muddy water running off the land after rains. And, by contrast we noticed the almost perfect protection nature provided against erosion with her dense cover of forest."

As a result of this observation, Bennett and McClendon conceived the term "sheet erosion," in contrast with rill and gully erosion, which up until then had been the field clues for soil erosion. In seeing the effects of sheet erosion, the surveyors had recognized the process by what was not there or by what they could not see. By virtue of participating in a soil survey that required them to report on the soils of Louisa County, Bennett and McClendon were required to find the means to express what they saw, and their jobs and scientific reputations depended on it. Their 21-page report on the soils of the county included comments on evidences of soil erosion.

The 1905 experience in Louisa County, Virginia, was a turning point for Bennett, one that he referred to throughout his life. In his retelling of the event, he made it clear that the immediate situation, the juxtaposition of a good soil with forest cover and a "washed" soil of the same subsoil provided them the crucial clues to this discovery—soil versus no soil. They could see that the "washed" soil had no topsoil when the contrasting soil was friable and soft, with organic matter, among other things. He attributed the strong impression of the experience to the shock of recognizing the true nature of a process he had lived with all of his life.

A second turning point that helped define the future direction of Bennett's career occurred in 1908 when President Theodore Roosevelt held the Governor's Conference on Natural Resources at the White House. T. C. Chamberlain, Head, Department of Geology, University of Chicago, spoke on "soil wastage." Chamberlain confirmed for Bennett that he was right to be concerned about the soil body and the connection between soils and the survival of a people. Bennett often cited Chamberlain in his writings and credited him with giving legitimacy to erosion as a serious national issue.

Unfortunately, the Governor's Conference did not produce the results that Roosevelt sought, namely, the enactment of legislation for natural resource conservation and flood control. Congress, balking at Roosevelt's continuing efforts to prod them into action, refused to support any of the President's conservation meetings and committees. The Bureau of Soils and the soil science community were also not ready to adopt Bennetts view that soil erosion was a serious problem and that it should be dealt with actively. How Bennett fared at the Bureau is a measure of the lack of esteem in which he was held. In 1909, he was made Inspector of Soil Surveys for the Southern Division, a supervisory position of fieldwork in 18 states. While this was a promotion, it was not much for someone with Bennett's energy, initiative, and commitment.

Also in 1909, as a measure of the Bureau's view of the perishability of soils, whether by erosion, by chemical or physical degradation, or by these factors in combination, the Bureau of Soils published its Bulletin 55. In this Bulletin, Professor Milton Whitney, Chief of the Bureau of Soils, argued that the soil was of inexhaustible and permanent fertility: "The soil is the one indestructible, immutable asset that the Nation possesses. It is the one resource that cannot be exhausted; that cannot be used up." At a later time, Bennett reacted to Whitney’s statement: "I didn’t know so much costly misinformation could be put into a single brief sentence." While Whitney no longer censored discussions of erosion out of Bennett’s reports, he apparently intended to "cool" Bennett down by sending him on surveys and projects in Alaska and Cuba, and in South and Central America.

Early in his career, Bennett worked hard to establish scientific credibility with a view to persuading his superiors to take initiative on the erosion problem. In the pursuit of this goal, he constructed a strong work ethic and a reputation as the foremost expert on soil erosion in the U.S. He also became the Bureaus expert on soils of the southern U.S., publishing *The Soils of the South* in 1921, and was the individual in the Bureau of Soils with the most experience of soils in South and Central America.

In his single-minded pursuit of a means of dealing with erosion, Bennett gained a reputation as a voracious reader of publications on geology and soils, and as a gargantuan worker, able to endure hardship and privation, as on his assignments to Alaska and to Honduras and Guatemala. Although Bennett was primarily motivated to do something about erosion, he continued to build his professional reputation by contributing to the primary, disciplinary focus of the period, namely, a sound basis for soil classification. Bennett's scientific prowess is often overlooked because of the large amount of publicity and emphasis given to his highly visible activities that occurred later.

Bennett, the Crusader

From his experiences in the field, Hugh Bennett had a conviction of the importance of erosion. But this conviction was not accepted nor appreciated in the Bureau of Soils, where Bennett's reports were received with indifference and skepticism. Soil conservation meant little or nothing to the public, including farmers. As Bennett later described it, "The term conservation had scarcely attained dictionary status." He also noted that, as a student at the University of North Carolina, no attention was given in textbooks or by the instructor to the role of land in economics or politics. The Bureau of Soils likewise had given no emphasis to erosion.

