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Soil and Surficial Geology Guidebook to the Oak Ridge Reservation, Oak Ridge, Tennessee

S. Y. Lee
D. A. Lietzke
R. H. Ketelle
J. T. Ammons

Environmental Sciences Division
Publication No. 3112

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ENVIRONMENTAL SCIENCES DIVISION

SOIL AND SURFICIAL GEOLOGY GUIDEBOOK TO THE OAK RIDGE RESERVATION, OAK RIDGE, TENNESSEE

compiled by

S. Y. Lee, D. A. Lietzke,[1] R. H. Ketelle,[2] and J. T. Ammons[3]

Environmental Sciences Division
Publication No. 3112

NUCLEAR AND CHEMICAL WASTE PROGRAMS
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NOTICE This document contains information of a preliminary nature. It is subject to revision or correction and therefore does not represent a final report.

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PREFACE

Welcome to Oak Ridge National Laboratory (ORNL)! This soil and surficial geology guidebook was prepared primarily for the field trip of the Southern Regional Soil Survey Work Planning Conference to be held in Knoxville, Tennessee, on June 13-17, 1988, but will be available for future field trips of other regional, national, and international conferences related to soil and geomorphic research. This guidebook is organized into four parts: (1) introduction to the Oak Ridge area; (2) geologic and hydrologic setting; (3) soil, surficial geology, and geomorphic relations; and (4) sitelogs, including soil description and characterization data. Physical, chemical, mineralogical, and engineering characterization of soils described in this guidebook is in progress. This guidebook will be revised when the characterization project is completed. Soil survey and characterization studies were begun about 5 years ago to support the Nuclear and Chemical Waste programs at ORNL and at the Oak Ridge Y-12 Plant. Part of the studies was conducted by the Department of Plant and Soil Science, The University of Tennessee, Knoxville.

Acknowledgments - We are grateful to the following graduate students: D. H. Phillips, R. E. Lambert, and H. C. Monger, Jr., who studied some soils in the Oak Ridge Reservation. Their work is cited where appropriate. Site review and evaluation prior to this publication by Dr. J. E. Foss, Head of the Plant and Soil Science Department, The University of Tennessee, Knoxville, and by D. L. Newton, D. E. Lewis, and R. P. Sims, Soil Conservation Service, U.S. Department of Agriculture are appreciated. Research was conducted on the Oak Ridge National Environmental Research Park.

May 1988

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INTRODUCTION

Most of the Oak Ridge Reservation (ORR) is located within the corporate limits of the City of Oak Ridge in eastern Tennessee (Fig. 1). The ORR is within the region known as the Great Valley of the Tennessee River and consists of approximately 15,000 ha of federally owned lands. The current ORR has evolved from land originally acquired in 1942 for construction of atomic bomb production facilities that were part of the Army's Manhattan Project. Today, three facilities, Oak Ridge National Laboratory (ORNL), Oak Ridge Y-12 Plant, and Oak Ridge Gaseous Diffusion Plant, are carrying out programs for energy research and development and for national defense. These three facilities represent an investment of more than $2.8 billion and house more than 14,000 research and production professionals.[1]

Physiographic and Geographic Setting

The ORR lies near the center of eastern Tennessee along the western edge of the Valley and Ridge physiographic Province that is located between the Cumberland Mountains to the northwest and the Great Smoky Mountains to the southeast. The Valley and Ridge Province is characterized by alternating elongated and parallel valley troughs and ridges trending northeast to southwest in general accord with the strike of the underlying rock strata. The succession of alternating ridges and valleys across the ORR in order from the southeast to the northwest is as follows: Copper Ridge, Melton Valley, Haw Ridge, Bethel Valley, Chestnut Ridge, Bear Creek Valley, Pine Ridge, Gamble Valley, East Fork Ridge, East Fork Valley, and Black Oak Ridge. Average elevation of the ORR is about 410 m above sea level at the ridge tops and about 230 m at the valley bottoms. The major streams flow to the southwest roughly parallel to the ridges and form part of Clinch River which winds along the southeast periphery of the reservation. Several embayments bound the ORR: the largest is the Bear Creek Embayment with an approximate surface area of 48 ha. Other embayments include Walker Branch, McCoy Branch, and Scarboro Creek.

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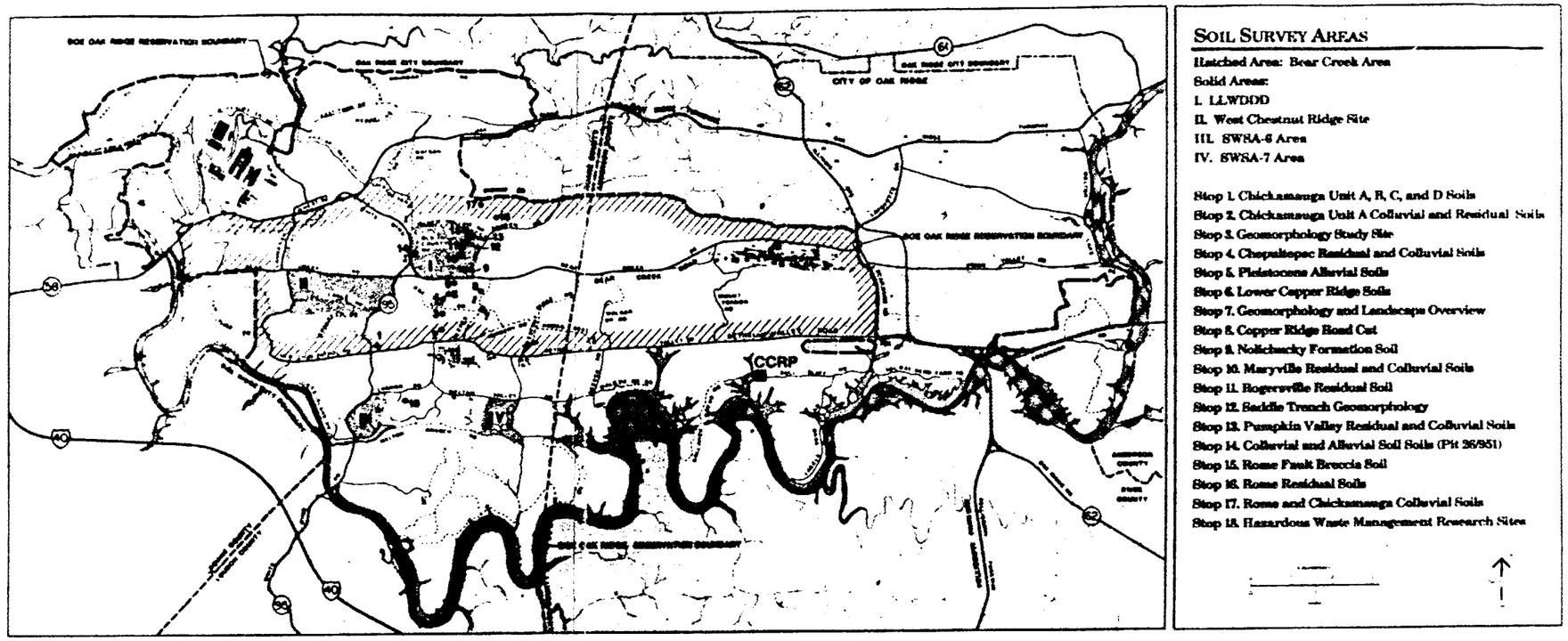

Fig. 1. Locations of soil survey areas and field trip stops on the Oak Ridge Reservation.

Climate, Vegetation, and Wildlife

The climate of the area is classified as humid, subtropical with a year-round mean temperature of 15°C, a January mean of about 3.5°C, and a July mean of about 25°C. Mean annual precipitation is about 138 cm based on 1948-85 yearly data.[2] Winter months are the period of highest rainfall, with relatively low intensity and long duration. Another peak in rainfall occurs in July, when short but heavy rains associated with thunderstorms are common. Annual water loss to the atmosphere by evapotranspiration is about 76 cm or about 55% of the total annual precipitation. Evapotranspiration is at a maximum from July to September, during the vegetation growing season.

Prior to acquisition by the federal government, open land areas had been used as pasture, hayland, and cropland within larger areas of woodland. Many of the upland landforms in the area were named from the forest vegetation, such as Chestnut Ridge, Pine Ridge, Haw Ridge, and Black Oak Ridge. It is doubtful that any old growth woodland exists on the ORR, since almost all areas were accessible to land users. Much land that was initially cleared for agriculture reverted to woodland when the soils were found to be unfarmable because of low residual fertility or severe erosion. With the creation of the ORR in 1942, most of the agricultural lands reverted to sage grass, weeds, briars, and scattered trees or to woodland.[3] The reversion occurred either by old field succession or by large-scale tree planting between 1947 and 1961. The predominant tree species on the reservation is yellow pine (including loblolly pine) with about 33% of the total reservation sawtimber volume.[4] Red and white oaks (26%) and yellow poplar (17%) are next abundant species. Other species include black walnut, black cherry, red cedar, hickory, chestnut oak, elm, sycamore, and ash.

The mixed plant communities maintained on the reservation have been a valuable asset to wildlife because a diversity of habitats is needed by the many wildlife species. There are approximately 250 species of birds, mammals, reptiles, and amphibians.[5] Data obtained from vehicle-killed white-tail deer indicate that growth of the reservation herd since 1969 has been exponential and point to

potential overpopulation and habitat destruction in the near future if the trend continues. Therefore, a reservation-wide annual deer-hunt season has been opened to the public since 1985.

History of Oak Ridge

Before the white man acquired the Oak Ridge area from the Cherokee Indians by the treaties of 1794 and 1805, practically all of the land was in forest, but with the development of the agricultural resources, much of the land was cleared of trees, and its use shifted from forestry to agriculture. During World War II, President Roosevelt made the decision that created Oak Ridge, a community in which people worked in secrecy for reasons of national security. Most of the workers came from all over the country and worked for the production of the most powerful force (atomic bomb) ever developed by man. The entire community was behind security fences with guards at the entrances, and everything in the community was owned and operated by the federal government. The security gates were removed in 1949. In 1955, the Federal Government sold the residential and commercial land to Oak Ridgers and gave the town the municipal facilities but retained about 65% of the land, which became the Oak Ridge Reservation. The City of Oak Ridge was incorporated in 1959, and the population is now estimated at approximately 28,000 in 92 square miles (according to the Oak Ridge Chamber of Commerce). Oak Ridge has several attractions: American Museum of Science and Energy, Children's Museum, Arboretum, and Graphite Reactor-National Historic Landmark are opened to visitors daily. In addition, Oak Ridge is surrounded by Tennessee Valley Authority (TVA) lakes and state parks.

Environmental Sciences Division, ORNL

The Environmental Sciences Division (ESD) is one of many basic and applied sciences, engineering, technology, and information divisions of ORNL. The Division originated in 1954 as the radiation ecology group within Health Physics Division. Established as the ESD in 1972, the Division performs problem-oriented research using interdisciplinary

teams representing the ecological, biological, chemical, mathematical, engineering, geological, and physical sciences. Now, the ESD is one of the largest single-unit environmental research laboratories in the world. The Division has played a key role in resolving national environmental issues related to the operation of conventional energy systems and developing new energy technologies.[6] The Department of Energy (DOE) has been the major sponsor of research programs, but other federal agencies and some private industries are increasingly utilizing our resources to solve environmental problems. The Division has undertaken many cooperative projects with universities and the private sector and maintains active programs for visiting scientists and graduate students.

GEOLOGY AND HYDROLOGY

The area described in this field guide is underlain by a heterogeneous assemblage of bedrock types of Cambrian and Ordovician age. Rock types include limestone and siltstones of the Chickamauga Group; cherty dolostones of the Knox Group; silty limestones, calcareous siltstones, and shales of the Conasauga Group; and sandstones and shales of the Rome Formation. Table 1 is a stratigraphic column of the rocks that outcrop along the field transect. Figure 2 from McMaster[7] is a geologic cross section of the transect area showing the orientation and distribution of each of the major bedrock groups. The transect area lies on the Whiteoak Mountain thrust sheet. The Whiteoak Mountain thrust fault zone underlies the Rome Formation to the northwest of the transect and is the cause of the local dip in bedrock orientation throughout the area.

Major topographic features of the area include Pine Ridge to the northwest and Bear Creek Valley, Chestnut Ridge, and Bethel Valley to the southeast. Current landforms are related to soil development and erosion characteristics of the various bedrock units that underlie the area. Pine Ridge is underlain by the Rome Formation, and the ridge

Table 1. Stratigraphic column of Cambro-Ordovician rocks, Whiteoak Mountain thrust block, Oak Ridge, Tennessee

ORNL WSM 5350

Age	Group	Formation/Unit	Description	Thickness (ft)
MIDDLE ORDOVICIAN	CHICKAMAUGA (Och)[b]	Unit H[a]	Thin interbedded limestone and calcareous siltstone. Gray, olive, buff, and maroon	>270
		Unit G	Limestone and siltstone in thick beds. Limestone fine- to medium-grained, nodular. Siltstone dark gray with vague limestone interbeds.	290
		Unit F	Laminated to thin-bedded calcareous and shaley siltstone. Maroon and olive gray.	20
		Unit E	Limestone and siltstone in thick beds. Limestone fine- to medium-grained, nodular and amorphous. Siltstone dark gray with limestone laminae.	300
		Unit D	Limestone. Medium-grained and stylolitic. Nodular and bedded chert.	140
		Unit C	Limestone and siltstone in thick beds. Limestone nodular and micritic. Siltstone calcareous and dark gray. Nodular chert.	95
		Unit B	Siltstone. Massive maroon and gray with limestone in thin, even beds.	250
		Unit A	Limestone and siltstone in thick beds. Dark to light gray, purplish to maroon. Nodular and bedded chert.	300
LOWER ORDOVICIAN	KNOX (O€k)	NEWALA Fm.	Medium-bedded dolostones and limestones with variable chert content, scattered chert matrix limestones. Abundant maroon mottling.	900 (est)
		LONGVIEW Fm.	Dense massive chert, bedded chert, and dolomoldic chert observed in residuum.	50–100 (est)
		CHEPULTEPEC Fm.	Dolostone, fine- to medium-grained, light to medium gray, medium to thick bedded, sandy near base.	500–100 (est)
UPPER CAMBRIAN		COPPER RIDGE Fm.	Dolostone, medium to thick bedded, fine to coarse crystalline medium to dark gray. Chert varieties include massive, cryptopoan, and oolitic.	900–1300 est

Table 1. Continued.

ORNL-WSM-5387

Age	Group	Formation/Unit	Description	Thickness (ft
MIDDLE CAMBRIAN	CONASAUGA (Ꞓc)	MAYNARDVILLE Fm.	Upper (Chances Branch Mbr.) – limestone and dolomitic limestone in thick massive beds	140
			Lower (Low Hollow Mbr.) – dolomitic limestone in thick massive beds. Light gray to buff	200
		NOLICHUCKY Fm.	Upper – shale and limestone in thin to thick beds. Shale dark gray or maroon. Limestone light gray, oolitic, wavy-bedded, or massive	60–140
			Lower – shale and limestone in medium to thick beds. Shale dark gray, olive gray or maroon. Limestone light gray, oolitic, glauconitic, wavy-bedded, and intraclastic	430–450
		MARYVILLE Fm.	Limestone and shale or siltstone in medium beds. Limestone light gray, intraclastic, or wavy-bedded. Shale or siltstone dark gray	320–410
		ROGERSVILLE Fm.	Shale and argillaceous limestone. Laminated to thin-bedded, maroon, dark gray, and light gray	80–110
		RUTLEDGE Fm.	Limestone and shale in thin beds. Limestone light to olive gray. Shale gray or maroon	100–120
		PUMPKIN VALLEY Fm.	Upper – shale and calcareous siltstone. Laminated to very thin-bedded. Shale reddish brown, reddish-gray, or gray. Calcareous siltstone light gray or glauconitic	130–150
			Lower – shale and siltstone or silty sandstone. Thin-bedded. Shale reddish-brown or gray to greenish gray. Siltstone and silty sandstone light gray	175
LOWER CAMBRIAN		ROME Fm. (Ꞓr)	Sandstone with thin shale interbeds. Sandstone fine-grained, light gray or pale maroon. Shale maroon or olive gray	Unknown

[a]Chickamauga Group stratigraphic subdivisions reflect those identified at the Oak Ridge National Laboratory site. Other formation names are consistent with regional stratigraphic nomenclature.
[b]Group name abbreviations are those commonly used on geologic maps and cross sections in the region.

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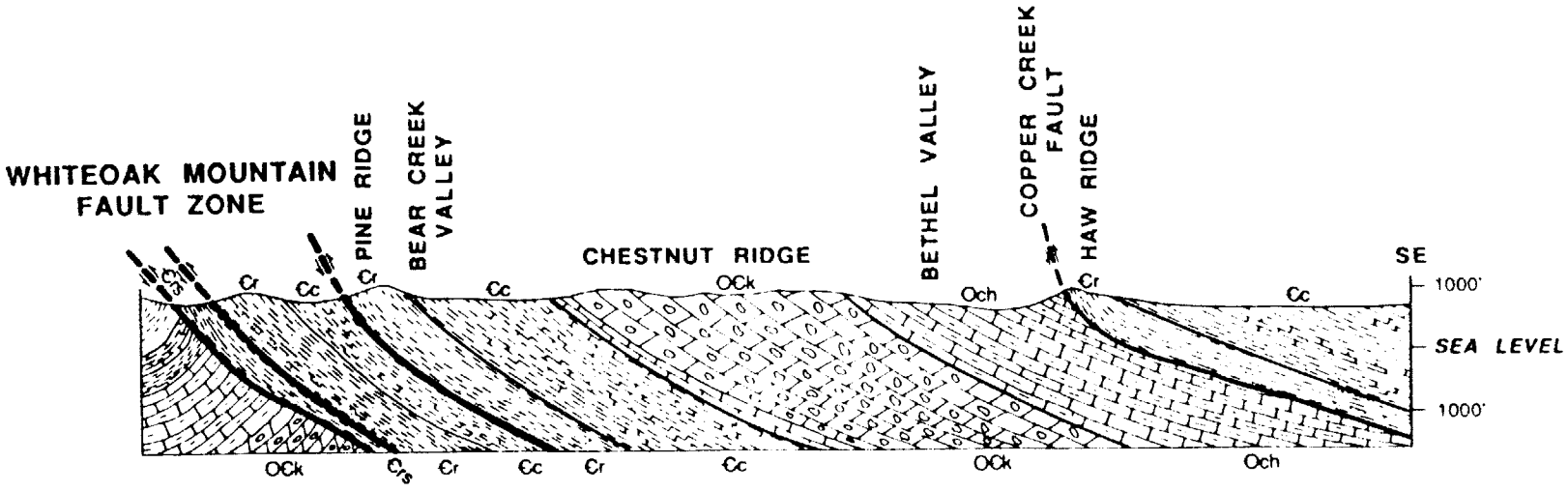

Fig. 2. Stratigraphic cross-section of Oak Ridge Reservation. (Group or formation symbols are defined in Table 1.)

crest is upheld by the erosion-resistant sandstone that occurs in the uppermost interval of the Rome.

Bear Creek Valley is underlain by the Conasauga Group, which is composed of shales, calcareous siltstones, and silty to clean limestones. Local scale topography within Bear Creek Valley is controlled by bedrock lithology with shales and clean limestones underlying a line of knobs near the center of the valley. Chestnut Ridge is underlain by the Knox Group cherty dolostones upon which thick (>30-m) residual soil deposits have developed. The Knox Group typically has a well-developed karst drainage system and a correspondingly low density of perennial surface drainage features. The thick soil mantle persists because of runoff shedding through a shallow (<1-m) drainage system which discharges to toeslope ephemeral flow channels. Bethel Valley is underlain by calcareous siltstones and silty to clean limestones of the Chickamauga Group. Soils that form on the Chickamauga are typically 3 m or less thick.

Area hydrology, like geomorphology, is related to geology. Soil infiltration and drainage characteristics, slope development, and erosion potential in the residual soils and saprolites are related to the parent geologic materials. Similarly, the groundwater regime in any area is a function of the bedrock types present, climatic conditions, and aquifer recharge potential.

The surface water drainage pattern in the Valley and Ridge Province tends to be a trellis or weak trellis pattern that results from erosion of dipping bedrock strata having variable erosion resistance. The general surface water drainage system in the Oak Ridge area is best described as a weak trellis pattern. The dominant control on stream orientation in the area is the geologic strike or outcrop trend of rock bedding. This direction, which is locally northeast to southwest, typically controls major stream orientations. Secondarily, stream flow directions are controlled by cross-cutting fracture orientations. This characteristic is exemplified locally by the orientation of tributaries and the tendency of some streams to cross geologic strike belts. In some areas discrete cross-cutting fracture

zones or tear faults are suspected to exist, while in other areas diffuse networks of similarly oriented fractures are suspected to account for stream orientations. The Bear Creek watershed is a good local example of this type of drainage. Bear Creek flows down the linear valley collecting the discharge of numerous small tributaries that flow across strike to intersect the main stream at near right angles. The main creek stem then makes a near right angle bend to flow across the valley, through the water gap in Pine Ridge, and on to the East Fork of Poplar Creek.

Interactions between surface water and groundwater in the transect area are also controlled by local geologic conditions. Precipitation runoff and infiltration are controlled by slope, soil, and vegetation factors. The area included in this transect contains a number of strongly contrasting terrains with respect to infiltration and runoff characteristics.

The sandstones and shales of the Rome formation uphold Pine Ridge and tend to form thin, sandy, residual and colluvial soils that overlie fractured and weathered bedrock. Slopes on Pine Ridge are steep. This combination of factors combines to form a landform that has fairly high water infiltration capacity. As a result, shallow groundwater flow occurs in the thin soils to recharge the fractured rock aquifer of the Rome and to feed numerous small springs near toeslopes of the ridge. Data are also becoming available suggesting that aquifer recharge to the Rome high on Pine Ridge supplies artesian pressure in the fractured sandstone to depths of several hundred feet down dip.

Hydrologic behavior of the Conasauga terrain is variable due to the heterogeneities of the bedrock present. Local terrain, soils, and nature of local bedrock structures control the local hydrologic conditions. Generally, low lying areas in the Conasauga terrain are surface water and groundwater discharge areas, and upland areas are infiltration areas feeding flow through soil, saprolite, and shallow bedrock zones to the adjacent discharge areas. Groundwater movement in the saprolite and bedrock of the Conasauga Group is generally controlled by fracture orientation and density.

The exception to fracture control in the Conasauga is in the Maynardville limestone, where a well-developed karst flow system occurs. The Maynardville outcrops in a strip along the southeast side of Bear Creek Valley. Deep solutioning and erosion in the Maynardville outcrop belt have resulted in formation of the strongly asymmetric valley cross section of Bear Creek Valley in which the main creek flows along strike in the Maynardville outcrop belt at the southeast side of the valley. Water levels in the Maynardville outcrop belt constitute the local base level for surface water and groundwater discharge. Because of the karst nature of the formation, Bear Creek experiences gains and losses in discharge along the valley as the surface water and groundwater components of this flow system vary in dominance.

The hydrologic system in the Knox Group outcrop belt on Chestnut Ridge is complex due to the presence of thick soil masses overlying solutioned dolostone bedrock. The surface water drainage system in many areas is ephemeral and surface drainage density is low compared to that on the Conasauga outcrop belt. Precipitation infiltration capacity is high in the gravelly surficial soils that form a cherty armor over the silty clay B horizon soils and saprolitic deeper soils. Shallow flow occurs in the surficial soils during wet seasons with recharge of moisture to the high moisture retention subsoils, percolation into local sinkholes, and discharge at toe slope springs in upland valleys. Many upland valley toeslope springs on Chestnut Ridge discharge water from perched saturated soil zones. Such waters are very low in dissolved solids, tend to have slightly acid pH, and apparently have neither contacted carbonate materials nor mixed with bedrock aquifer waters. The bedrock aquifer in the Knox outcrop belt occurs in solutioned zones in the bedrock beneath the overlying soils. Groundwater flow in such zones is controlled by the location and orientation of solution channels. Water-table elevations in the Knox bedrock aquifer are higher than those in either Bear Creek Valley to the northwest or Bethel Valley to the southeast. Consequently a number of bedrock springs occur adjacent to Chestnut Ridge, where water that recharged the Knox aquifer on the ridge discharges to surface flow.

The Chickamauga Group outcrop belt in Bethel Valley receives local recharge from precipitation infiltration and surface streamflow from adjacent valleys emanating from the Knox. Bedrock units within the Chickamauga in Bethel Valley are calcareous siltstones with interspersed clean limestones. The water table typically lies near the soil/bedrock interface with recharge occurring on upland areas and discharge in low lying areas. Ground water flow in the upper bedrock zone is controlled by weathered fractured, and, in the cleaner limestones, local solution conduits. Karst development in the Chickamauga is much weaker than that in the Knox dolostones and Maynardville limestone because of the much higher clastic sediment content.

SURFICIAL GEOLOGY AND PEDOLOGY

The Bear Creek soil survey area is underlain on the south by the Chickamauga Formation, in the middle by the Knox Group and the Conasauga Group, and on the north, by the Rome Formation, the Whiteoak Mountain fault, and a different slice of Chickamauga. A small part of East Fork Ridge underlain by Reedsville and Sequatchie Formations is also included. One major objective of the soil survey was to locate approximate boundaries between every formation or member of a group.

The locations of major geologic groups of the area were generally mapped, but the location of each formation within a group was not.[7] With the exception of most members of the Chickamauga Group and the Maynardville Limestone of the Conasauga Group, there are very few outcrops of hard rock. A few areas of ledges and pinnacles are exposed in the upper and lower Knox Group. Other rock outcrops occur in stream channels. Therefore, the characteristics of oxidized and weathered rock, defined here as saprolite, and soil morphology were used to locate the boundaries and extent of each major geologic formation.

Characteristics of saprolite and saprolitic materials can be drastically different from those of the unoxidized and unleached parent rock. The upper saprolitic materials of the Knox Group, for example,

consist of an acidic high silt and clay content residue into which clay has been either translocated or neo-formed. Iron and manganese oxides are a common but lesser component of most saprolites. Soil mapping located the residual soils that formed from each kind of saprolite from each of the geologic formations wide enough to be mapped where they are exposed at the surface. Substantial areas are covered by alluvium and colluvium of more than one age of deposition.

The youngest rocks in the survey area belong to the Chickamauga Group. This group is represented by five distinctive geologic units, labeled A through E. Unit E, the youngest, consists of a mixture of calcareous mudstones and limestones and occupies low topographic position in the broader landscape. Most areas of Unit E occur south of Bethel Valley and New Zion Patrol roads. The soils are mostly Hapludalfs and Argiudolls. Unit D consists of cherty limestones that occur in elongated landform knobs. The soils are deeply weathered and are Hapludults or Paleudults. Unit C consists of gray limestones and has shallow soils, Hapludalfs and Argiudolls, with high clay content in the subsoil and a dark surface layer. Unit B consists of maroon mudstones with very shallow and extremely eroded soils. Very severely eroded soils are Orthents, while less eroded soils are mostly Hapludalfs. Vegetation is mostly red cedar and Virginia pine. Unit A, the oldest, is a cherty limestone. The soils are mostly Hapludalfs with some Hapludults. The brick-shaped tabular chert that litter the ground surface serves to distinguish it from the uppermost Knox Group soils. The lowermost Unit A of the Chickamauga is separated by a disconformity or an ancient erosion surface from the uppermost formation of the Knox Group.

The Knox Group consists of five recognizable formations that are commonly identified by their location (with respect to formations above and below) and by the type of chert they contain. The youngest formation in the Knox is the Mascot. This formation contains subrounded jasperoid and chalcedonous chert, a visual clue used to separate it from the Unit A of the Chickamauga with its tabular chert. The next formation in the Knox is the Kingsport. This formation

contains variable chert, much of which is oolitic. In soil mapping, it was not possible to distinguish the Mascot from the Kingsport. They are grouped together into the Newala Formation, which can be distinguished from the Chickamauga above and the Longview and Chepultepec formations below. The Longview Formation typically contains abundant dolomoldic chert, which clearly distinguishes the formation. Because of its relatively high chert content the Longview Formation tends to be a ridge former. The Chepultepec Formation occurs below the Longview. It has variable chert content and contains some very fine-grained sandstone strata and lenses that contribute to a loam rather than a silt loam surface and a slightly lower subsoil clay content. Sometimes the presence of loess masks the presence of higher sand content in the surface. Soils that formed in Chepultepec saprolite have 5YR hues in the upper mottle-free subsoil, while soils that formed in saprolites of the Longview and Newala Formations above and the Copper Ridge Formation below typically have 2.5YR hues in the upper mottle-free subsoil. The Copper Ridge Formation is the lowest and oldest of the Knox Group. This formation also has variable chert content, but most of the chert is massive. A thick lag gravel layer, thick E horizons, gradational E/B and B/E horizons, and red upper subsoil horizons with much lower but highly variable chert content are common features of Copper Ridge soils. The lower portion of the Copper Ridge including the transition to the underlying Maynardville Formation of the Conasauga Group is massive dolomite that contains very little chert and/or low amounts of other impurities. The residue collapses so that saprolite does not form. Instead, red clay is nearly in contact with hard rock with a thin weathering zone only 1 to 5 cm thick. The soils in this section are mostly Alfisols and are located only on the steep sideslope of Chestnut Ridge above Bear Creek Road. Common rock outcrops, mostly ledges, are a surface feature. A topographic bench part of the way up the slope marks the break between the lower chert-free part of the Copper Ridge and the upper cherty part of the Copper Ridge that forms saprolite or saprolitic materials. Most soils on the Knox are Paleudults, with some Hapludults on very steep slopes.

The Conasauga Group is the next oldest group of diverse formations. This group is represented on the ground surface by the Maynardville, Nolichucky, Maryville, Rogersville, Rutledge, and Pumpkin Valley formations. The Conasauga Group occurs in narrow steeply thrusted and intricately folded and faulted bands with a total thickness in the survey area of about one-half mile. Each individual formation has some on-the-ground exposure. Transitional boundary zones between each formation occupy on-the-ground area, with some transition zones being rather narrow (less than 25 to 50 ft) and some being 50 to more than 100 ft wide.

The transition between the Maynardville Formation and the Knox Group Copper Ridge Formation is a low chert content dolomite or dolomitic limestone that contains impurities of silt and clay-sized particles and iron oxide. This transition zone is located on the steep slopes south of Bear Creek Road and is mostly covered by thin to thick Knox colluvium or by Pleistocene- to modern-aged alluvium and Knox colluvium, with the exception of some outcrops of rock between Bear Creek Road and Bear Creek.

The Maynardville Formation consists of high carbonate content limestone that contains clay and silt, but little iron. This formation occurs mostly in the floodplain and present low terraces of Bear Creek. When these rocks weather, saprolite does not form. Soils that form in the residue are shallow, and rock outcrops are common. However, most of the Maynardville Formation is covered by Bear Creek alluvium. The lowermost part of the Maynardville Formation is a clay-rich or argillaceous limestone with interbeds of claystone in the transition zone where the Maynardville merges with the uppermost Nolichucky Formation. Rock weathering in this transition zone has produced a relatively thick saprolite, high in silt and clay, and very sticky. Maynardville soils are either Hapludalfs or Hapludults depending on depth to rock and amount of leaching.

The Nolichucky Formation consists predominantly of claystone, but contains lenses and strata of siltstone and very fine grained sandstone throughout. In the uppermost and lowermost parts, it also contains

some lenses and strata of argillaceous limestone. The Nolichucky Formation is usually characterized as having a relatively low calcium carbonate content, when compared to the Maryville Formation below and the Maynardville Formation above. The Nolichucky Formation can be quite easily recognized at the surface by the mostly brownish saprolite color. This brown oxidized saprolite color is derived from the darker brown of the unoxidized rock beneath. Nolichucky saprolite also has strata of olive brown saprolite, which increase in thickness near the Maryville boundary zone. Because of the low carbonate content and the highly jointed and fractured nature of this formation, water has been able to percolate downward, allowing oxidation and hydrolysis reactions to proceed to considerable depth. The resulting chemically weathered and very acidic materials form a thick saprolite that maintains a rather high-bulk density, but tree roots are able to penetrate along planes, joints, and fractures to considerable depth. The Nolichucky Formation, when compared to the Maryville Formation, has a relatively low iron content based on iron coatings on joint and fracture faces in the saprolite. The soil that forms in the Nolichucky saprolite on stable landforms has a yellow brown to strong brown clay enriched subsoil. The dominant soils on the Nolichucky are Ruptic-Ultic Dystrochrepts, with lesser areas of Typic Hapludults on very gentle and stable landforms and Typic Dystrochrepts on very steep slopes.

An increase in calcium carbonate content in the lowermost Nolichucky and increasing amounts of olive-hued saprolite strata marks the broad transition with the upper Maryville Formation beneath. This transition zone is 50 to more than 100 ft wide. The Maryville Formation on this site consists of calcareous siltstones and argillaceous limestone. Thin strata of very fine-grained calcareous sandstone also occur throughout, and glauconitic strata become common in the lowermost part of the formation. The Maryville Formation also has a relatively high iron oxide and manganese content, which is reflected by thick bright red or dark red iron oxide coatings or fragments in the upper saprolite and thick black manganese oxide coatings or fragments below the zone of iron oxide coatings. The

Maryville saprolite is easily recognized by the color of its oxidized and leached saprolite. The unoxidized rock has a very dark gray color, but as oxidation and hydrolysis proceed, the rock acquires a dark olive color (5YR hue). Because of continued weathering and proximity to the surface, the saprolite changes to light olive brown (2.5YR hue); the lower subsoil saprolite fragments can have a yellowish brown (10YR hue). The dominant Maryville soils are Ruptic-Ultic Dystrochrepts. However, soils that form in the uppermost saprolite on stable landforms generally have a red or yellowish red subsoil enriched in translocated clay and are Typic Hapludults. Typic Dystrochrepts occur only on the steepest sideslopes. The Maryville soils in the Bear Creek area have morphologic characteristics very similar to those in SWSA-6[8]. The results of chemical and mineralogical characterization now underway are needed to determine whether the chemical and mineralogical properties of the two areas are also very similar.

The transition zone between the Maryville and Rogersville formations is usually less than 50 ft wide. It is marked by the increased presence of greenish, bluish and pinkish claystone and siltstone saprolite strata. Also present in the lowermost Maryville and throughout the Rogersville are fine grained glauconitic sandstone strata. The Rogersville is typically less than 100 ft thick and is exposed only on steep obsequent northeast facing slopes. However, there are several locations in the area where the Rogersville is considerably thicker. Some of the increased thickness is evidently caused by local faulting which shoved slices of Rogersville upon other slices of Rogersville, and there are locally thicker sections. The dominant soils on the Rogersville are Ruptic-Ultic Dystrochrepts. On stable landforms, with slopes less than about 6%, soils that form in Rogersville saprolite have a yellowish brown to yellowish red clayey subsoil and are Typic Hapludults.

Most evidence of the Rutledge Formation, which occurs between the Pumpkin Valley and Rogersville formations, is a generally linear depression in which streams flow or which has been largely filled with colluvium derived from the Rome and Pumpkin Valley formations.

However, some areas of the Rutledge Formation have a high silt content and are more like a calcareous siltstone. These siltstone areas form saprolite that is exposed at the surface, and they are the only known exposures of Rutledge soils, which are classified as Ruptic-Ultic Dystrochrepts.

The Pumpkin Valley Formation has two recognizable members that weather to form distinctive soils. The upper member is an interbedded claystone and siltstone with abundant strata of very fine-grained glauconitic sandstone. The saprolite has a distinctive purple violet tint, which along with the dark green of the glauconite, makes it easily recognized. The dominant soils on the upper Pumpkin Valley are mostly Ruptic-Ultic Dystrochrepts. The lower Pumpkin Valley is dominated by still more permeable siltstone and by very fine-grained glauconitic sandstone. This saprolite can be identified by its higher sand content and colorful appearance, with colors ranging from red, violet, yellow, and brown to shades of green. Soils that formed from the lower saprolite have well expressed morphology with red clay enriched subsoil horizons, even on quite steep slopes. Most soils are Typic Hapludults with lesser amounts of Ochreptic Hapludults, with Typic Dystrochrepts only on slopes steeper than 45%.

The Rome Formation in the Bear Creek soil survey area occupies the upper third of the south side of Pine Ridge and continues on the north side of Pine Ridge to a major fault (Whiteoak Mountain). A bench landform high on the south side of Pine Ridge marks the boundary between the Pumpkin Valley and Rome. The bench is formed by the presence of a thick grayish white to yellow brown sandstone that contains abundant feldspars. This bench is usually covered with colluvium. Most drainageways on the south side of Pine Ridge have cut headwards through the Pumpkin Valley until they impinge on this uppermost Rome sandstone unit. Some of these deeper drainageways contain springs, while others have only wet weather seepage areas. Rome Formation saprolite on the south side of Pine Ridge is identified by the presence of a medium grained sandstone that has a yellow red oxidized color. Just below this sandstone is fissile maroon and

greenish gray shale, which is exposed only on the highest knobs of the ridge. However, where this fissile unit occurs on sideslopes and in saddles, it is usually covered by colluvium that contains large quantities of hard gray siliceous sandstone gravels and cobbles from the sandstone unit that holds up the Ridge.

The Rome Formation contains several members that occur between the crest of Pine Ridge and the Whiteoak Mountain fault. One member is a feldspathic sandstone and siltstone that weathers to form a yellowish saprolite, in which soils (Typic and Ochreptic Hapludults) with strong brown clay enriched subsoil horizons have formed. Another member is a hard pinkish fine-grained sandstone that is mostly cemented by iron oxides. Soils are thin Typic Dystrochrepts over this member. Another member is a red and dark red mudstone with Typic Dystrochrepts or Ochreptic Hapludults depending on slope gradient. However, most soils on the Rome are thin and do not have clay enriched subsoil horizons. Most soils are Typic Dystrochrepts with some areas of Typic and Ochreptic Hapludults. The Rome Formation also produced abundant colluvium from past geomorphic processes. Rome colluvial soils are Typic Hapludults.

The Whiteoak Mountain fault marks the location where the Rome Formation has been thrust over the Chickamauga. This fault zone in the Rome can be identified by the presence of fault breccia in which soils with fairly thick clayey subsoils have formed and in which distance to paralithic saprolite is deep. The Chickamauga below the fault is different from the Chickamauga on the south side of the survey area. It seems to have a higher siltstone and shale content, to have a lower limestone content, and to contain variable chert. Most of the soils are underlain by Cr horizons and not lithic limestone rock. The northernmost part of the survey area, north of the fault is underlain by younger formations of the Chickamauga and other younger formations that occur above the Chickamauga.

SOIL-LANDFORM RELATIONSHIPS

Soil-landform relationships are the most pronounced on the formations of the Conasauga Group where tilted and differentially weathered relatively impermeable shale and siltstone saprolites, plus slope gradient and slope shape, greatly affect surface and subsurface water flow. Soils with continuous argillic horizons occur only on slopes less than about 5% or 6%. Most soils on the Conasauga, up to slopes of about 40% to 45%, are Ruptic-Ultic Dystrochrepts. Typic Dystrochrepts occur on forest slopes exceeding 45%. Some soils on lower slope gradient, once severely eroded from agricultural activities and reverted back to forest, are also classified as Typic Dystrochrepts. Soil-landform relationships are less pronounced on the Knox. Permeable underlying rock and saprolite and dominant karst geomorphic processes have allowed most water to infiltrate, giving rise to stable landform surfaces. Most soils on the Knox with slopes less than 40% are Typic Paleudults. Only on very steep slopes are there Typic Hapludults. Most Chickamauga landforms are relatively subdued and there is greater relationship of soils to geologic materials than to landforms.

Topographic inversion on the Conasauga and Knox has resulted in old colluvial and alluvial soils being located on broad ridge tops and gentle sideslopes. The most strongly developed areas of karst topography with numerous large depressions are located on Chestnut Ridge.

SOIL SURVEY BRIEF

The ongoing soil survey and characterization projects at the ORR have several specific objectives. The major objectives are (1) to map soils in relation to bedrock formations on the site; (2) to evaluate landform stability, potential erosion, and drainage problems; and (3) to develop interpretive materials for forestry and wildlife management, hazardous waste disposal, and other land-use planning.