In the context of such a passive view of erosion, Bennett set out to make people aware of the process and its effects. From the time of the Louisa Count survey, Bennett went on to find and report on the staggering erosion problems he saw—and he saw them everywhere now. His surveys from around 1909 record the nature, extent and location of eroded conditions. In 1910, a field party consisting of three members of the Mississippi Geological Survey and two Bureau of Soils surveyors, Bennett and Howard C. Smith, completed a survey of Lauderdale County, Mississippi. This survey identifies an "erosion phase" of Orangeburg sandy loam, designating a soil not as a distinct soil type, but as a soil that is modified by erosion. They assert through classification that a soil difference was the result of erosion.

The Lauderdale report apparently was not edited in Washington, so its extended discussion of erosion effects and recommendations to remedy them was allowed to stand. Bennett carried on with survey work, describing erosion wherever he found it and raising awareness of it in the surveys and in his personal contacts. In 1911, as Inspector for the Southern Division of the soil survey, Bennett was responsible for the classic report on Fairfield County, South Carolina. There, by the account of his staff, 136,000 acres of formerly cultivated land had been ruined by erosion. The survey included three photographs taken in the county. The first two showed steep hillsides that had been cleared and planted to cotton and were highly eroded. A third photograph showed a field being reclaimed by the use of contour cultivation and terracing. This was the first survey to allocate a separate section to "Rough Gullied Land" as to a soil type. Bennett expected this report to arouse public opinion. It was met instead with massive indifference.

The Fairfield County report was followed in 1913 by a soil survey of Stewart County, Georgia. This survey featured a gully of thousands of acres named "Providence Cave" because it grew by undercutting that had begun where rain dripped from the eaves of a barn. This report was accorded the same cold reception as previous reports.

Bennett was disappointed that others would not see how erosion was hurting his native region so badly, but he was not discouraged. In order to create motion in the direction of erosion and its control, he concluded that he had to foster an interest in the subject among the public and among the members of his discipline. He was in a good position as Inspector for the Southern Division, and later for the larger Eastern Division, to bring interest within the discipline. He began to emphasize land use as a topic to generate more interest in erosion. He found more attentive audiences when he talked about land capability and management before warming up to his favorite topic of soil erosion.

Bennett seems to have been regarded by the Bureau of Soils hierarchy as a promising, but impetuous, young scientist. After his surveys of 1910, 1911, and 1913 emphasizing erosion, he was sent away on special assignments, as far away as possible it seemed. Whether or not he was intentionally sent away to distance him from his course of action, his publications trail shows him having worked in the Panama Canal Zone in 1909 and 1913, Alaska in 1914 and 1916, and the area bordering warring Honduras and Guatemala in 1919. In the latter assignment, he served with the international boundary commission. This intended diversion of Bennett's energies

had an opposite effect for the Bureau hierarchy because it gave him an opportunity to further hone his skills for the erosion fight that was to ensue.

Bennett was moved out of the field to Washington in 1918, and at that point began to speak and write more forcefully. His first significant presentation outside his traditional audiences was to the Southern Forestry Association meeting in Atlanta in 1921. He presented a paper that was later published in the Proceedings of the Association meeting. Recalling that the Division of Forestry had been established to conserve resources, Bennett said it was "singing to the choir" at the Forestry meeting when he could not get a hearing in his own Bureau. However, he persisted in working to establish a sound, scientific reputation by publishing extensively on soils in the South; conducting detailed technical investigations for his articles on the humid tropics; and with R.O.E. Davis, contributing suggestions for technical improvement in the textural triangle to simplify soil survey work. He also worked hard during this period to promote interest in erosion with scientists outside the Bureau of Soils and with the public in general.