Intensive soil survey activities on the ORR were started in 1983 to provide a site-specific data base for actual site development for low-level radioactive waste disposal. The initiation of the soil survey and characterization project was prompted by lack of data as well as by the limited applicability of existing data. Soil survey reports of Anderson and Roane counties (where the ORR is located) were the only available sources for soil information at the time. However, the Anderson County soil survey was made during the 1970s at a map scale of 1:15,840.[9] The report provides only estimated physical and chemical data of each soil series. The Roane County soil survey was made during the 1930s and published at a scale of 1:48,000 on a planimetric base.[10] Interpretations in the report are therefore either obsolete or nonexistent. For intensive and detailed site planning, soil mapping with more detail is required, and eventually a site-specific data base is needed to plan for actual site development or intensive land use. Several intensive soil surveys of the ORR have been recently made for waste management projects. For land-use and soil-conservation planning, the Roane County portion of the Bear Creek area was surveyed at a scale of 1:12,000 (Fig. 1). The soil survey of the West Chestnut Ridge site and Solid Waste Storage Areas 6 and 7 (SWSA-6 and SWSA-7) was conducted at a scale of 1:2,400, and the Low-Level Waste Disposal Development and Demonstration (LLWDDD) site was mapped at a scale of 1:1,200.[8,11-13] When precise location of different soils is required for site-specific research projects, maps of small areas have been made at a scale of 1:240.

Individual soils and map units were established within a hierarchical framework. For each soil, highest priority was given to soil morphology, which is related to (and largely controlled by) bedrock formation, hydrology, and geomorphic processes, all of which define the soil system. To establish mapping units, each soil was subdivided according to landform configuration and slope gradient, wetness, and erosion class. During mapping, soil profiles were exposed by barrel auger. For characterization, pits were prepared at least 3 m deep or to backhoe-refusal depth if less than 3 m. All major

soils were described and sampled according to the methodology of the Revised Soil Survey Manual. Most of the soil characterization was performed by Department of Plant and Soil Science, The University of Tennessee, Knoxville, through a research and development subcontract with the ESD at ORNL. Soil characteristics including physical, chemical, mineralogical, and engineering properties were determined--not only for the control section of soil profiles but also for the saprolite zone.[14,15]

SITELOGS

Stop 1. Chickamauga Unit A, B, C, and D Soils

Soil series no.: 75D3.

Location: ORR. About 800 ft north of the intersection of Bethel Valley Road and Route 95. On the east side of Route 95, part of the way around the first curve.
Classification: Typic Hapludalfs; fine, mixed, thermic.
Geomorphic position: Lower sideslope of upland.
Slope and aspect: 12 to 25% southwest.
Parent material(s): Unit A of Chickamauga.
Vegetation: Old field succession pine and cedars.
Described by: Lietzke.
Date: March 21, 1988.

Soil Description

Oi 4 to 0 cm; leaves and needles.

A 0 to 4 cm; very dark brown (10YR 3/3) silt loam; moderate fine granular structure; very friable; common fine roots; 10 to 15% chert fragments; clear wavy boundary.

Ap 4 to 12 cm; yellowish brown (10YR 5/4) cherty silt loam; weak medium granular structure; friable; common medium and fine roots; 15 to 20% chert fragments; abrupt wavy boundary.

Bt 12 to 35 cm; yellowish red (5YR 5/8) clay; moderate medium subangular blocky structure; firm; peds coated with strong brown (7.5YR 5/6) clay; few fine roots; 10 to 15% chert fragments; clear wavy boundary.

BC 35 to 60 cm; yellowish red (5YR 5/8) silty clay loam; weak coarse subangular blocky structure; very firm; peds coated with thick strong brown (7.5YR 5/6) clay; brownish yellow (10YR 6/8) saprolite colors in ped interiors; few fine roots; 10 to 15% chert fragments; gradual wavy boundary.

CB 60 to 104 cm; red (2.5YR 4/8) and brownish yellow (10YR 6/8) saprolite that easily crushes to silty clay; very firm; strong brown (7.5YR 5/6) clay flows in cracks and pores; few fine roots; less than 10% chert fragments; gradual wavy boundary.

C 104 to 122 cm; brownish yellow (10YR 6/8) and red (2.5YR 4/8) saprolite that easily crushes to silty clay or silty clay loam; very firm; light gray (10YR 7/2) vertical flow zones; yellowish red (5YR 5/8) and strong brown (7.5YR 5/6) clay plugged areas; few fine roots; less than 5% chert fragments; abrupt wavy boundary.

Cr 122 cm; hard oxidized and partially leached limestone; pH 7.8 at contact.

Note: In-place chert layer at 104 cm, which perches water above it. Upper part of Bt has thin B/E horizon.

Soil series no.: 88D3.

Location: ORR. Transect parallel to Route 95 from corner of Bethel Valley Road on east side.
Classification: Typic Hapludalfs; fine, mixed, thermic.
Geomorphic position: Upland sideslope.
Slope and aspect: 12 to 15% slopes.
Parent material(s): Residuum from lower part of Unit B Chickamauga.
Vegetation: Pines and cedars of severely eroded old field succession.
Described by: Lietzke.
Date: March 21, 1988.

Soil Description

Oi 2 to 0 cm; leaf litter, pine needles, and moss.

A 0 to 4 cm; black (10YR 2/1) cherty silt loam; strong fine granular structure; very friable; common fine and medium roots; 15 to 20% chert fragments from slopes above; abrupt wavy boundary.

Bt 4 to 36 cm; dark red (2.5YR 3/6) clay; strong medium angular blocky structure; very firm; few medium roots; no fragments; clear wavy boundary.

C 36 to 68 cm; reddish brown (2.5YR 4/4) saprolite that easily crushes to silty clay loam; firm; few fine roots; clear wavy boundary.

Cr 68 to 75 cm; reddish brown (2.5YR 4/4) saprolite that crushes to silt loam; firm with very firm areas.

Soil series no.: 80.

Location: ORR. Corner of Bethel Valley Road and Route No. 95 and then north parallel to Route 95 on east side of road.
Classification: Lithic and (Paralithic) Hapludalfs; fine, mixed, thermic. (Solway?)
Geomorphic position: Upland sideslope.
Slope and aspect: 5 to 12% southeast.
Parent material(s): Residuum of upper Unit B Chickamauga.

Vegetation: Severely eroded old field succession of pines, cedars, and hardwoods.
Described by: Lietzke.
Date: March 21, 1988

Soil Description

Oi 2 to 0 cm; leaf litter.

A 0 to 6 cm; dark reddish brown (5YR 2/2) silt loam; strong fine granular structure; very friable; many fine roots; less than 5% fragments; clear wavy boundary.

Bt 6 to 28 cm; dark reddish brown (2.5YR 3/4) clay; strong medium and coarse subangular blocky structure; friable; dark reddish brown (5YR 3/3) ped coatings; common fine and medium roots; less than 5% fragments; abrupt inclined boundary.

R 28 cm; reddish limestone with interbedded oxidized and partially leached paralithic shale.

Soil series no.: 81.

Location: ORR. Corner of Bethel Valley road and Route 95, about 50 ft from pit for No. 87 soil.
Classification: Lithic Hapludalfs; fine, mixed, thermic in eroded areas; and Lithic Argiudolls in uneroded areas.
Geomorphic position: Upland shoulder and sideslope on north side of No. 87 elongated knobs.
Slope and aspect: 20 to 25% north.
Parent material(s): Unit C of Chickamauga.
Vegetation: Pines, cedars, and hardwoods typical of old field succession.
Described by: Lietzke.
Date: March 21, 1988.

Soil Description

Oi 4 to 0 cm; leaf litter and needles.

A 0 to 6 cm; very dark brown (10YR 2/2) silty clay loam; strong fine granular structure; very friable; common fine and medium roots; 5 to 10% lag chert from Unit D; clear wavy boundary.

Bt1 6 to 18 cm; yellowish brown (10YR 5/6) clay; moderate medium subangular blocky structure; very firm; common fine and medium roots; few limestone fragments; clear wavy boundary.

Bt2 18 to 38 cm; light olive brown (2.5Y 5/6) clay; moderate medium subangular blocky structure; very firm; brown (10YR 5/3) ped coatings; few fine and medium roots; few limestone fragments; abrupt irregular and inclined boundary.

R 38 cm; grayish limestone. Depth to rock varies from less than 10 cm to about 50 cm within small pit.

Soil series no.: 87.

Location: ORR. Corner of Bethel Valley and Route 95.
Classification: Typic Paleudults; clayey, mixed, thermic.
Geomorphic position: Upland upper sideslope.
Slope and aspect: 5 to 12% southwest.
Parent material(s): Unit D residuum of Chickamauga.
Vegetation: Old field successional pines.
Described by: Lietzke.
Sampled by: Lietzke and Timpson.
Date: March 21, 1988.

Soil Description

Oi 4 to 0 cm; leaf litter and pine needles.

E 0 to 7 cm; grayish brown (10YR 5/2) very cherty silt loam; very friable; common fine roots; many pores; 50 to 60% chert fragments; clear wavy boundary.

E/B 7 to 20 cm; light yellowish brown (10YR 6/4) E part and strong brown (7.5YR 5/6) B part; very cherty silt loam; weak fine subangular blocky structure; very friable; common fine and medium roots; many pores; 35 to 50% chert fragments; abrupt wavy boundary. (Base of old plow layer.)

Bt1 20 to 58 cm; red (2.5YR 4/8) silty clay loam; moderate medium subangular blocky structure; friable; few brownish yellow remnant saprolite colors in ped interiors; peds coated with red (2.5YR 4/6) clay; few fine and medium roots; 5 to 10% chert fragments; gradual wavy boundary.

Bt2 58 to 91 cm; yellowish brown (10YR 5/6) ped interiors with thick red (2.5YR 4/8) clay films; silty clay loam or silty clay; moderate medium subangular blocky structure; firm; few fine roots; many pores; 5 to 10% chert fragments; diffuse wavy boundary.

BC1 91 to 158 cm; mixed olive yellow (2.5Y 6/6) and light yellowish brown (2.5Y 6/4) matrix with red (2.5YR 4/8) streaks; silty clay loam or silty clay; moderate medium and coarse subangular blocky structure; firm; thin red (2.5YR 4/8) clay films on most ped faces; few fine roots; many pores; 10 to 15% chert fragments; diffuse wavy boundary.

BC2 158 to 207 cm; mixed olive yellow (2.5Y 6/6) and red (2.5YR 4/8); cherty silty clay loam or silty clay; moderate coarse parting to medium subangular blocky structure; firm; thin yellowish red (5YR 5/8) clay films on most ped faces; few fine roots; many pores; 25 to 35% oriented chert fragments; diffuse wavy boundary.

CB1 207 to 280 cm; mixed olive yellow (2.5Y 6/6) and red (2.5YR 4/8); cherty silty clay loam; weak coarse subangular blocky structure; very firm; thin yellowish red (5YR 5/8) clay films on some ped faces; light gray (10YR 7/2) in flow zone streaks; few fine roots; many tubular pores to about 260 cm; 15 to 25% oriented chert fragments; diffuse wavy boundary (bottom of pit).

C1 280 to 310 cm; mixed red (2.5YR 4/8) and yellowish red (5YR 5/6) saprolite that easily crushes to silty clay or silty clay loam; very firm; thin yellowish red (5YR 5/8) clay in some faces and in pores; light gray (10YR 7/2) identifying flow zones in the saprolite; 10 to 15% chert fragments (augered).

Note: BC1 was subdivided into BC11 (91 to 124 cm) and BC12 (124 to 158 cm) for sampling purposes.

Stop 2. Chickamauga Unit A Colluvial and Residual Soils

Soil series no.: 75 Inclusion.

Location: ORR. Chestnut Ridge Transect. First pit north of Bethel Valley Road along telephone line.
Classification: Typic Hapludults; loamy-skeletal, siliceous, thermic.
Geomorphic position: Upland shoulder and upper sideslope.
Slope and aspect: 20-25% southwest.
Parent material(s): Chert bed in upper Unit A of Chickamauga.
Vegetation: Chestnut oak.
Described by: Lietzke.
Date: March 21, 1988.

Soil Description

Oi 4 to 0 cm; leaves, needles and root mat.

A 0 to 14 cm; very dark grayish brown (10YR 3/2) extremely cherty silt loam; moderate fine granular structure; very friable; many fine roots; 75 to 85% chert fragments; clear wavy boundary.

E 14 to 40 cm; grayish brown (10YR 5/2) extremely cherty silt loam; weak fine granular structure; very friable; many fine and medium roots; 70 to 80% chert fragments; clear wavy boundary.

Bt 40 to 85 cm; brown (10YR 5/3) and yellowish brown (10YR 5/4) extremely cherty silt loam or silty clay loam; clay bridging between chert fragments; few fine roots; 85 to 90% chert fragments; abrupt irregular boundary.

C or CR 85 to 100 cm; open rubble of chert; highly fractured; fractures probably filled with calcium carbonate at one time.

Soil series no.: 69 (541).

Location: ORR. Chestnut Ridge Transect. Second pit north of Bethel Valley Road.
Classification: Typic or Ultic Hapludalfs (Fragihapludalfs); loamy-skeletal, siliceous, thermic.
Geomorphic position: Old gully fill on upland sideslope.
Slope and aspect: 12 to 25% southwest.
Parent material(s): Colluvium from Unit A of Chickamauga.
Vegetation: Edge of woods with pines and oaks and a few poplars.
Described by: Lietzke.
Sampled by: Lietzke and Timpson.
Date: March 22, 1988.

Soil Description

Oi	4 to 0 cm; leaf litter and root mat.
A	0 to 2 cm; very dark grayish brown (10YR 3/2) extremely cherty silt loam; moderate fine granular structure; very friable; many fine and medium roots; 60 to 70% chert fragments; clear wavy boundary.
E1	2 to 23 cm; brown (10YR 5/3) very cherty silt loam; weak fine granular structure; very friable; many fine and medium roots; 45 to 50% chert fragments; gradual wavy boundary.
E2	23 to 40 cm; pale brown (10YR 6/3) very cherty silt loam; weak fine granular structure; very friable; many fine and medium roots; 40 to 45% chert fragments; gradual wavy boundary.
Bt1	40 to 80 cm; strong brown (7.5YR 4/6) very cherty silty clay loam; moderate fine subangular blocky structure; friable; common fine roots; 40 to 50% chert fragments; gradual wavy boundary.
Bt2(x)	80 to 110 cm; strong brown (7.5YR 4/6) extremely cherty silty clay loam; moderate fine subangular blocky structure; friable but with about 40% firm and brittle areas; brown (7.5YR 4/4) clay on ped faces, fragment surfaces, and bridging between fragments; light yellowish brown (10YR 6/4) skeletans as vertical streaks; common fine roots; 40 to 50% chert fragments; abrupt wavy boundary.
2Bt3	110 to 129 cm; dusky red (10R 3/3) clay; moderate medium prismatic structure; very firm; few fine roots less than 5% chert fragments; clear wavy boundary.
2BC	129 to 170 cm; reddish black (10R 2/1) to very dusky red (10R 2/2) clay; weak coarse prismatic structure; very firm; few fine roots, no fragments; abrupt wavy boundary (base of stratum).
2CB	170 to 189 cm; strong brown (7.5YR 4/6) and dusky red (10R 3/2) saprolite that easily crushes to clay; very firm; few fine roots; pH 6.4; no fragments; abrupt wavy boundary.
2C1	189 to 220 cm; olive brown (2.5Y 4/4) saprolite that easily crushes to clay; very firm; few fine roots; no fragments; abrupt wavy boundary.
2C2	220 to 248 cm; weak red (2.5YR 4/2) saprolite with olive yellow and dusky red streaks that easily crushes to clay; very firm; few fine roots; no fragments.

2Cr 248 to 252 cm; dark reddish gray hard oxidized and partially leached saprolite; slight effervescence with acid.

Note: The pit cuts across an old colluvium filled gully. Thickness of colluvium ranges from 50 cm to about 130 cm around pit.

Soil series no.: 75D.

Location: ORR. Chestnut Ridge Transect. Third pit north of Bethel Valley Road.
Classification: Typic Hapludalfs; fine, mixed, thermic.
Geomorphic position: Upland mid-sideslope
Slope and aspect: 12 to 25% southwest.
Parent material(s): Unit A of Chickamauga.
Vegetation: Oaks and white pine.
Described by: Lietzke.
Sampled by: Lietzke and Timpson.
Date: March 22, 1988.

Soil Description

Oi 5 to 0 cm; leaf litter.

A 0 to 15 cm; dark brown (10YR 3/3) cherty silt loam; strong fine granular structure; very friable; many fine and medium roots; 15 to 25% chert fragments; clear wavy boundary.

E 15 to 23 cm; brown (7.5YR 5/4) cherty silt loam; moderate fine granular structure; very friable; common medium roots; 15 to 25% chert fragments; clear wavy boundary.

B/E 23 to 44 cm; strong brown (7.5YR 5/6) B part and light brown (7.5YR 6/4) E part; cherty silty clay loam; moderate fine subangular blocky structure; very friable; common medium roots; 15 to 20% chert fragments; clear wavy boundary.

Bt1 44 to 80 cm; red (2.5YR 4/6) silty clay loam; strong coarse subangular blocky parting to strong medium and fine subangular blocky structure; friable; light brown (7.5YR 6/4) skeletans along some primary ped faces in upper part; common fine and medium roots; 10 to 15% chert fragments; clear wavy boundary.

Bt2 80 to 98 cm; dark reddish brown (2.5YR 3/4) clay; strong coarse prismatic parting to moderate coarse subangular blocky structure; very firm; light brown (7.5YR 6/4) pressure faces on prisms; black manganese specks in ped interiors; few fine and medium roots; 5 to 10% oriented chert fragments; clear wavy boundary.

BC 98 to 120 cm; dusky red (10R 3/2) clay; weak medium prismatic structure; very firm; few fine roots; no fragments; abrupt wavy boundary.

CB 120 to 150 cm; dark reddish brown (5YR 3/4) saprolite that easily crushes to clay; very firm; many tubular pores; few fine roots; no fragments; gradual wavy boundary.

C 150 to 158 cm; reddish brown (5YR 4/3) saprolite that easily crushes to clay; very firm; few fine roots; common tubular pores; abrupt wavy boundary.

R 158 cm; light gray and maroon limestone.

Note: Depth to rock in pit is 96 to 150 cm in pedon and highly irregular. Lower part of pit has colluvium over residuum (No. 541). Some areas in the pit have a thin Cr horizon over rock.

Stop 3. Geomorphology Study Site

Soil series no.: 62-63.

Location: ORR. Chestnut Ridge Transect. Pit at intersection of Gas Line Road and telephone line.
Classification: Typic Paleudults; clayey or clayey-skeletal, kaolinitic, thermic.
Geomorphic position: Upland crest of middle ridge of Chestnut Ridge. (ancient lower-side slope before topographic inversion in late Tertiary or early Pleistocene.
Slope and aspect: 12 to 25% west.
Parent material(s): Uppermost Chepultepec and lowermost Longview fragmented residuum.
Vegetation: Oaks.
Described by: Lietzke.
Sampled by: Lietzke, Ammons, and Timpson.
Date: March 22, 1988.

Soil Description

Oi 5 to 0 cm; leaf litter and root mat.

A 0 to 4 cm; very dark grayish brown (10YR 3/2) extremely cherty silt loam; moderate fine granular structure; very friable; many fine and medium roots; 50 to 60% chert fragments; clear wavy boundary.

E 4 to 28 cm; very pale brown (10YR 7/4) very cherty silt loam; weak fine granular structure; very friable; common fine and medium roots; 35 to 50% chert fragments; clear wavy boundary.

Bt1 28 to 56 cm; yellowish red (5YR 5/8) very cherty clay or very cherty clay loam; moderate medium subangular blocky structure; firm; yellowish red (5YR 5/8) clay films on ped faces; common fine and medium roots; 30 to 40% chert fragments; gradual wavy boundary.

Bt2 56 to 160 cm; mottled red (10R 4/8) and brownish yellow (10YR 6/8) very cherty clay; weak coarse subangular blocky structure; very firm; yellowish red (5YR 5/8) clay films on ped faces; few fine roots; 35 to 45% chert fragments; gradual wavy boundary. (Most of the primary soil colors are inherited from the saprolite.)

Bt3 160 to 200 cm; mottled red (10R 4/8) and brownish yellow (10YR 6/8) and relict light gray (10YR 7/2) flow zones; very cherty clay; weak coarse subangular blocky structure; very firm; yellowish brown (10YR 5/8) clay films on ped faces and coating light gray areas; few fine roots; 35 to 45% chert fragments; gradual wavy boundary. (Most of the primary soil colors are inherited from saprolite colors.)

Note: The Bt2 was subdivided for sampling purposes into three sections and labeled as follows: Bt21 56 to 92 cm, Bt22 (92 to 130 cm), and Bt23 (130 to 160 cm).

Soil series no.: Sinkhole Pit.

Location: ORR. Chestnut Ridge Transect. Intersection of Gas Line Road and telephone line. First pit south of intersection.
Classification: Typic Hapludults; fine-silty, mixed or siliceous, thermic. Geomorphic position: Bottom of partially breached upland karst depression
Slope and aspect: 2 to 5% south.
Parent material(s): Loess over ancient cherty paleosol.
Vegetation: Hardwoods.
Described by: Lietzke.
Date: April 22, 1988.

Soil Description

Oi 5 to 0 cm; leaf litter and root mat.

C 0 to 10 cm; yellowish red (5YR 4/6) cherty clay loam; moderate fine granular structure; very friable; common fine and medium roots; many pores; 15 to 25% chert fragments; abrupt wavy boundary. (Overwash from pipeline construction.)

A 10 to 20 cm; olive brown (2.5Y 4/3) silt loam; weak fine granular structure; very friable; common fine and medium roots; many pores; 5 to 10% chert fragments; clear wavy boundary.

E 20 to 33 cm; light olive brown (2.5Y 5/4) silt loam; weak medium subangular blocky structure; very friable; common fine and medium roots; many pores; less than 5% chert fragments; clear wavy boundary.

Bt1 33 to 67 cm; light olive brown (2.5Y 5/6) silt loam or silty clay loam; moderate medium subangular blocky structure; very friable; common fine and medium roots; many pores; less than 5% chert fragments; clear wavy boundary. (Base of loess.)

Bt2 67 to 79 cm; mixed light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/4) cherty silty clay loam; weak medium subangular blocky structure; friable; few fine roots; common pores; 15 to 25% chert fragments; gradual wavy boundary. (Mixed zone.)

Agb 79 to 90 cm; light brownish gray (2.5Y 6/2) cherty silt loam or cherty silty clay loam; weak medium subangular blocky structure; friable; few fine roots; common pores; 25 to 35% chert fragments; gradual wavy boundary. (Old A horizon.)

Egb 90 to 104 cm; light brownish gray (2.5Y 6/2) very cherty silt loam or very cherty silty clay loam; weak medium subangular blocky structure; friable; few light olive brown (2.5Y 5/6) drainage mottles; few fine roots; common pores; 30 to 50% chert fragments; gradual wavy boundary.

Btgb 104 to 115 cm; light brownish gray (2.5Y 6/2) extremely cherty silty clay loam; weak medium subangular blocky structure tending towards massive; very firm; cracks, ped faces, and pores coated with yellowish brown (10YR 5/8) and strong brown (7.5YR 4/6) iron plasma; few fine roots; few pores; greater than 50% chert fragments.

Note: Standing water in pit at 115 cm, probably perched.
Parent materials are recent subsoil overwash, thin cherty slope wash (A horizon) over loess over cherty slope wash over ancient cherty paleosol (similar to the ancient cherty paleosol in the next pit to the south).

Soil series no.: 722.

Location: ORR. Chestnut Ridge Transect. Pit No. 5 from Bethel Valley Road.
Classification: Typic Paleudults; loamy-skeletal, siliceous, thermic.
Geomorphic position: Upland crest of broad ridge into which a depression has formed. Ancient toeslope colluvium.
Slope and aspect: 12 to 25% southwest.
Parent material(s): Ancient Tertiary colluvium over lowermost Newala residuum. Considerable chert in upper profile is dolomoldic.
Vegetation: Pines, oaks, with scattered poplar.
Described by: Lietzke.
Sampled by: Lietzke and Timpson
Date: March 22, 1988

Soil Description

Oi 4 to 0 cm; leaf litter and root mat.

A 0 to 6 cm; dark grayish brown (2.5YR 4/2) extremely cherty silt loam; moderate fine granular structure; very friable; many fine and medium roots; many pores; 60 to 75% chert fragments; clear wavy boundary.

E1 6 to 20 cm; brown (10YR 5/3) very cherty silt loam; weak fine granular structure; very friable; common fine and medium roots; many pores; 40 to 50% chert fragments; gradual wavy boundary.

E2 20 to 60 cm; yellowish brown (10YR 5/4) very cherty silt loam; weak fine subangular blocky structure; very friable; few fine and medium roots; many medium and large pores; gradual wavy boundary.

Bt 60 to 170 cm; strong brown (7.5YR 5/6) extremely cherty silty clay loam; weak medium subangular blocky structure; friable; clay bridging between fragments and some brittle areas with pale brown (10YR 6/3) skeletans; few fine roots; many large and medium pores from ants, termites and roots; 65 to 75% chert fragments; clear wavy boundary.

2E 170 to 180 cm; strong brown (7.5YR 5/8) very coarse sandy loam; massive; very friable; some clay bridging between fragments; few fine roots; many pores; 90% chert fragments (2 to 10 mm); abrupt irregular boundary.

2Bt 180 to 210 cm; red (2.5YR 4/8) very cherty clay with brownish yellow (10YR 6/8) mottles; moderate medium subangular blocky structure; very firm; few fine roots; 35 to 50% chert fragments. (Large fragments prevented deeper investigation.)

Note: Bt horizon subdivided into Bt1 (60 to 110 cm) and Bt2 (110 to 170 cm) for sampling purposes. Part of Bt is fragic. Part of pedon consists of old groundhog hole? Old stump filling is also present in part of pit wall, which was once a termite or ant colony given the large open pores. Most chert in colluvium is from the Copper Ridge, Chepultepec and Longview formations. Chert is mostly highly weathered and can be easily broken without too much effort. Many chert faces are coated with red iron plasma. Iron plasma has penetrated oolitic chert. These soils were mapped only on broad upland ridges. Areas of these soils in Anderson County were probably mapped as "Bodine."

Soil series no.: 68.

Location: ORR. Chestnut Ridge Transect. Pit No. 4 from Bethel Valley Road.
Classification: Typic Paleudults; loamy-skeletal or clayey-skeletal or clayey, siliceous or kaolinitic, thermic.
Geomorphic Position: Upland upper sideslope (once lower sideslope of ancient Tertiary landform before Pleistocene topographic inversion).
Slope and aspect: 12 to 25% southwest.
Parent material(s): Thin ancient colluvium over lowermost Newala residuum.
Vegetation: Pines and chestnut oak with sourwood and black gum.
Described by: Lietzke.
Sampled by: Lietzke and Timpson.
Date: March 22, 1988.

Soil Description

Oi 5 to 0 cm; leaf litter and root mat with less than 2-cm A horizon.

E1 0 to 15 cm; grayish brown (2.5YR 5/2) very cherty silt loam; weak fine granular structure; very friable; common medium and fine roots; 40 to 50% chert fragments; gradual wavy boundary. (2-cm-thick A horizon is included.)

E2 15 to 43 cm; light yellowish brown (2.5YR 6/4) very cherty silt loam; weak fine granular structure; very friable; few medium and fine roots; 30 to 40% chert fragments; gradual wavy boundary.

B/E 43 to 74 cm; strong brown (7.5YR 5/8) B part and brownish yellow (10YR 6/6) E part; cherty silty clay loam; moderate fine subangular blocky structure; very friable; few fine and medium roots; 30 to 40% chert fragments; gradual wavy boundary.

Bt1 74 to 130 cm; red (2.5YR 4/8) with brownish yellow (10YR 6/8) saprolite colors increasing in the lower part; cherty clay; moderate medium and fine subangular blocky structure; firm; yellowish red (5YR 5/8) clay films on ped faces; few fine roots; 30 to 40% chert fragments; gradual wavy boundary.

Bt2 130 to 170 cm; red (2.5YR 4/6 and brownish yellow (10YR 6/8) saprolite colors; cherty clay; moderate medium subangular blocky structure; very firm; yellowish red (5YR 5/8) clay films on ped faces; few fine roots; 30 to 40% chert fragments; gradual wavy boundary.

Bt3 170 to 180 cm; brownish yellow (10YR 6/8) and red (2.5YR 4/6) saprolite colors; cherty clay; weak medium subangular blocky structure; very firm; yellowish red (5YR 5/8) clay films on ped faces; few fine roots; 30 to 40% chert fragments. Large chert fragments precluded deeper investigation.

Note: The Bt1 horizon was subdivided into two sections for sampling purposes. Bt11 (74 to 94 cm) and Bt12 (94 to 130 cm). This soil contains much oolitic chert which is highly weathered and quite soft. Most chert in the lower Newala is soft and can be cut with a spade or broken by a barrel auger.

Stop 4. Chepultepec Residual and Colluvial Soils

Soil series no.: 62E.

Location: ORR. Chestnut Ridge Transect. Second pit north of Gas Line Road and telephone line intersection.
Classification: Typic Hapludults; clayey, mixed, thermic.
Geomorphic position: Upland mid sideslope.
Slope and aspect: 25 to 45% west-northwest.
Parent material(s): Chepultepec residuum.
Vegetation: Chestnut, red and white oak.
Described by: Lietzke.
Sampled by: Lietzke, Ammons and Timpson.
Date: March 23, 1988

Soil Description

Oi 5 to 0 cm; leaf litter and root mat.

E 0 to 17 cm; pale olive (5YR 6/3) cherty loam; weak fine granular structure; very friable; many fine and medium roots; many pores; 15 to 25% chert fragments; gradual wavy boundary.

E/B 17 to 40 cm; olive yellow (2.5YR 6/6) E part and yellowish brown (10YR 5/6) B part; cherty loam; weak fine granular structure; very friable; many fine and medium roots; many pores; 15 to 25% chert fragments; gradual wavy boundary. (Lower boundary contains B/E horizon.)

Bt1 40 to 69 cm; yellowish red (5YR 5/8) clay or clay loam; moderate fine subangular blocky structure; friable; common medium and fine roots; many pores; 5 to 10% chert fragments; gradual wavy boundary.

Bt2 69 to 99 cm; yellowish red (5YR 5/8) with red (2.5YR 4/8) and yellowish brown (10YR 5/6) saprolite colors; clay or clay loam; moderate fine subangular blocky structure; firm; yellowish red (5YR 5/8) clay films on all ped faces; common medium and fine roots; many pores; 5 to 10% chert fragments; gradual wavy boundary.

BC 99 to 139 cm; brownish yellow (10YR 6/6) and red (2.5YR 4/8) saprolite colors; clay or clay loam; weak coarse subangular and angular blocky structure; very firm; red (2.5YR 4/8) clay films on many ped faces and coating large pores; few fine roots; many pores; 5 to 10% chert fragments; gradual wavy boundary.

CB 139 to 187 cm; yellowish brown (10YR 5/8) saprolite that easily crushes to silty clay loam; angular blocks from fractured saprolite; very firm; strong brown (7.5YR 5/6) clay flows on most faces; water flow zones with light gray (10YR 7/1) interiors and olive yellow (2.5Y 6/8) exteriors; few fine roots; many pores; clear wavy boundary.

C1 187 to 231 cm; strong brown (7.5YR 5/6) and brownish yellow (10YR 6/8) saprolite that easily crushes to silty clay loam; angular blocks from fractured saprolite; very firm; yellowish red (5YR 5/8) clay flows on some faces; red (2.5YR 4/8) iron plasma in pores and coating some faces; few fine roots; many pores; fewer than 5% chert fragments; clear wavy boundary. (Manganese concentration zone marks base of horizon.)

C2 231 to 276 cm; yellowish red (5YR 5/6) and brownish yellow (10YR 6/8) multicolored saprolite with thin strata of disoriented highly weathered grayish and reddish very fine-grained sandstone that crushes to silty clay loam; very firm; water flow zones with light gray (10YR 7/2) interiors and yellowish iron depleted exteriors; few fine roots; common to many manganese concentrate bodies; fewer than 5% chert fragments;

Soil series no.: 69 (shallow) hillside phase.

Location: ORR. Chestnut Ridge Transect. Pit No. 9 from Bethel Valley Road. Third pit north of Gas Line Road and telephone line intersection.
Classification: Typic Paleudults; loamy-skeletal, siliceous, thermic.
Geomorphic position: Upland sideslope below structural bench.
Slope and Aspect: 12 to 25% northwest.
Parent Material(s): Colluvium over Chepultepec residuum.
Vegetation: Red maple, a few tulip poplars; and red and white oak.
Described by: Lietzke.
Sampled by: Lietzke, Ammons, and Timpson.
Date: March 23, 1988.

Soil Description

Oi/A 10 to 0 cm; leaf litter and root mat along with a very thin A horizon less than 2 cm thick.

E1 0 to 10 cm; pale olive (5YR 6/3) cherty silt loam; weak fine granular structure; very friable; many fine roots and pores; 15 to 20% chert fragments; gradual wavy boundary.

E2 10 to 26 cm; pale olive (5YR 6/4) cherty silt loam; weak fine granular structure; very friable; common fine and medium roots; many pores; 15 to 25% chert fragments with a gradual increase in fragment content in the lower part; gradual wavy boundary.

2E3 26 to 44 cm; light yellowish brown (2.5YR 6/4) very cherty silt loam; moderate fine subangular blocky structure; very friable; few fine roots; many pores; 40 to 50% chert fragments; gradual wavy boundary.

2Bt(x) 44 to 66 cm; yellowish brown (10YR 5/6) extremely cherty silty clay loam; weak fine subangular blocky structure; firm with very firm brittle areas; few fine roots; many pores; 50 to 60% chert fragments; abrupt wavy boundary.

3Bt1 66 to 120 cm; yellowish red (5YR 5/8) and red (2.5YR 4/8) very cherty silty clay loam or clay; moderate medium subangular blocky structure; firm; pink (7.5YR 7/4) streaks of E material in the upper part; strong brown (7.5YR 5/6) clay films on most ped faces and some dark red iron plasma in pores; few fine roots; many pores; 35 to 40% chert fragments; gradual wavy boundary.

3Bt2 120 to 148 cm; red (2.5YR 4/8) and brownish yellow (10YR 6/8) clay; weak medium and coarse subangular blocky structure; very firm; yellowish red (5YR 5/8) clay films on most ped faces, and some dark red iron plasma in pores; light gray (10YR 7/1-7/2) water flow streaks; few fine roots; many pores; fewer than 15% chert fragments; gradual wavy boundary.

3BC 148 to 184 cm; brownish yellow (10YR 6/6 and 6/8) with red (2.5YR 4/8) areas; silty clay or silty clay loam saprolite; angular blocks; very firm; yellowish red (5YR 5/8) clay films on most block faces; light gray (10YR 7/1-7/2) water flow streaks; few fine roots; many pores; fewer than 15% chert fragments; gradual wavy boundary.

3CB 184 to 203 cm; brownish yellow (10YR 6/8) and red (2.5YR 4/8) silty clay loam saprolite; angular blocks; very firm; yellowish red (5YR 5/8) clay films on many block faces; olive yellow (2.5Y 6/6) water flow streaks; white bodies from soft chert and some black manganese concentrates; few fine roots; common pores; less than 15% chert fragments; gradual wavy boundary.

Stop 5. Pleistocene Alluvial Soil

Soil series no.: 94-Knox. Sampled

Location: ORR. Chestnut Ridge Transect. Second pit south of Bear Creek Road.
Classification: Typic Hapludults; fine-loamy, siliceous, thermic.
Geomorphic position: Toeslope with terrace alluvium covering extremely cherty colluvium.
Slope and aspect: 5 to 12% north.
Parent material(s): Pleistocene alluvium over gray cherty colluvial paleosol.
Vegetation: Hardwoods.
Described and sampled by: Lietzke, Ammons, and Timpson.
Date: March 29, 1988.

Soil Description

Oi 2 to 0 cm; leaf litter.

Ap 0 to 30 cm; brown (10YR 4/3) cherty loam; moderate fine granular structure; very friable; many medium and fine roots; many pores; 15 to 20% chert fragments; abrupt wavy boundary.

BE 30 to 44 cm; strong brown (7.5YR 5/6) loam; moderate medium subangular blocky structure; very friable; many pores; common medium and fine roots; 10 to 15% chert fragments; clear wavy boundary.

Bt1 44 to 80 cm; yellowish red (5YR 5/6) heavy loam; moderate medium subangular blocky structure; very friable; thin patchy strong brown (7.5YR 5/6) clay films on ped faces; many pores; few fine roots; 5 to 10% chert fragments; clear wavy boundary.

Bt2 80 to 114 cm; yellowish red (5YR 5/6) loam; moderate fine and medium subangular blocky structure; very friable; thin patchy strong brown (7.5YR 5/6) clay films on ped faces; red (2.5YR 4/6) iron plasma on some ped faces in lower part; many pores; few fine roots; 5 to 10% chert fragments; abrupt wavy boundary. Gravel bed at base of horizon. (Base of slack water alluvium.)

2BC 114 to 150 cm; yellowish red (5YR 5/6) and red (2.5YR 4/8) extremely gravelly clay loam; massive; firm; strong brown (7.5YR 5/6) clay plugging and bridging between gravels; no roots; 50 to 70% chert gravels; placic layer at lower boundary; abrupt wavy boundary. (Stream channel deposit.)

3Eg1 150 to 168 cm; light yellowish brown (2.5Y 6/4) silt loam with pale olive (5Y 6/3) mottles; massive; firm; strong brown (7.5YR .6) clay flows and pore fillings; 1 to 5% chert fragments; clear wavy boundary. (Old A horizon loess cap.)

3Eg2 168 to 186 cm; light yellowish brown (2.5Y 6/4) cherty silt loam with light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) mottles; massive; firm; strong brown (7.5YR 5.6) clay flows and pore fillings; 15 to 25% chert fragments; clear wavy boundary. (Base of old alluvium.)

4Eg3 186 to 203 cm; yellowish brown (10YR 5/4) extremely cherty silty clay loam; massive; very firm; pinkish gray (7.5YR 7/2) mottles; yellowish red (5YR 5/6) clay plasma coating cracks; black manganese bodies visible; more than 50% chert fragments; gradual wavy boundary. (Top of cherty coluvial paleosol.)

4Btg 203 to 230 cm; light gray (10YR 7/2) extremely cherty silty clay loam; massive; very firm; light yellowish brown (2.5Y 6/4) mottles; yellowish red (5YR 5/6) iron and clay plasma in flow zones and coating large cracks; manganese flecks in voids; more than 50% chert fragments.

Note: The following lists materials from oldest to youngest:
- old colluvium paleosol
- chert-free loess mantle
- stream channel alluvium (old stream channel cuts into cherty colluvium, channel fill becomes covered by slack water alluvium and is further backfilled by cherty alluvium
- slack water alluvium
- thin cherty colluvium from agricultural activities on the surface.

Stop 6. Lower Copper Ridge Soil

Soil series no.: 61

Location: ORR. Chestnut Ridge Transect. First pit south of Bear Creek Road
Classification: Typic Hapludalfs and Typic Hapludults; clayey, mixed, thermic.
Geomorphic position: Upland lower sideslope just above colluvium.
Slope and aspect: 12 to 25% west.
Parent Material(s): Dolomite from lower Copper Ridge Formation.
Vegetation: Cedars and pines.
Described and sampled by: Lietzke, Ammons, and Timpson.
Date: March 29, 1988.

Soil Description

Oi 4 to 0 cm; leaf litter.

Ap 0 to 22 cm; brown (10YR 4/3) cherty silt loam; strong fine granular structure; very friable; many fine and medium roots; many pores; 25 to 35% chert fragment lag gravel from higher slopes; abrupt wavy boundary.

E 22 to 47 cm; brown (7.5YR 5/4) cherty silt loam; moderate fine granular structure; very friable; common fine roots; many pores; 15 to 25% chert fragment lag gravel from higher slopes; clear wavy boundary.