Biographers comment that while Bennett was not being advanced in the Bureau of Soils, he was gaining substantial recognition outside his organization as an expert on soils and soil erosion. He had developed many contacts among the public through his soil survey work and he informally promoted erosion control with them. He also had many contacts among the state experiment station researchers because the soil surveys were carried out in cooperation with the states. In addition, erosion studies were initiated at several state experiment stations around 1916. Bennett kept in communication with researchers in the State Experiment Stations who were interested in erosion, and information was exchanged through this network. Station researchers likewise were receiving no support from their superiors in Washington for their work on soil erosion. It naturally followed that a strong esprit de corps developed among soil scientists working on erosion and Bennett was the major promoter of the contagious spirit.

In the mid-1920s, Bennett began publishing in the popular and farm magazines, such as *American Game*, *Country Gentleman*, and *Nature*, and he contributed a monthly article to *Farm Journal* from late 1925 through 1926. In total, he published at least 40 items between 1920 and 1930, despite having had several assignments in South and Central America and the Caribbean during that period. His best known publication from this period was the 1928 Circular 33: *Soil Erosion, A National Menace*. Written with the help of W. R. Chapline of the U.S. Forest Service, the circular was regarded as more effective than any of the preceding erosion bulletins in that it was not technical and did not discuss erosion control measures. Instead, coming shortly after the great Mississippi flood of 1927, the costliest in lives and property the nation had ever seen, Bennett and Chapline's bulletin emphasized only the damages caused by erosion and the need for action to stop it.

Soon after the publication of this circular, Bennett finally saw some federal funding approved for erosion research. This came about through his connection to A. B. Conner, Director of the Texas Experiment Station. According to a prearranged plan, Conner was to discuss erosion with Congressman Buchanan of Texas. When the congressman maintained, as they expected he would, that federal money was to be spent for defense, Conner would bring up the large expenditure for battleships, and then argue that protecting the soil that supports the citizenship protects the nation. This devious arrangement worked and, as a result, Bennett was soon asked to testify before Buchanan's subcommittee. An amendment was attached to the 1929 appropriation for the Department of Agriculture authorizing $160,000 over four years for soil erosion research. This money was to be used by the USDA "to investigate the causes of soil erosion and the possibility of increasing the absorption of rainfall by the soil in the United States."

Over a period of two years, Bennett established a network of ten erosion stations in various problem areas of the country: Clarinda, Iowa; Hayes, Kansas; Bethany, Missouri; Statesville, North Carolina; Zanesville, Ohio; Guthrie, Oklahoma; Temple, Texas; Tyler, Texas; Pullman, Washington; and La Crosse, Wisconsin. Of these ten, those at Bethany and Guthrie were already in existence, but experiments at these stations were adjusted to match a model so that all of the stations were controlling and testing the same variables. With this approach, for the first time, commensurable data on soil erosion from different locations in the U.S. became available. Bennett provided findings from these stations in "The National Program of Soil and Water Conservation" in 1930 at the annual convention of the American Society of Agronomy, the largest, longest established, and most prestigious body he had addressed up to that point.

More than 25 years after the Louisa County, Virginia, discovery of sheet erosion, Hugh Hammond Bennett finally saw some positive tangible results of his efforts to arouse the American public to act. The soil erosion peril was, for the first time in the nation's history, an official concern. His crusade was successful, but there was much more yet to come.

Bennett, the Administrator

President Franklin Roosevelt, in promoting his New Deal agenda, encouraged the Congress to establish a Civilian Conservation Corps (CCC). The Corps was envisioned as a means of reducing unemployment, making a positive contribution to the future state of the nation's resources, and instilling in the young men of the Corps a sense of a stake in that future. The CCC was established "to carry out reforestation and other conservation projects in the national forests and national parks." A five-million-dollar appropriation was made available for erosion control on private and public lands, with work to be administered by the Bureau of Agricultural Engineering in the USDA.

Bennett approached his superior, Assistant Secretary of Agriculture Rexford Tugwell, who represented the USDA on the Board of Public Works, about how the job was to be carried out. Bennett by this time had finally attained some degree of acknowledgment within the USDA. Tugwell, a new administrator with Roosevelt's administration, greeted Bennett as the nation's erosion expert. Thus, with Bennett's planning and Tugwell's support, the Soil Erosion Service (SES) was established in the Department of the Interior (DI) in September 1933. Predictably, the head of this new agency was Hugh Hammond Bennett!