B/E 47 to 63 cm; yellowish red (5YR 4/6) B part and strong brown (7.5YR 5/6) E part; very cherty silt loam or very cherty silty clay loam; moderate fine subangular blocky structure; friable; common fine roots; 35 to 45% lag chert fragments; many pores; clear wavy boundary.

Bt1 63 to 77 cm; red (2.5YR 4/8) silty clay loam; moderate medium and fine subangular blocky structure; friable; few fine roots; 5 to 15% chert fragments; many pores; gradual wavy boundary.

Bt2 77 to 109 cm; red (2.5YR 4/6) clay; strong medium and fine subangular and angular blocky structure with common pressure faces; friable; few fine roots; less than 5% chert fragments; many pores; gradual wavy boundary.

BC 109 to 185 cm; red (2.5YR 4/6) and yellowish red (5YR 5/8) silty clay or clay; strong fine angular blocky structure with many pressure faces; friable; few fine roots; less than 5% chert fragments; many pores; abrupt irregular boundary. (dolomite floaters occurred at 114 and 139 cm and at 180 to 190 cm. dark red (2.5YR 3/6) clay occurs in contact with the dolomite and extends out about 10 cm from the rock contact).

C&Cr 185 to 190 cm; pale brown (10YR 6/3) oxidized and partially leached dolomite pinnacles and ledges with red (2.5YR 4/6) and dark red (2.5YR 3/6) clay infillings; nonsticky; abrupt irregular boundary.

R 190 cm; hard but oxidized and slightly weathered dolomite.

Note: Depth to rock in the pit ranges from 25 cm to more than 200 cm, with outcrops immediately upslope from the pit.

Stop 7. Geomorphology and Landscape Overview

ORNL is located on the Chickamauga Group. The Unit B, composed of reddish shales, siltstones, and limestones, occurs at the intersection of Bethel Valley Road and the west entrance to ORNL. The hill about 200 ft north of Bethel Valley Road is underlain by the Unit A, composed of cherty limestones with interbedded maroon and dusky red shales. At the intersection of Bethel Valley Road and Reeves Road we turn left. Here the underlying rock is Unit B. The higher hills are Unit A. The substation is located of the uppermost Knox Group Newala Formation. As the road goes up the first steep hill, the soils are Paleudults of the Newala Formation. The bench landform at the top of this first hill contains a thin layer of cherty colluvium and the cherty residuum beneath. As the road starts up the second hill after going under the power lines, there are exposures of red and dark red ancient alluvium exposed in the ditch bank and gullies of the left side of the road and also on the right side of the road as it bears left around a curve. The entire cleared sideslope above the road contains ancient alluvium and toeslope (alluvium-cherty colluvium) soils. The broad crest of Chestnut Ridge at the intersection of substation road and gas line road is underlain by either residual or ancient colluvial soils. Chert fragments in this ancient colluvium are relatively soft, and most can be cut with a spade. Many are coated with iron oxide and the oolitic types are permeated with iron oxide.

At the crest of Chestnut Ridge, a view to the south shows Melton Hill underlain by the Knox Copper Ridge Formation with Conasauga soils at its base. The intervening ridge, Haw Ridge, is underlain by the Rome Formation. A major fault (Copper Creek fault) occurs on the south side of Haw Ridge, marking the surface location where faulting thrust the Rome Formation over much younger Chickamauga rocks. The Chickamauga Group extends to about the crest of the southernmost ridge of Chestnut Ridge, where there is an erosion surface discontinuity that separates it from the Knox Group. The middle ridge of Chestnut Ridge is held up mostly by the high chert content Longview Formation. To the north on the sideslopes is the Chepultepec Formation. The north ridge of Chestnut Ridge is underlain by the Copper Ridge Formation. A road cut featuring a representative example of a Copper Ridge soil has been dressed down for viewing. Beyond the Copper Ridge soil exposure, the road cuts through ancient alluvium and colluvium identified by the dark surface color and deep red upper subsoil. The Knox merges with the Maynardville of the uppermost Conasauga Group between Bear Creek Road and Bear Creek. The low landforms beyond are underlain by the Nolichucky Formation. The Maryville Formation forms a low dissected ridge just beyond. The Rogersville Formation occurs on the obsequent sides of Maryville Formation hills and the Rutledge Limestone in a topographic low at the base. The Pumpkin Valley Formation forms the lower foothills of Pine Ridge. Pine Ridge is underlain by resistant sandstone of the uppermost Rome Formation. In the far distance on a clear day, the Cumberland Mountains are visible.

Stop 8. Copper Ridge Road Cut

Soil series no.: 60 (roadcut).

Location: ORR. Reeves Road cut below ridge crest where Gas Line Road and the power line intersect.
Classification: Typic Paleudults; clayey; kaolinitic, thermic.
Geomorphic position: Mid-upland sideslope.
Slope and aspect: 25 to 45% southeast.
Parent material(s): Copper Ridge residuum.
Vegetation: Cutover area under powerline.
Described by: Lietzke.
Date: April 22, 1988.

Soil Description

A 0 to 10 cm; brown (10YR 4/3) cherty silt loam; moderate fine granular structure; very friable; 15 to 25% chert fragments; few fine roots; clear wavy boundary.

E 10 to 22 cm; reddish yellow (7.5YR 6/6) very cherty silt loam; weak medium granular structure; very friable; 30 to 50% chert fragments; few fine roots; clear wavy boundary.

B/E 22 to 37 cm; red (2.5YR 4/8) very cherty clay B part, and strong brown (7.5YR 5/6) very cherty silty clay loam E part; moderate medium subangular blocky structure; friable; 30 to 40% chert fragments; few fine roots; gradual wavy boundary.

Bt1 37 to 57 cm; red (2.5YR 4/8) very cherty clay; moderate medium subangular blocky structure; firm; yellowish red (5YR 4/6) clay films on ped faces; 30 to 40% chert fragments; few fine roots; gradual wavy boundary.

Bt2 57 to 90 cm; red (2.5YR 4/8) cherty clay; moderate medium subangular blocky structure; firm; red (2.5YR 4/6) clay films on ped faces; 15 to 25% chert fragments; few fine roots; gradual wavy boundary.

Bt3 90 to 150 cm; red (2.5YR 4/8) clay; moderate medium subangular blocky structure; firm; red (2.5YR 4/6) clay films on ped faces; some olive yellow (2.5Y 6/8) saprolite colors; less than 15% chert fragments; few fine roots; gradual wavy boundary.

BC 150 to 200 cm; mixed red (2.5YR 4/8), yellowish brown (10YR 6/8) and olive yellow (2.5Y 6/8) clay; moderate medium subangular blocky structure; very firm; pale olive (5Y 6/3) water flow zone streaks with a goethite halo.

Note: The high chert content in the upper 57 cm is from lag gravel and pedoturbation. Typical Copper Ridge soil with very high lag chert content in A, E, and upper B horizons and little chert below. Chert content in the Copper Ridge on the ORR is highly variable, and its content in the family control section cannot be mapped.

Stop 9. Nolichucky Formation Soil (Table 2, Fig. 3)

Soil no.: 51B3.

Location: LLWDDD Site. E30230, N29250 Y-12 grid.
Pedon classification: Ruptic-Ultic (Ruptic-Aquultic) Dystrochrepts; loamy-skeletal, mixed, thermic.
Geomorphic position: Upper slightly convex sideslope of low hillside.
Slope: 4% with southeast aspect.
Parent material: Saprolite from claystone, siltstone and argillaceous limestone along with thin strata of very fine sandy loam.
Described by: Lambert, Lietzke and Jenkins. March 13, 1987
Date: March 13, 1987.

Note: Because of the ruptic nature of the soil, it was necessary to describe three profiles in order to encompass the "cyclic" variability of one pedon.

Soil Description

Argillic Part

Oi 2 to 0 cm; leaf litter.

Ap 0 to 18 cm; dark yellowish brown (10YR 4/4) shaly silt loam; moderate fine granular structure; very friable; many fine and medium roots between peds; many fine pores; pH 4.7; abrupt wavy boundary.

Bt 18 to 33 cm; mottled yellowish red (5YR 5/8), yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) silty clay; moderate medium subangular blocky structure; firm; common fine prominent brownish gray (10YR 6/2) mottles in ped interiors; many continuous and distinct brown (7.5YR 5/4) clay films on ped faces; few fine and medium roots between peds; common fine pores; pH 4.8; clear irregular boundary. (Argillic horizon part of pedon.)

BC 33 to 64 cm; strong brown (7.5YR 5/6) shaly silty clay loam; weak medium subangular blocky structure; firm; common medium prominent light brownish gray (2.5Y 6/2) mottles in ped interiors; many continuous distinct brown (7.5YR 5/4) clay films on ped faces and coating rock fragments; common discontinuous prominent red (2.5YR 4/6) iron stains on some ped faces; common fine and medium roots; few to common pores; pH 4.8; abrupt inclined boundary. (Thin sandstone strata are 10YR 6/8.)

C 64 to 71 cm; strong brown (7.5YR 5/6) very shaly silty clay loam; massive rock controlled structure; firm; common discontinuous faint brown (7.5YR 5/4) clay films on rock fragments; few fine roots in cracks; common fine pores; about 50% shale and siltstone fragments; pH 4.8; abrupt inclined boundary.

2CB 71 to 81 cm; yellowish red (5YR 5/6) silty clay; massive; firm; many discontinuous distinct brown (7.5YR 5/4) clay films on fracture and joint faces; few fine roots; few fine pores; pH 4.8; abrupt irregular inclined boundary. (Argillaceous limestone saprolite stratum sandwiched between shale and siltstone saprolite.)

3Cr 81 to 92 cm; oxidized and leached saprolite from siltstone and shale; fragment interiors are brown (7.5YR 5/6); common discontinuous prominent red (2.5YR 4/6) iron-clay films on fragment faces; light brownish gray (2.5Y 6/2) water flow zones.

4Cr2 92 to 100 cm; oxidized and leached saprolite from siltstone and claystone; fragment interiors are yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6); very firm; many discontinuous prominent red (10R 4/8) stains on fragment faces; few discontinuous distinct strong brown (7.5YR 4/6) clay coatings on fragment faces in flow zones; very few fine roots in flow zones; pH 4.8.

<u>Cambric Part</u> (Located about 1 m away from Argillic part)

O 2 to 0 cm; leaf litter; abrupt smooth boundary

Ap 0 to 20 cm; dark yellowish brown (10YR 4/4) silt loam; moderate fine granular structure; very friable; many fine roots throughout; many fine and medium tubular pores; pH 4.7; abrupt wavy boundary.

Bw 20 to 40 cm; brown (7.5YR 5/4) extremely shaly silty clay loam; weak medium subangular blocky structure; firm; many continuous faint brown (7.5YR 5/4) clay films on some ped faces and on most shale fragments; few fine roots; many pores; pH 4.8; clear irregular inclined boundary. (Cambic part of soil profile with less than 50% pedogenic structure.)

Cr 40 to 70 cm; oxidized and leached saprolite from claystone and siltstone; fragment interiors have (10R 4/8) iron coatings on some fragment faces; common discontinuous prominent black manganese coatings on other fragment faces; many discontinuous brown (7.5YR 5/4) clay films on other rock fragments in more permeable zones; water flow zones have gray (10YR 5/1) streaks; root mats continue down through gray areas; pH 4.8.

Ruptic Part (Located about 1 m away from Cambric part)

Ap 0 to 18 cm; Dark yellowish brown (10YR 4/4) shaly silt loam; weak fine granular structure; very friable; many fine and medium roots between peds; many fine pores; pH 4.7; abrupt wavy boundary.

Cr 18 to 30 cm; oxidized and leached saprolite from siltstone and claystone; fragment interiors are (10YR 5/6 or 7.5YR 5/6) rock-controlled structure; very firm; fragments coated with either brown (7.5YR 5/4) clay or black manganese coatings; few fine roots in cracks; pH 4.8; abrupt inclined boundary.

2Bt 30 to 66 cm; yellowish brown (10YR 5/6) silty clay loam; moderate coarse subangular blocky structure; firm; common fine prominent gray (10YR 6/1) mottles in ped interiors; ped exteriors are coated with continuous brown (7.5YR 5/4) clay; common fine and medium roots between peds; common fine and medium pores; pH 4.8; abrupt inclined boundary. (This horizon formed in saprolite from argillaceous limestone. This section was described just above the massive C horizon zone, which perched water into this Bt zone.)

3Cr 66 to 117 cm; oxidized and leached saprolite from siltstone and claystone; rock-controlled structure; very firm; many discontinuous prominent red (2.5YR 4/6) iron stains on some fragment faces; other fragments are partially coated by black manganese oxides; no clay films were noted on fragments. Water seems to flow in the unsaturated mode in this material. pH 4.9.

Table 2. Soil: Nolichucky Formation Soil (Ruptic-Ultic Dystrochrepts; loamy-skeletal, mixed, thermic) Soil No.: 51E

Depth cm	Horizon	Soil Particle Size: Total Sand (%)	Total Silt (%)	Total Clay (%)	Sand: VCOS (%)	COS (%)	MS (%)	FS (%)	VFS (%)	Silt: COSI (%)	FSI (%)	Coarse Frags. (%)	Atterberg Limits: Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Activity Ratio
0-18	Ap	17.3	58.0	24.7	4.1	2.7	1.3	3.0	6.2	29.2	28.8	13.1	35.9	24.9	11.0	0.44
18-150	Cr	38.4	28.8	32.8	20.1	10.3	2.9	3.0	2.1	9.5	19.3	95.0	-	-	-	-
150-250	2Cr	27.7	47.6	24.7	13.0	4.0	1.6	2.0	7.1	21.8	25.8	88.8	-	-	-	-
250+	3Cr (R)	28.1	45.2	26.7	9.3	11.6	2.2	2.7	2.3	26.8	18.4	96.2	-	-	-	-
250+	3Cr (Y)	32.1	42.5	25.4	14.3	5.0	1.4	2.6	8.8	20.5	22.0	94.7	-	-	-	-

Depth cm	Total Carbon (%)	Dithionite Extractable Fe (%)	Dithionite Extractable Mn (%)	Hydrox. Reduc. Mn ppm	Calcium Carbonate Equiv. (%)	Bulk Density ($g\ cm^{-3}$)	Particle Density ($g\ cm^{-3}$)	Total Porosity (%)	Available Water: 1/3 Bar (%)	15 Bar (%)	AWC ($cm\ cm^{-1}$)	AWC Profile cm
0-18	1.30	2.36	0.10	855	-	1.44	2.60	44.70	27.50	19.19	0.12	
18-150	0.08	2.62	0.18	1630	-	1.34	2.72	50.74	29.03	22.73	0.00	
150-250	0.10	2.26	0.08	131	-	1.55	2.72	43.16	32.91	20.31	0.02	
250+	0.25	2.35	0.11	1225	-	1.26	2.72	53.68	22.01	17.52	0.00	
250+	0.11	2.94	0.19	1595	-	1.26	2.72	53.68	38.21	21.02	0.01	2.2

Depth cm	pH (1:1) water	Extractable Bases: Ca (cmol(+)/kg)	Mg	K	Na	Sum	CEC	Base Saturation (%)	KCl Extractable: Al (cmol(+)/kg)	H	Acidity	Radionuclide Sorption Ratio: Co (L/kg)	Sr	Cs	Tc	U
0-18	4.70	1.12	0.44	0.27	0.02	1.85	15.30	12.1	5.2	0.7	5.9	7575	167	>10000	0.15	3604
18-150	4.81	0.16	0.84	0.36	0.05	1.41	22.40	6.3	12.0	0.7	12.7	1848	1995	>10000	-	3659
150-250	4.95	0.05	0.56	0.23	0.09	0.93	34.15	2.7	12.4	0.6	13.0	-	-	-	-	-
250+	4.82	0.28	1.15	0.36	0.17	1.96	21.05	9.3	10.2	0.7	10.9	3104	3736	>10000	-	3580
250+	4.82	0.14	0.91	0.23	0.06	1.34	20.56	6.5	9.4	0.9	10.3	1476	1667	>10000	-	4228

Clay Fraction Mineralogy by XRD

[ND = not detected, TR = trace (<10%), L = low (10-20%), M = medium (20-30%), H = high (>30%)]

Depth (cm)	Smectite	Vermiculite	Hydroxy int. Vermiculite	Chlorite	Kaolinite	Illite	Gibbsite	Feldspars	Quartz
0-18	ND	TR	L	ND	TR	M	ND	ND	M
18-150	ND	L	TR	ND	TR	H	ND	ND	TR
150-250	-	-	-	-	-	-	-	-	-
250+	ND	L	TR	ND	TR	H	ND	ND	TR
250+	ND	L	L	ND	TR	M	ND	ND	TR

Notes: (R) - Saprolite containing abundant reddish iron coatings. (Y) - Saprolite containing yellowish clay and/or iron coatings.

YP 4406

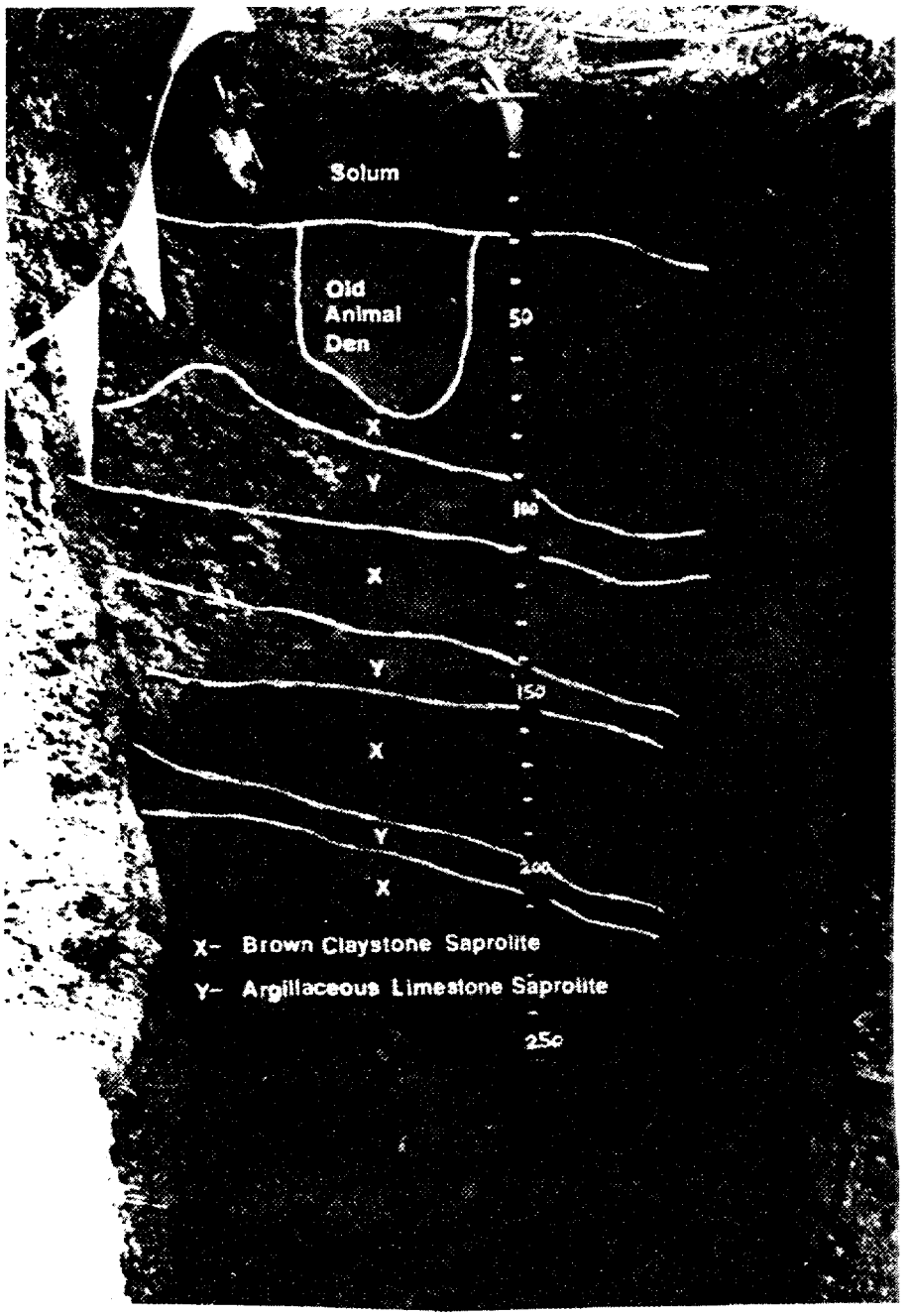

Fig. 3. Photograph of Nolchucky Pit. Values are given in centimeters.

Stop 10. Maryville Residual and Colluvial Soils (Table 3, Fig. 4)

Soil no: 42D Maryville Soil.

Location: LLWDDD Site. E32060, N30200 Y-12 grid.
Classification: Ruptic-Ultic Dystrochrepts; loamy-skeletal, mixed, thermic.
Geomorphic Position: Upper third of convex upland sideslope.
Slope: 18% with southeast aspect.
Parent material: Saprolite from claystone, and siltstone, along with thin strata of very fine-grained sandstone.
Described by: Lambert and Alley.
Date: June 11, 1987.

(This profile was described in the same pit as the No. 49 profile but on side wall.)

Soil Description

Cambic Part

A 0 to 5 cm; dark brown (10YR 3/3) shaly silt loam; moderate fine and medium granular structure; friable; many fine roots and pores throughout; pH 4.7; clear smooth boundary.

Bw 5 to 16 cm; dark yellowish brown (10YR 4/4) very shaly loam; weak fine and medium subangular blocky structure; firm; common fine and medium roots and pores throughout; pH 4.7; gradual inclined boundary.

Note: The intermittent Bt horizon occurs at about the same depth and extends deeper down dip into the Cr horizon beneath. It has a 5YR to 2.5YR hue and clayey texture.

Soil no: 49D Conasauga old colluvium

Location: LLWDDD Site. E32060, N30200 Y-12 grid.
Classification: Typic Hapludults; clayey mixed, thermic.
Geomorphic position: Narrow old gully fill on upper slightly convex sideslope of hillside.
Slope: 18% with southeast aspect.
Parent material: Old colluvium derived from Maryville and Rogersville residuum.
Described by: Lambert and P. D. Alley.
Date: June 11, 1987.

Soil Description

O 2 to 0 cm; leaf litter and pine needles; abrupt wavy boundary.

A 0 to 5 cm; very dark grayish brown (10YR 3/2) shaly silt loam; moderate fine and medium granular structure; friable; many fine roots throughout; many fine pores; pH 4.6; clear smooth boundary.

E 5 to 14 cm; dark yellowish brown (10YR 4/4) loam; weak fine subangular blocky structure; friable; common fine roots throughout; common fine pores; pH 4.7; clear smooth boundary.

Bt1 14 to 50 cm; mottled yellowish red (5YR 4/6 and 5/8) clay; strong medium subangular blocky structure; firm; many continuous faint yellowish red (5YR 4/6) clay films on faces of peds; few fine roots between peds; few to common pores; pH 4.6; gradual wavy boundary.

Bt2 50 to 84 cm; mottled yellowish brown (10YR 5/4), strong brown (7.5YR 5/6) and red (2.5YR 4/6) clay; moderate medium subangular blocky structure; firm; common discontinuous distinct yellowish brown (10YR 5/4) clay films on faces of some peds; few fine roots between peds; pH 4.8; clear wavy boundary.

2CB 84 to 102 cm; highly mottled red (2.5YR 4/6), black (5Y 2/1), and olive (5Y 5/6) extremely shaly clay; massive; rock-controlled structure; very firm; many continuous distinct red (2.5YR 4/6) clay films on rock fragments; common patchy black manganese coatings on some fragment faces; few fine roots on fragment faces; pH 4.8; clear steeply inclined boundary.

2Cr1 102 to 149 cm; oxidized and leached saprolite from claystone and siltstone that has olive brown (2.5YR 4/4) fragment interiors; rock-controlled structure; very firm; many continuous prominent dark red (10R 3/6) iron oxide coatings and black manganese coatings on fragment faces; few fine root mats in upper part where roots extend downward on dip planes; pH 4.8; steeply inclined gradual boundary (60 degree dip).

2Cr2 14 to 300 cm; oxidized and leached saprolite from claystone and siltstone; fragment interiors are olive (5Y 4/4) to olive gray (5Y 5/2); rock controlled structure; very firm; most fragments are coated with weak red (10R 4/4) iron oxides or black manganese oxides; some fragments in water flow zones are coated with olive gray (5Y 5/2) clay; pH 5.2.

Table 3. Soil: Maryville residual and colluvial soils Conasauga old colluvium
(Typic Hapludults; clayey, mixed, thermic) Soil No.: 49D

Depth cm	Horizon	Soil Particle Size: Total Sand (%)	Total Silt (%)	Total Clay (%)	Sand VCOS (%)	Sand COS (%)	Sand MS (%)	Sand FS (%)	Sand VFS (%)	Silt COSI (%)	Silt FSI (%)	Coarse Frags. (%)	Atterberg Limits: Liquid Limit (%)	Plastic Limit	Plasticity Index	Activity Ratio
0-14	A-E	33.2	55.1	11.7	5.0	3.9	1.6	4.5	18.2	28.3	26.8	22.4	33.1	29.1	4.0	0.34
14-84	Bt1-Bt2	16.9	37.7	45.4	4.6	3.1	1.2	2.1	5.9	14.8	22.9	11.0	58.3	30.8	27.5	0.61
84-102	2CB	14.7	40.2	45.1	5.1	2.5	0.9	2.1	4.1	15.7	24.5	65.3	-	-	-	-
102-149	2Cr1	41.7	25.9	45.1	17.4	9.2	2.7	4.7	7.7	10.3	15.6	94.4	-	-	-	-
149-300	2Cr2	24.2	37.3	38.5	12.2	4.8	1.8	2.3	3.1	10.2	27.1	89.6	-	-	-	-

Depth cm	Total Carbon (%)	Dithionite Extractable Fe (%)	Dithionite Extractable Mn (%)	Hydrox. Reduc. Mn ppm	Calcium Carbonate Equiv. (%)	Bulk Density (g cm^{-3})	Particle Density (g cm^{-3})	Total Porosity (%)	Available Water 1/3 Bar (%)	Available Water 15 Bar (%)	AWC (cm cm^{-1})	AWC Profile cm
0-14	2.76	1.92	0.04	86	-	0.94	2.59	63.67	30.28	14.69	0.11	
14-84	0.35	3.67	0.00	12	-	1.24	2.67	53.58	36.40	27.09	0.12	
84-102	0.16	3.99	0.01	26	-	1.38	2.67	48.31	34.15	26.08	0.04	
102-149	0.13	3.16	0.05	80	-	1.59	2.67	42.04	28.75	20.54	0.01	
149-300	0.18	2.14	0.12	1200	0.49	1.55	2.67	42.04	31.32	22.25	0.01	11.5

Depth cm	pH (1:1) water	Extractable Bases Ca (cmol(+)/kg)	Mg	K	Na	Sum	CEC	Base Saturation (%)	KCl Extractable Al (cmol(+)/kg)	H	Acidity	Radionuclide Sorption Ratio Co (L/kg)	Sr	Cs	Tc	U
0-14	4.65	2.52	0.59	0.24	0.03	3.28	13.50	25.0	2.6	0.6	3.2	7296	185	2538	0.44	1843
14-84	4.65	2.84	1.83	0.37	0.02	5.06	23.87	21.2	9.0	1.0	10.0	217	234	>10000	0.04	>10000
84-102	4.81	0.10	0.82	0.28	0.02	1.22	23.87	5.1	9.8	0.8	10.6	-	-	-	-	-
102-149	4.85	0.08	2.22	0.29	0.08	2.67	23.26	11.5	8.9	1.2	10.1	-	-	-	-	-
149-300	5.22	1.58	3.71	0.03	0.19	5.81	22.64	25.7	6.8	0.9	7.7	1960	2231	>10000	-	>10000

Clay Fraction Mineralogy by XRD
[ND = not detected, TR = trace (<10%), L = low (10-20%), M = medium (20-30%), H = high (>30%)]

Depth (cm)	Smectite	Vermiculite	Hydroxy int. Vermiculite	Chlorite	Kaolinite	Illite	Gibbsite	Feldspars	Quartz
0-14	ND	TR	M	ND	TR	L	ND	ND	M
14-84	ND	H	M	ND	TR	M	ND	ND	L
84-102	-	-	-	-	-	-	-	-	-
102-149	-	-	-	-	-	-	-	-	-
149-300	ND	M	L	ND	TR	M	ND	ND	L

Notes:

YP 4407

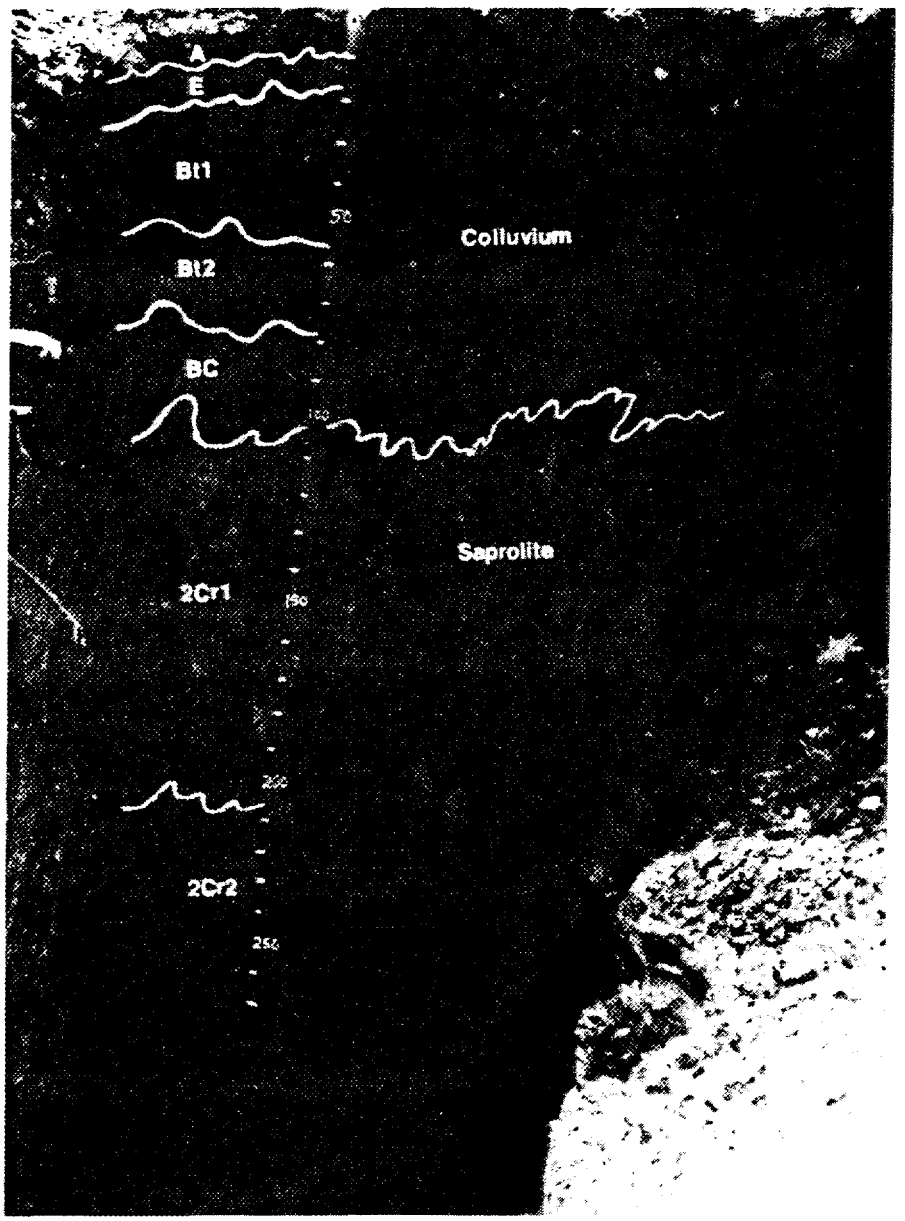

Fig. 4. Photograph of No. 49 soil. Values are given in centimeters.

Stop 11. Rogersville Residual Soil (Table 4, Fig. 5)

Soil no: 36D2. (Profile 36-E) moderately eroded.

Location: LLWDDD Site. E32025, N30540 Y-12 grid.
Classification: Ruptic-Ultic Dystrochrepts; loamy-skeletal, mixed, thermic.
Geomorphic Position: Upper convex sideslope and summits of low hills.
Slope: 10% with west aspect.
Parent material: Saprolite from claystone, siltstone, and thin to thick strata of glauconitic very fine grained sandstone.
Described by: Lambert.
Date: March 14, 1987.

Soil Description

Cambic Part

Oi 2 to 0 cm; leaf litter.

A 0 to 4 cm; very dark grayish brown (10YR 3/2) shaly clay loam; moderate medium granular structure; friable; many fine roots and pores throughout; pH 4.5; abrupt wavy boundary.

Bw 4 to 25 cm; yellowish brown (10YR 5/4) shaly loam; moderate fine and medium subangular blocky structure; friable; common patchy yellowish brown (10YR 5/6) clay films on ped faces and coating most fragments in the lower part; common medium and fine roots and pores throughout; pH 4.5; gradual inclined boundary.

Cr1 25 to 200 cm; variegated light gray (5BG 7/1), yellowish red (5YR 5/6), and yellowish brown (10YR 5/6) oxidized and leached saprolite from claystone and siltstone; extremely firm; common discontinuous yellowish red (5YR 5/6) iron-clay films on fragment faces; and discontinuous yellowish brown (10YR 5/6) clay films on fragment faces; few root mats in upper part; pH 4.7; clear inclined boundary.

Cr2 200 to 300 cm; variegated light gray (5BG 7/1), reddish yellow (7.5YR 6/6), and red (2.5YR 4/6) oxidized and leached saprolite from claystone and siltstone; extremely firm; common distinct reddish yellow (7.5YR 5/6) and red (2.5YR 4/6) iron-clay coatings on fragment faces; pH 5.0.

Argillic Part

Oi 2 to 0 cm; leaf litter.

A 0 to 4 cm; very dark grayish brown (10YR 3/2) shaly clay loam; moderate medium granular structure; friable; many fine roots and pores throughout; pH 4.5; abrupt wavy boundary.

E 4 to 12 cm; yellowish brown (10YR 5/4) shaly clay loam; moderate fine and medium subangular blocky structure; friable; common fine and medium roots and pores throughout; pH 4.5; clear wavy boundary.

Bt1 12 to 25 cm; yellowish brown (10YR 5/6) shaly clay loam; moderate medium subangular blocky structure; firm; discontinuous brown (10YR 5/3) skeletans on some ped faces; most faces coated with yellowish brown (10YR 3/4) clay; common fine and medium roots between peds; common pores; pH 4.6; clear wavy boundary.

Bt2 25 to 33 cm; yellowish brown (10YR 5/6) very shaly clay loam; moderate medium subangular blocky structure; firm; discontinuous yellowish brown (10YR 5/4) clay films on ped faces and coating most fragments; common fine pores; pH 4.7; clear irregular boundary.

Cr1 33 to 200 cm; variegated light gray (5BG 7/1), yellowish red (5YR 5/6), and yellowish brown (10YR 5/6) oxidized and leached saprolite from claystone and siltstone; extremely firm; common discontinuous yellowish red (5YR 5/6) iron-clay films on fragment faces; and discontinuous yellowish brown (10YR 5/6) clay films on fragment faces; few root mats in upper part; pH 4.7; clear inclined boundary.

Cr2 200 to 300 cm; variegated light gray (5BG 7/1), reddish yellow (7.5YR 6/6), and red (2.5YR 4/6) oxidized and leached saprolite from claystone and siltstone; extremely firm; common distinct reddish yellow (7.5YR 6/6) and red (2.5YR 4/6) iron-clay coatings on fragment faces; pH 5.0 (A glauconitic zone had a 1:1 water pH of 4.3).

Table 4. Soil: Rogersville residual soil (Ruptic-Ultic Dystrochrepts; loamy-skeletal, mixed, thermic) Soil No.: 36E

Depth cm	Horizon	Soil Particle Size: Total Sand %	Total Silt %	Total Clay %	Sand VCOS %	Sand COS %	Sand MS %	Sand FS %	Sand VFS %	Silt COSI %	Silt FSI %	Coarse Frags. %	Atterberg Limits: Liquid Limit %	Plastic Limit	Plasticity Index	Activity Ratio
0-25	A-Bw	25.2	42.2	32.6	5.0	4.0	2.2	4.9	9.1	14.0	28.2	29.0	46.0	31.5	14.5	0.44
25-200	Cr1	38.3	25.0	36.7	14.8	10.2	3.3	6.0	4.0	7.0	18.0	77.1	-	-	-	-
100	Cr1 (G)	48.7	23.7	27.7	8.9	6.4	4.3	18.4	10.7	13.6	10.0	94.1	-	-	-	-
200+	Cr2	60.1	21.6	18.3	30.1	13.0	3.7	7.1	6.2	7.3	14.3	91.3	-	-	-	-

Depth cm	Total Carbon %	Dithionite Extractable Fe %	Dithionite Extractable Mn %	Hydrox. Reduc. Mn ppm	Calcium Carbonate Equiv. %	Bulk Density g cm^{-3}	Particle Density g cm^{-3}	Total Porosity %	Available Water: 1/3 Bar %	15 Bar %	AWC cm cm^{-1}	AWC Profile cm
0-25	2.64	2.63	0.04	295	-	1.57	2.64	45.54	31.92	23.20	0.09	
25-200	0.18	4.83	0.00	10	-	1.63	2.66	38.82	28.56	20.78	0.03	
100	0.23	3.93	0.00	17	-	1.63	2.66	38.82	28.17	21.25	0.01	
200+	0.00	2.47	0.00	10	-	1.63	2.66	38.82	21.76	15.05	0.01	6.0

Depth cm	pH (1:1) water	Extractable Bases Ca cmol(+)/kg	Mg	K	Na	Sum	CEC	Base Saturation %	KCl Extractable Al cmol(+)/kg	H	Acidity	Radionuclide Sorption Ratio Co L/kg	Sr	Cs	Tc	U
0-25	4.46	2.44	3.69	0.29	0.03	6.45	22.03	29.3	7.8	0.7	8.5	2107	207	>10000	0.84	3239
25-200	4.76	0.06	0.52	0.52	0.03	1.13	22.03	5.1	13.4	1.0	14.4	938	1008	>10000	-	>10000
100	4.35	0.08	0.53	0.46	0.02	1.09	30.60	3.6	18.6	1.7	20.3	-	-	-	-	-
200+	5.00	0.02	1.23	1.38	0.09	2.72	23.76	11.7	12.4	0.9	13.3	-	-	-	-	-

Clay Fraction Mineralogy by XRD

[ND = not detected, TR = trace (<10%), L = low (10-20%), M = medium (20-30%), H = high (>30%)]

Depth (cm)	Smectite	Vermiculite	Hydroxy int. Vermiculite	Chlorite	Kaolinite	Illite	Gibbsite	Feldspars	Quartz
0-25	ND	L	TR	ND	H	M	ND	ND	M
25-200	ND	L	TR	ND	M	H	ND	ND	TR
100	-	-	-	-	-	-	-	-	-
200+	-	-	-	-	-	-	-	-	-

Notes: (G) - Saprolite containing glauconitic zones.

YP 5216

Fig. 5. Photograph of Rogersville Pit. Values are given in centimeters.