Upon receiving the SES appropriation, Bennett lost no time in undertaking work that he had been trying to get done for decades. By mid-October 1933, there were twelve people on the payroll, and the erosion reconnaissance survey was started immediately. One of the first administrative actions affecting the SES was the transfer to it from the Forest Service of over 150 CCC camps.

Over the next two years, Bennett set up approximately 40 large demonstration projects, applying a wide array of soil conserving and restoring practices at the demonstration sites. The CCC participants were engaged in doing the actual work on the demonstration projects, e.g., planting trees, building erosion control structures, planting cover crops. This work was well received by the farming communities and the general public, and it attracted much favorable attention. In December, Henry C. Wallace, Secretary of the USDA, sent Harold Ickes, Secretary of the DI, a memorandum requesting the transfer of the SES to the USDA, a move reputed to have demonstrated the success and popularity of the SES research and demonstrations. The value of the SES work was soon to be realized as the forces of nature were about to act in a spectacular way to drive home the reality and devastation of soil erosion, a fact that Hugh Bennett had being preaching for 25 years.

In 1934, just as the first national survey of soil erosion was being completed, wind storms hit the drought-stricken Great Plains and the term "dust bowl" was born. On May 12, 1934, a major storm hit the plains, later to be described by Bennett as a turning point in the battle to get public attention to the erosion problem:

"This particular dust storm blotted out the sun over the nation’s capital, drove grit between the teeth of New Yorkers, and scattered dust on the decks of ships 200 miles out to sea. I suspect that when people along the seaboard of the eastern United States began to taste fresh soil from the plains 2,000 miles away, many of them realized for the first time that somewhere something had gone wrong with the land. It seems to take something like a disaster to awaken people who have been accustomed to great national prosperity, such as ours, to the presence of a national menace. Although we were slowly coming to realize that soil erosion was a major national problem, even before that great dust storm, it took that storm to awaken the nation as a whole to some realization of the menace of erosion."

That something had gone wrong with the land was indeed evident in 1934, and the resulting public concern led to a great deal of public and private effort to remedy the situation.

In March 1935, a bill was introduced in Congress to set up the Soil Conservation Service as a permanent agency of the government. It was one of many dropped in the hopper under the urgency of the Dust Bowl and its accompanying consequences of depression, unemployment, and hunger. Bennett was called by a Senate

committee to argue the case for the proposed legislation. His appearance and what followed it are now legendary. A Bennett biographer, Wellington Brink, graphically describes the event:

"The witness was not cheerful, but he was persistent, informed, and courageous. He told a grim story. He had been telling it all morning. Chapter by chapter, he annotated each dismal page with facts and figures from a reconnaissance he had just completed. . . . The witness did not hurry. He did not want to hurry. That extra ace he needed was not yet at hand. Well he realized that the hearing was beginning to drag. Out of one corner of his eye, he noted the polite stifling of a yawn, but Hugh Bennett continued deliberatively. . . . Bennett knew that a dust storm was on its way. He had newspaper items and weather reports to support this knowledge. But it seemed mighty slow arriving. If his delaying tactics were successful, the presence of the swirling dust—material evidence of what he was talking about—ought to serve as a clincher for his argument. Presently one of the senators remarked—off the record—'It is getting dark. Perhaps a rainstorm is brewing.' Another ventured, 'Maybe its dust.' 'I think you are correct,' Bennett agreed. 'Senator, it *does* look like dust.' The group gathered at a window. The dust storm for which Hugh Bennett had been waiting rolled in like a vast steel-town pall, thick and repulsive. The skies took on a copper color. The sun went into hiding. The air became heavy with grit. Government's most spectacular showman had laid the stage well. All day, step by step, he had built his drama, paced it slowly, risked possible failure with his interminable reports, while he prayed for Nature to hurry up a proper denouement. For once, Nature cooperated generously."

The committee went back to the conference table no longer in doubt. This was the turning point. The 74th Congress passed without a dissenting vote Public Law 46, The Soil Conservation Act, the first soil conservation act in the history of this or any other nation. It was signed by the President on April 27, 1935.