Stop 12. Saddle Trench Geomorphology (Fig. 6)

The saddle is located about 606 m north of Bear Creek on the drill Road Transect. In this saddle, diagrammatically illustrated in Fig. 6, the Rutledge and Pumpkin Valley formations join in a topographic low, which has an elevation in the range of 270 to 273 m and which was produced by headward-eroding drainageways located in the trace of the Rutledge Formation on either side. A thick soil had to have formed on this original toeslope landform during periods of stability when the underlying saprolite would be deeply weathered. Evidence in the trench (Fig. 6) suggests that during some time in the Pleistocene, the old residual soil was stripped off down to hard coherent rock or very firm saprolite, with strata of harder rock more resistant to erosion than softer strata. The soil numbers in Fig. 6 are tentative and are placed on stratigraphic units according to soil morphology of similar colluvial and residual soils adjacent to this trench. Colluvium No. 25A, (which is older than No. 25 colluvium) filled in the drainageway created by the stripping, and a soil formed during the stable period that followed. The No. 25A soil formed in an environment with a fluctuating or perched water table, as evidenced by the mottled zone in the lower part. The No. 25A colluvial soil was mostly stripped off during another erosion episode, so that only two small areas were preserved next to higher areas of harder saprolite. After the stripping, the gully was filled with No. 25 colluvium, the oldest of the Pumpkin Valley colluvial soils that are still present and have not been completely buried or destroyed by mass wastage. A stable period followed, and a soil formed in this colluvium. Another period of instability stripped part of the No. 25 soil from the saddle. The gully was filled with No. 26 colluvium, the most extensive of the Pumpkin Valley colluviums. The mottled zone in the underlying No. 25 paleosol probably formed during the development of the No. 26 soil, which formed in a moderately wet environment as evidenced by the presence of the 10YR hue in the Bt horizon rather than the more normal 7.5YR and 5YR hue found in Bt horizons in higher landforms nearby. Another erosional episode partially removed the No. 26 soil, and the resultant gully was backfilled by the No. 951 alluvium. (The identification of alluvium in this trench is based on the presence of a few pebbles and rock fragments in the material and the alluvium's similarity to more widespread alluvium nearby.) The environment during the deposition of the alluvium was wet enough for crayfish to construct burrows through and into the underlying No. 25 paleosol. These burrows are identified at the 4.8-, 5.7-, and 7.5-m marks on the diagram. These old burrows have smoothed sidewalls, unlike stump fills, which have irregular sidewalls.

The Rutledge residual soil, No. 30, has formed a red-yellow clayey Bt horizon at the far south end of the trench. Surface erosion from past agricultural activities probably stripped off the upper E and transition horizon to the Bt horizon, which is now directly beneath the A horizon.

This saddle is located within about 100 m of two stream piracy events. The stream channel just west of this saddle once flowed easterly across this saddle and then south through a gap in a Maryville ridge. A headward cutting drainage way from Gum Branch cut off the flow through the gap. Another headward cutting drainageway cut through the Maryville ridge to the west and captured the headwaters of the stream that now flows west of this saddle. Subsequent erosion and reversed channel gradients left the alluvial and colluvial remnants preserved in this saddle.

It is very evident that there have been periods of stability and instability over a considerable length of time. These stable and unstable periods most probably are climatically controlled on a regional basis and related to the climate perturbations of the Pleistocene and Holocene. Thus far, no datable carbon materials or buried A horizons have been located. The sequence of events in the Saddle Trench predate the erosional-depositional events that are more extensively preserved at elevations of 251 to 254 m.

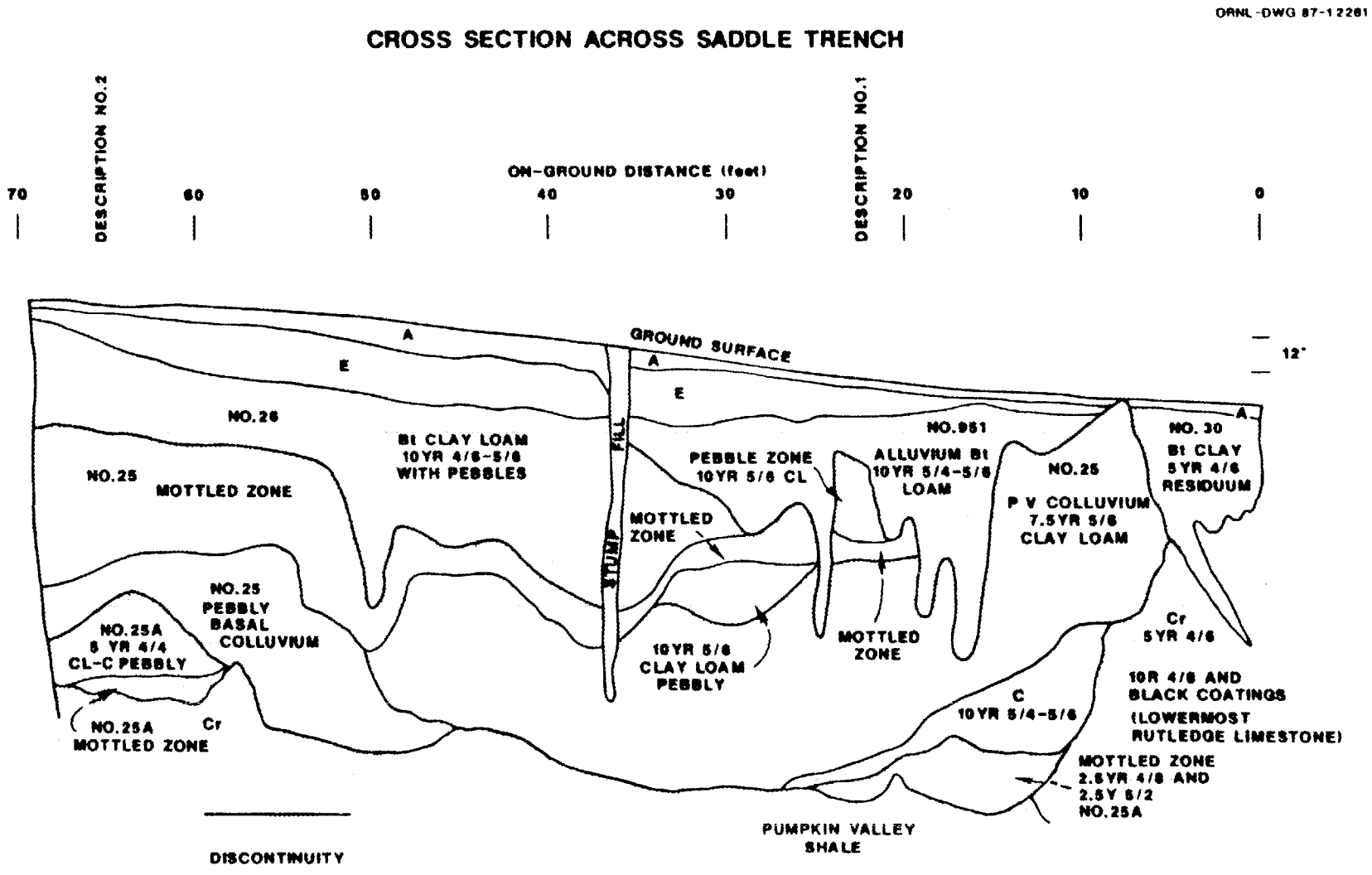

Fig. 6. Cross section across Saddle Trench (C = clay; CL = clay loam; CL-C = clay loam-cl PV = Pumpkin Valley; 1 ft = 0.3048 m).

Descriptions from Saddle Trench in the LLWDDD site

Saddle Description No.1

Location: About 21 ft north of the south end of the trench.
Parent materials: Thin old alluvium over old colluvium which is over Rutledge residuum.
Classification: Typic Hapludults; fine-loamy, mixed, thermic

Description

Oi 2 to 0 cm; partially decomposed leaves and litter.

A 0 to 2 cm; dark brown (10YR 4/3) very fine sandy loam; moderate fine granular structure; very friable; many fine and medium roots; 1 to 2% pebbles; pH 6.0; abrupt wavy boundary.

E 2 to 32 cm; yellowish brown (10YR 5/4) very fine sandy loam; weak fine granular structure; very friable; common medium roots; 1 to 2% pebbles; pH 6.2; clear wavy boundary.

Bt1 132 to 52 cm; yellowish brown (10YR 5/8) loam; weak fine subangular blocky structure; very friable; 1 to 2% pebbles; thin discontinuous yellowish brown (10YR 5/6) clay films on ped faces; many pores; pH 5.5; gradual wavy boundary.

2Bt2 52 to 100 cm; strong brown (7.5YR 5/6) gravelly clay loam; moderate fine subangular blocky structure; friable; few fine roots; 15 to 20% subrounded pebbles; few fine roots common pores; pH 5.0; gradual wavy boundary.

2Bt2 100 to 125 cm; strong brown (7.5YR 5/6) gravelly clay loam with common medium distinct light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; firm; few medium roots; 15 to 20% pebbles; common pores; continuous strong brown (7.5YR 5/6) clay films on ped faces that also cover mottles; pH 5.0; gradual wavy boundary.

2Bt3 125 to 162 cm; red (2.5YR 4/8) ped interiors and yellowish brown (10YR 5/6) ped exteriors; gravelly loam; weak coarse prismatic parting to moderate medium subangular blocky structure; firm; thick strong brown (7.5YR 5/6) clay films on primary ped faces; few medium roots common pores; pH 5.0; abrupt wavy boundary.

3C1 162 to 180 cm; highly mottled red (2.5YR 4/8) and light brownish gray (2.5Y 6/2) loam; massive, no rock structure; no roots; very soft highly weathered pebbles; pH. 4.5; abrupt wavy boundary.

4C2 180 to 204 cm; red (2.5YR 4/8), gray and violet Rutledge saprolite; massive; very soft; clear irregular wavy boundary.

4Cr 204 to 225 cm; highly weathered Rutledge saprolite.

Note: Vertical streaks associated with prismatic structure start in the lower part of 2Bt2 horizon and extend through the 2Bt3 horizon.

Saddle Description No.2

Location: About 4.2 m south of the north end of the trench.
Classification: Typic Hapludults; fine-loamy, mixed, thermic.
Parent Materials: Old alluvium over Pumpkin Valley colluvium over Pumpkin Valley residuum.

Description

Oi 2 to 0 cm; partially decomposed organic matter.

A 0 to 2 cm; brown (10YR 4/3) very fine sandy loam; weak fine granular blocky structure; very friable; many fine and medium roots; many tubular pores; 5% pebbles; clear wavy boundary.

E 2 to 26 cm; yellowish brown (10YR 5/4) very fine sandy loam; weak fine granular structure; very friable; common fine and medium roots and pores; 5% pebbles; gradual wavy boundary.

Bt1 26 to 55 cm; yellowish brown (10YR 5/8) loam; weak fine subangular blocky structure; very friable; few fine and medium roots and pores; 10% pebbles; clear wavy boundary. (This horizon is a mixture of alluvium and colluvium.)

2Bt2 55 to 76 cm; yellowish brown (10YR 5/6) loam; moderate fine and medium subangular blocky structure; friable; few roots; many pores; 10 to 15% pebbles; thin discontinuous dark yellowish brown (10YR 4/4) clay films on ped faces; clear wavy boundary.

2Bt3 76 to 92 cm; strong brown (7.5YR 5/6) gravelly clay loam; moderate medium subangular blocky structure; friable; few fine roots; many pores; 15 to 20% pebbles; vertical flow zones start at the top of this horizon; clear wavy boundary.

2Bt4 92 to 115 cm; brown (7.5YR 4/4) gravelly clay loam; weak medium subangular blocky structure; friable; few fine roots; common pores; 15 to 15% pebbles; clear wavy boundary.

3Bt5 115 to 148 cm; reddish brown (5YR 4/4) clay loam; weak coarse subangular blocky structure; firm; few fine roots; common pores; 5 to 10% soft sandstone pebbles; continuous brown (7.5YR 4/4) clay films on ped faces; gradual wavy boundary.

3Bt6 148 to 180 cm; yellowish red (5YR 5/6) clay loam-clay; weak coarse subangular blocky structure; firm; few fine roots; common pores; 5% pebbles; many medium yellowish brown (10YR 5/4) mottles covered by yellowish brown (10YR 4/4) clay films; abrupt wavy boundary.

4C 180 to 196 cm; soft Pumpkin Valley saprolite with red and gray faces; crushes to shaly silty clay loam; few fine roots and root mats in lower part.

4Cr 196 cm weathered Pumpkin Valley saprolite.

Stop 13. Pumpkin Valley Residual and Colluvial Soils (Table 5, Fig. 7)

Soil no.: 24C2 (Profile 24-N) moderately eroded.

Location: LLWDDD Site. E32275, N30840 Y-12 grid.
Classification: Ruptic-Ultic Dystrochrepts; loamy-skeletal, mixed, thermic.
Geomorphic position: Convex sideslopes and summits of low hills.
Slope: 10% with southeast aspect.
Parent material: Saprolite from claystone, from siltstone, and from thin to thick strata of glauconitic, very fine grained sandstone of upper member.
Described by: Lietzke and Lambert.
Date: April 03, 1987.

Note: Only the residual soil in this pit was described.

Oi 2 to 0 cm; leaf litter.

A 0 to 8 cm; dark grayish brown (10YR 4/2) shaly loam; moderate fine granular structure; friable; common to many fine and medium roots and pores throughout; pH 4.5; clear smooth boundary.

E 8 to 25 cm; light yellowish brown (10YR 6/4) shaly loam; weak fine and medium subangular blocky structure; friable; common fine roots throughout; many pores; pH 4.5; gradual wavy boundary (gradual boundary includes a thin strong brown (7.5YR 4/4) Bt1 horizon).

Bw 25 to 55 cm; yellowish red (5YR 4/6) very shaly clay loam; weak fine and medium subangular blocky structure; firm; nearly continuous red (2.5YR 4/8) clay films on fragment faces and on some ped faces; few patchy red (10R 4/8) iron oxide-clay coatings on some fragment faces; few to common fine roots; common to many pores; pH 4.7; clear inclined boundary. (Cambic horizon part of pedon.)

Bt 25 to 66 cm; yellowish red (5YR 4/6) shaly clay; moderate medium subangular blocky structure; firm; continuous reddish brown (5YR 4/4) clay films on ped faces; few to common fine roots between peds; many pores; pH 4.5; clear inclined boundary. (Argillic horizon part of pedon.)

B/Cr 55 to 118 cm; weak red (2.5YR 4/2) extremely shaly clay; weak medium subangular blocky structure (B part) and massive saprolite (Cr part); very firm; nearly continuous reddish brown (5YR 4/4) clay films on fragment faces; few fine roots; many pores; pH 4.7; abrupt irregular inclined boundary.

Cr 118 to 200 cm; highly variegated weak red (2.5YR 4/2) and red (2.5YR 5/6) oxidized and leached saprolite from siltstone, claystone, and glauconitic very fine grained sandstone; extremely firm; nearly continuous reddish brown (5YR 4/4) clay coatings on fragment faces; patchy red (10R 4/8) iron oxide coatings on some fragment faces; very few fine roots in cracks; pH 4.8.

Table 5. Soil: Pumpkin Valley Residual and Colluvial Soil (Ruptic-Ultic Dystrochrepts; clayey, mixed, thermic) Soil No.: 24N

Depth cm	Horizon	Soil Particle Size: Total Sand (%)	Total Silt (%)	Total Clay (%)	Sand VCOS (%)	Sand COS (%)	Sand MS (%)	Sand FS (%)	Sand VFS (%)	Silt COSI (%)	Silt FSI (%)	Coarse Frags. (%)	Atterberg Limits: Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Activity Ratio
0-25	A-E	43.8	44.1	12.1	2.0	1.8	1.0	9.1	29.9	19.4	24.7	31.7	28.3	24.3	4.0	0.33
25-66	Bw-Bt	15.3	34.8	49.9	2.8	1.5	0.7	2.9	7.4	9.6	25.2	27.7	60.9	33.0	27.9	0.56
66-118	Cr1	84.9	9.6	5.5	9.1	6.9	6.0	50.9	12.0	6.1	3.5	18.1	-	-	-	-
118+	Cr2	77.0	13.3	9.7	11.0	6.1	3.7	40.4	15.8	6.7	6.6	87.7	-	-	-	-

Depth cm	Total Carbon (%)	Dithionite Extractable Fe (%)	Dithionite Extractable Mn (%)	Hydrox. Reduc. Mn ppm	Calcium Carbonate Equiv. (%)	Bulk Density ($g\ cm^{-3}$)	Particle Density ($g\ cm^{-3}$)	Total Porosity (%)	Available Water: 1/3 Bar (%)	Available Water: 15 Bar (%)	Available Water: AWC ($cm\ cm^{-1}$)	Available Water: AWC Profile cm
0-25	2.03	1.49	0.02	187	-	1.22	2.60	53.14	26.46	11.67	0.12	
25-66	0.31	4.35	0.00	8	-	1.47	2.69	45.41	36.23	27.96	0.08	
66-118	0.06	4.17	0.00	13	-	1.57	2.74	42.85	15.50	10.42	0.07	
118+	0.00	2.30	0.12	1190	-	1.57	2.74	42.85	17.62	11.16	0.01	7.6

Depth cm	pH (1:1) water	Extractable Bases: Ca (cmol(+)/kg)	Mg	K	Na	Sum	CEC	Base Saturation (%)	KCl Extractable: Al (cmol(+)/kg)	H	Acidity	Radionuclide Sorption Ratio: Co (L/kg)	Sr	Cs	Tc	U
0-25	4.49	0.32	0.07	0.12	0.00	0.51	9.18	5.6	2.6	0.4	3.0	391	49	1819	0.23	746
25-66	4.58	0.38	1.20	0.33	0.00	1.91	25.70	7.4	9.7	1.2	10.9	151	157	>10000	0.27	>10000
66-118	4.76	0.20	1.15	0.27	0.00	1.62	21.42	7.6	12.7	1.0	13.7	938	1046	>10000	-	3923
118+	4.84	0.03	1.14	0.18	0.01	1.36	21.42	6.4	12.6	1.1	13.7	-	-	-	-	-

Clay Fraction Mineralogy by XRD

(ND = not detected, TR = trace (<10%), L = low (10-20%), M = medium(20-30%), H = high (>30%)

Depth (cm)	Smectite	Vermiculite	Hyroxy int. Vermiculite	Chlorite	Kaolinite	Illite	Gibbsite	Feldspars	Quartz
0-25	ND	TR	H	ND	H	TR	ND	ND	M
25-66	ND	L	M	ND	H	L	ND	ND	L
66-118	ND	M	L	ND	H	M	ND	ND	L
118+	-	-	-	-	-	-	-	-	-

Notes:

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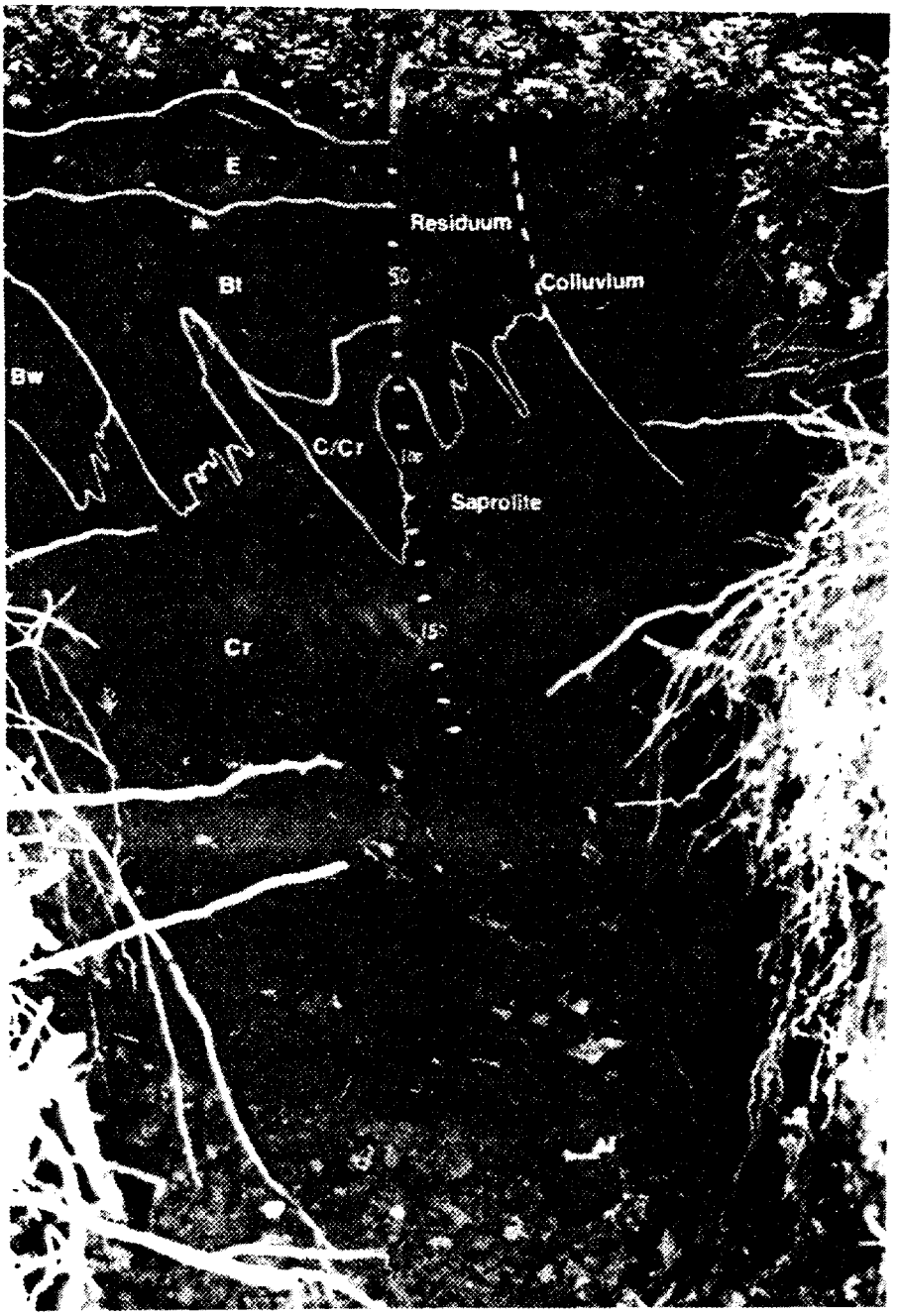

Fig. 7. Photograph of Pumpkin Valley pit. Values are given in centimeters.