With the passage of Public Law 46, the Soil Conservation Service (SCS) was established as a permanent agency in the USDA. The soil erosion and soil conservation activities that had been carried out in the Soil Erosion Service of the Interior Department were transferred to the Agriculture Department. The only logical choice to be the first Chief of the newly created Soil Conservation Service was Hugh Hammond Bennett. Bennett had mixed feelings about the transfer of the SES program into the USDA and its new agency, the SCS. He had high professional regard for Interior Secretary Harold Ickes and credited Ickes for much of the rapid progress of the SES. In addition, the SCS was not received warmly by sister agencies in the USDA. However, Bennett and his colleagues had strong agricultural constituents in farmers and they enjoyed close relations with members of Congress, many of whom were from agricultural areas.

Bennett was disturbed with the slowness of getting conservation on the ground. After two years of work, the SCS reported the completion of less than one million acres of treated land. One reason for the slow progress, thought Bennett, was the lack of involvement of farmers in the nationwide program. Out of this need for farmer participation came the idea of soil conservation districts, an idea credited primarily to Hugh Bennett. He modestly gave credit to others but he stated on many occasions: "I consider the soil conservation districts movement one of the most important developments in the whole history of agriculture. It has proved even more effective, I am convinced, than we had dared to expect."

Nearly a year of technical and legal work was required to develop an appropriate document to implement the concept of conservation districts. The completed document was called *A Standard State Soil Conservation Districts Law*. After much review, President Roosevelt sent a letter in February 1937 to all the state governors, enclosing the standard enabling act and recommending that each state adopt such a law as part of an effective national effort to conserve the soil. A total of 22 states had enacted the district enabling law by the end of 1937. The formation of local districts began immediately, starting usually with a local petition signed by 25 residents and a referendum election that established the district's boundaries. It was most fitting that the first conservation district in the nation, the Brown Creek Soil Conservation District, was established in Hugh Bennett's home county, Anson County, North Carolina, in August 1937.

Hugh Bennett officially concluded his career of distinguished public service on April 30, 1952, when he retired from the SCS. He died on July 7, 1960, after a long battle with cancer.

Epilogue

Hugh Hammond Bennett was a special man for a special time in history. However one wishes to explain it—be it divine appointment, planetary alignment, or extraordinary insight of the individual himself, the timing of Hugh Bennett's presence on the world stage was perfect. A major task at a critical time in Americas history needed to be accomplished, and he was uniquely qualified as the man for the task.

Upon reviewing his career, which took many turns and produced many achievements, one can see how each stage of his life prepared him for the next. His boyhood life on a cotton plantation in North Carolina instilled in him the qualities of thrift, hard work, stamina, endurance, love, respect, and gratitude. All of these qualities would benefit him at one time or another in his dealings with people and in managing programs. His scientific training and experience provided a solid foundation for soil erosion research and interaction with scientists. His soil survey experience provided him an understanding of the soils of the U.S. unmatched by anyone else of his time.

Also, through his soil survey experience, he developed strong professional associations with soil scientists and endearing personal friendships with people all across the land. These personal and professional relationships stood him in good stead as he assumed leadership responsibilities in the government. Even the cooling-off assignments to distant lands served to strengthen his scientific credibility and extend his interpersonal ties across political and cultural lines. All of these experiences equipped him for his finest hour, namely, his courageous response to one of the worst crises in American history, the Dust Bowl and all its concomitant human misery and distress.

A man of the soil, Hugh Bennett left a rich legacy for all who follow in the soil science profession. He left an enviable publication record: five books; more than 400 technical, semi-popular and popular papers; hundreds of soil survey reports, magazine articles and miscellaneous materials not officially totaled by the USDA. It is estimated that Bennett's signed production exceeds 1,000 items.

He struck out many times. He continued to call soil erosion a national menace in the face of official rebuffs. He risked the laughs and the jeers of the academic intelligentsia. He reached his 30th, 40th, and even 47th birthdays before any influential scientists would take him seriously. Although Hugh Bennett received many scars, none of them ever dampened his sense of humor, his sense of humanity, or his sense of scientific simplicity.

Hugh Hammond Bennett was many things—visionary, scholar, strategist, politician, tactician, realist, prophet, naturalist, to name a few. He had the uncanny ability to wear the right hat for the right issue at the right time. He was a man who loved the land, but who loved mankind even more. He was a man's man! A tribute by Louis Bromfield, a well- known conservationist and Bennett contemporary, sums it up well: "Hugh Bennett deserves the greatest honor from the American people as one of the greatest benefactors since the beginning of their history."