Stop 14. Colluvial and Alluvial Soil (Pit 26/951) (Table 6, Fig. 8)

Soil no.: 26/951 C3.

Location: LLWDDD Site. E27875, N30780 Y-12 grid.
Classification: Typic Hapludults; fine-loamy, mixed, thermic.
Geomorphic position: Low terrace covered toeslope with some convexity.
Slope: 10% with west aspect.
Parent material: Pumpkin Valley colluvium over Pleistocene alluvium derived from mostly local sources over Pumpkin valley residuum.
Described by: Lambert and Lietzke.
Date: June 9, 1987.

Ap 0 to 21 cm; dark brown (10YR 4/3) gravelly loam; moderate medium and coarse granular structure; friable; common fine and very fine roots throughout; many pores throughout; pH 4.7; abrupt smooth boundary.

Bt1 21 to 43 cm; yellowish red (5YR 4/6) and brownish yellow (10YR 6/8) gravelly clay loam; weak fine and medium subangular blocky structure; firm; thin continuous reddish brown (5YR 4/6) clay films on ped faces; few fine roots between peds; many pores; pH 4.9; clear wavy boundary. (Base of youngest colluvium.)

2Bt2 43 to 55 cm; yellowish red (5YR 4/6) and reddish brown (5YR 4/4) clay loam; moderate medium subangular blocky structure; firm; thin continuous reddish brown (5YR 4/4) clay films on ped faces: few fine roots between peds; many pores; pH 4.9; clear wavy boundary.

2BC 55 to 74 cm; yellowish red (5YR 4/6 and yellow (5Y 7/6) gravelly clay loam; weak medium subangular blocky structure; firm; thin discontinuous yellowish red (5YR 4/6) clay films on ped faces; few patchy manganese oxide coatings on some ped faces; few fine roots; many fine pores; pH 4.9; clear wavy boundary.

3Bt 74 to 87 cm; reddish brown (5YR 4/4) and yellowish red (5YR 4/6) clay loam; moderate medium subangular blocky structure; firm; thin continuous yellowish red (5YR 4/6) clay films on ped faces; few fine roots between peds; many fine pores; pH 4.9; clear wavy boundary. (Base of intermediate colluvium.)

4Ab 87 to 95 cm; mottled light brownish gray (2.5Y 6/2) and yellowish red (5YR 4/6) loam; weak fine and medium subangular blocky structure; firm; thin patchy yellowish red (5YR 4/6) clay films on ped faces; patchy strong brown (7.5YR 4/4) iron oxyhydroxide stains throughout; few to common fine roots between peds; many fine pores; pH 4.9; clear irregular boundary.

4Btb 95 to 122 cm; brownish yellow (10YR 6/8), yellow (2.5Y 8/8), and light greenish gray (5BG 6/2) gravelly clay loam; weak fine and medium subangular blocky structure; very firm; thin discontinuous dark yellowish brown (10YR 4/4) clay films on ped faces; common patchy strong brown (7.5YR 5/6) iron oxyhydroxide coatings on some ped faces; very few fine roots between peds; many fine pores; pH 4.9; clear wavy boundary. (Base of oldest colluvium.)

5Bt'1 122 to 146 cm; dark brown (7.5YR 4/4), yellowish brown (10YR 5/4), and brownish yellow (10YR 6/8) loam; moderate medium subangular blocky structure; very firm; thin discontinuous dark brown (7.5YR 4/4) clay films on ped faces; patchy manganese oxide stains on some ped faces; very few fine roots between peds; common fine pores; pH 4.9; clear wavy boundary.

5Bt'2 146 to 202 cm; dark brown (7.5YR 4/4) and yellowish brown (10YR 5/4) clay loam; weak coarse subangular blocky structure; very firm; thin continuous dark brown (7.5YR 4/4) clay films on ped faces; patchy manganese oxide stains on ped faces; very few fine roots between peds; many fine pores; pH 4.9; clear wavy boundary. (Base of upper alluvium.)

6Bw1 202 to 234 cm; light olive brown (2.5Y 5/4) loam; weak medium subangular blocky structure; firm; patchy manganese oxide coatings on some ped faces and patchy brownish yellow (10YR 6/8) iron oxyhydroxide stains on other ped faces; very few fine roots between peds; pH 4.9; clear wavy boundary.

6Bw2 234 to 270 cm; mottled dark yellowish brown (10YR 4/8) and light olive brown (2.5Y 5/4) loam; weak medium subangular blocky structure; firm; thin discontinuous reddish brown (5YR 4/4) clay films on faces of primary peds; patchy manganese coatings on secondary ped faces; very few fine roots between peds; few to common fine pores; pH 4.9; clear wavy boundary. (Base of older alluvium.)

7C 270 to 325 cm; mottled brownish yellow (10YR 6/8), yellow (2.5Y 7/8), and olive yellow (5Y 6/6) oxidized and leached saprolite from lower member of Pumpkin Valley Formation; contains greenish glauconitic strata; firm; common patchy dark red (10R 3/6) iron stains on joint and fracture faces; few very fine roots along dip planes; pH 5.0; clear inclined boundary. (Pumpkin Valley residuum.)

7Cr 325 to 350 cm; highly variegated and mottled oxidized and leached saprolite from middle member of Pumpkin Valley; very firm; few root mats in upper part along dip planes; pH 5.1.

Table 6. Soil: Colluvial over old alluvial soil (Typic Hapludults; fine-loamy, mixed, thermic) Soil No: 26/951

Depth cm	Horizon	Soil Particle Size: Total Sand (%)	Total Silt (%)	Total Clay (%)	Sand: VCOS (%)	COS (%)	MS (%)	FS (%)	VFS (%)	Silt: COSI (%)	FSI (%)	Coarse Frags. (%)	Atterberg Limits: Liquid Limit (%)	Plastic Limit (%)	Plasticity Index	Activity Ratio
0-21	Ap	48.4	31.5	20.1	1.8	2.3	1.9	12.0	30.4	11.7	19.8	28.0	32.1	22.9	9.2	0.46
21-122	Bt1-4Bt	34.9	36.9	28.2	5.8	2.2	0.9	8.5	17.5	18.3	18.6	13.4	40.8	23.6	19.2	0.68
122-270	5Bt1-6Bw2	31.9	35.6	32.5	0.3	0.1	0.4	8.3	22.8	19.4	16.2	0.1	45.3	20.9	24.4	0.75
270	7C-7Cr	45.2	33.3	21.5	9.6	4.9	2.5	17.4	10.8	11.1	22.2	93.2	-	-	-	-

Depth cm	Total Carbon (%)	Dithionite Extractable Fe (%)	Dithionite Extractable Mn (%)	Hydrox. Reduc. Mn ppm	Calcium Carbonate Equiv. (%)	Bulk Density (g cm^{-3})	Particle Density (g cm^{-3})	Total Porosity (%)	Available Water: 1/3 Bar (%)	15 Bar (%)	AWC (cm cm^{-1})	AWC Profile cm
0-21	1.71	2.14	0.03	246	-	1.14	2.63	56.66	21.15	16.16	0.04	
21-122	0.12	2.77	0.02	48	-	1.55	2.66	41.73	26.52	20.01	0.10	
122-270	0.09	1.92	0.01	53	-	1.46	2.66	45.11	27.37	19.70	0.11	
270+	0.00	4.09	0.02	135	-	1.59	2.73	41.76	25.20	17.37	0.01	14.0

Depth cm	pH (1:1) water	Extractable Bases (cmol(+)/kg): Ca	Mg	K	Na	Sum	CEC	Base Saturation (%)	KCl Extractable (cmol(+)/kg): Al	H	Acidity	Radionuclide Sorption Ratio (L/kg): Co	Sr	Cs	Tc	U
0-21	4.70	2.10	0.66	0.28	0.03	3.07	13.22	23.2	3.2	0.3	3.5	4688	201	8651	0.24	2216
21-122	4.91	1.29	0.55	0.10	0.09	2.03	15.05	13.5	6.9	0.1	7.0	320	346	>10000	0.27	3715
122-270	4.96	0.31	0.45	0.17	0.03	0.96	16.77	5.7	6.3	0.1	6.4	314	337	>10000	0.14	5679
270+	5.10	0.26	0.93	0.24	0.04	1.47	17.75	8.3	8.5	0.3	8.8	1498	1717	>10000	-	3355

Clay Fraction Mineralogy by XRD

{ND = not detected, TR = trace (<10%), L = low (10-20%), M = medium (20-30%), H = high (>30%)}

Depth (cm)	Smectite	Vermiculite	Hydroxy int. Vermiculite	Chlorite	Kaolinite	Illite	Gibbsite	Feldspars	Quartz
0-21	ND	L	M	ND	H	L	ND	ND	M
21-122	ND	M	L	ND	M	L	ND	ND	L
122-270	ND	M	M	ND	H	L	ND	ND	L
270+	ND	H	TR	ND	L	M	ND	ND	M

Notes:

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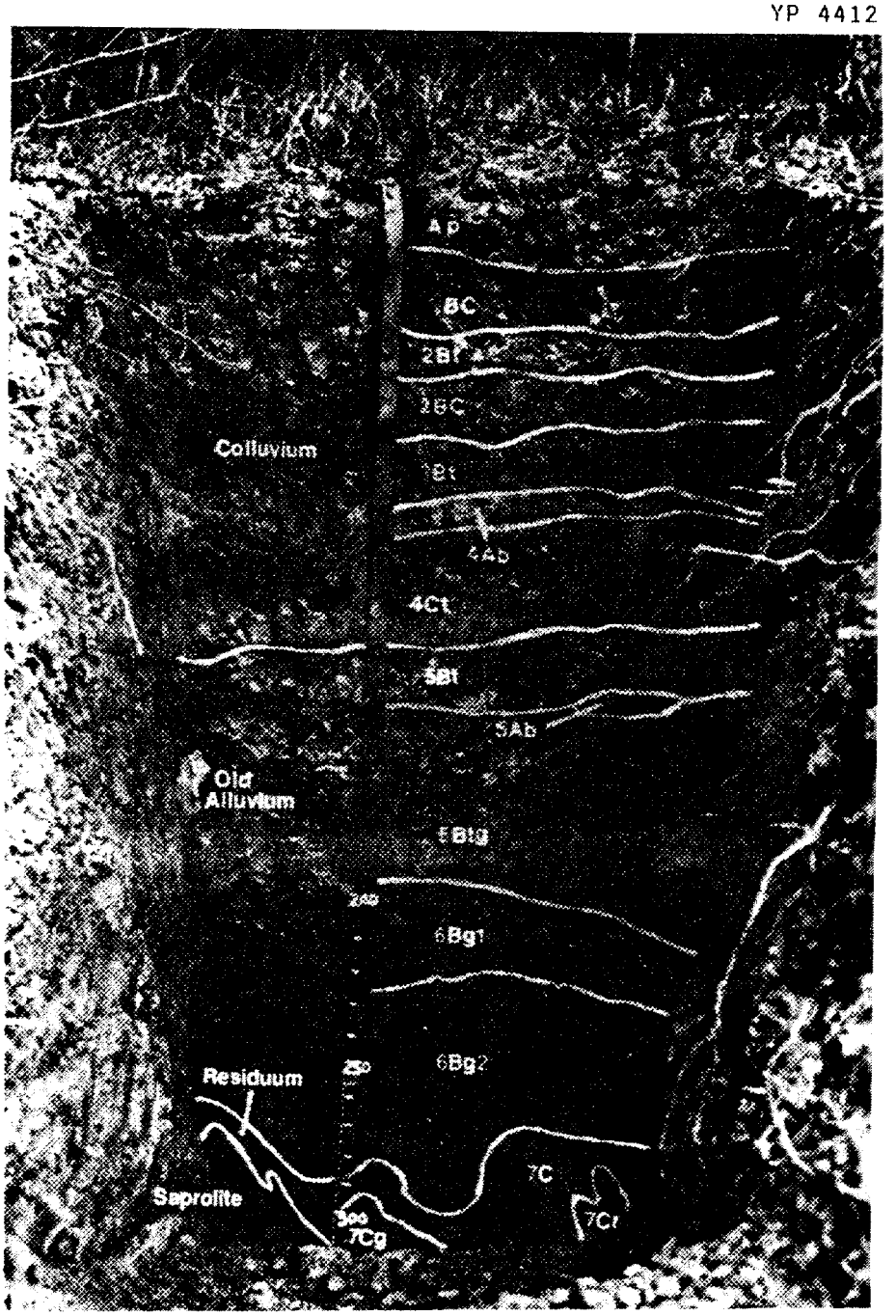

Fig. 8. Photograph of Pumpkin Valley colluvium over old alluvium over Pumpkin Valley residuum. Values are given in centimeters.

Stop 15. Rome Breccia Soil

Soil no.: 601 D3.

Location: ORR: McNew Hollow, a short way below the drainage divide that separates McNew Hollow drainage basin from Gum Branch basin.
Classification: Typic Hapludults; clayey, mixed, thermic.
Geomorphic position: Lower upland sideslope along edge of fault.
Slope and aspect: 12 to 25% southeast.
Parent material(s): Fault breccia saprolite from the upper Rome containing yellowish feldspathic siltstone, sandstone and limestone.
Vegetation: Hardwoods and pines.
Described and sampled by: Lietzke, Ammons, and Timpson.
Date: April 14, 1988.

Soil Description

Oi & A 4 to 0 cm; leaf litter with many fine and medium roots.

E 0 to 10 cm; yellowish brown (10YR 5/4) very fine sandy loam or silt loam; moderate fine granular structure; very friable; common medium roots; many pores; gradual wavy boundary.

E/B 10 to 20 cm; yellowish brown (10YR 5/4) E part, and yellowish brown (10YR 5/8) B part; very fine sandy loam or silt loam; moderate medium subangular blocky structure; very friable; common medium roots; many pores; gradual wavy boundary. (B/E horizon included in the lower boundary.)

Bt1 20 to 32 cm; strong brown (7.5YR 5/6) silty clay loam; moderate medium subangular blocky structure; very friable; continuous dark yellowish brown (10YR 4/6) clay films on ped faces; common fine roots; many pores; 20% soft breccia fragments of siltstone and fine grained sandstone; gradual wavy boundary.

Bt2 32 to 70 cm; strong brown (7.5YR 5/8) and red (2.5YR 4/8) saprolitic interiors; silty clay or clay; moderate medium subangular blocky structure; friable; continuous yellowish red (5YR 5/6) clay films on ped faces; common fine roots; many pores; 40% soft breccia fragments of siltstone and fine grained sandstone; clear wavy boundary.

BC 70 to 90 cm; olive brown (2.5Y 4/6) clay plugged brecciated siltstone saprolite that easily crushes to silty clay loam; clay plugs are yellowish red (5YR 4/6); very friable; common fine roots; many pores; 75% soft fragments of siltstone and very fine grained sandstone; clear wavy boundary.

CB 90 to 126 cm; strong brown (7.5Y 5/8) clay plugged brecciated fine grained sandstone saprolite that easily crushes to loam or very fine sandy loam; yellowish red (5YR 4/6) clay plugs; very friable; common fine roots; many pores; 75% soft fragments of siltstone and very fine grained sandstone; clear wavy boundary.

C1 126 to 150 cm; olive (5Y 5/4) brecciated siltstone saprolite plugged with yellowish red (5YR 4/6) clay in open porous areas and on most primary fragment faces but coated with black manganese or red iron plasma on secondary fragment faces; about 85% firm siltstone fragments; many pores; few fine roots; clear wavy boundary.

C2 150 to 200 cm; brownish yellow (10YR 6/8) brecciated siltstone saprolite plugged with yellowish red (5YR 4/6) clay in open porous areas and on most primary fragment faces and as replacement for limestone breccia fragments; about 85% very soft siltstone fragments; many pores; few fine roots; clear wavy boundary.

C3 200 to 255 cm; olive brown (5Y 4/4) brecciated siltstone saprolite plugged with strong brown (7.5YR 4/6) clay in open porous areas and on most primary faces; secondary fragment faces of saprolite coated with black manganese plasma; about 90% very firm siltstone fragments; many pores; few fine roots; clear wavy boundary.

C4 255 to 300 cm; black manganese replacement of brecciated limestone fragments; cracks plugged by yellowish red (5YR 4/6) clay; some olive brown (5Y 4/4) siltstone fragments coated with black manganese and red (10R 4/8) iron plasma; very soft with no hard fragments; few fine roots; many pores.

Note: There are no hard coarse fragments in this profile. Only one hard gravel fragment was picked from the pit face.

Stop 16. Rome Residual Soils

Soil no.: 6F.

Location: Roane County, ORR east of Gum Branch Road, in uppermost section of Gum Branch watershed
Classification: Typic Dystrochrepts; loamy-skeletal, or fine-loamy, mixed, thermic.
Physiography: Upland.
Geomorphic position: Linear mid-sideslope.
Slope and aspect: 50% east.
Parent material(s): Dusky red Rome mudstone surficial creep and underlying residuum.
Vegetation: Pines and hardwoods.
Described by: Lietzke.
Date: September 30, 1986.
Sampled by: Lietzke, Ammons, and Timpson.
Date: April 24, 1988.

Soil Description

Oi 5 to 0 cm; leaves, needles and twigs.

A 0 to 2 cm; dark brown (10YR 3/3) gravelly very fine sandy loam; moderate fine granular structure; very friable; many fine and medium roots; many pores; 15 to 25% sandstone fragments; clear wavy boundary.

E1 2 to 7 cm; reddish brown (5YR 4/3) gravelly very fine sandy loam; weak fine granular structure; very friable; few fine and medium roots; many pores; 20 to 25% sandstone fragments; clear wavy boundary.

E2 7 to 15 cm; reddish brown (5YR 5/4) gravelly very fine sandy loam; weak medium subangular blocky structure; very friable; light reddish brown (5YR 6/3) skeletans on many ped faces; few fine and medium roots; many pores; 25 to 30% sandstone fragments; clear wavy boundary.

Bw1 15 to 23 cm; reddish brown (5YR 4/4) loam; weak medium subangular blocky structure; friable; light reddish brown (5YR 6/3) skeletans on many ped faces; few fine and medium roots; many pores; 5 to 15% sandstone fragments; clear wavy boundary.

Bw2 23 to 38 cm; reddish brown (5YR 4/3) loam; moderate medium subangular blocky structure; friable; reddish brown (5YR 5/3) skeletans on many ped faces; few fine and medium roots; many pores; 5 to 15% sandstone fragments; abrupt wavy boundary.

2CB 38 to 92 cm; dark reddish brown (5YR 3/3), strong brown (7.5YR 5/8) and pinkish gray (7.5YR 6/2) extremely gravelly very fine sandy loam; massive; friable; dark reddish brown (5YR 3/4) soil material on many fragment faces; common fine roots; many pores; 5 to 75% sandstone fragments; abrupt wavy boundary. Note: For sampling purposes, this horizon was split into BC (38 to 63 cm) and CB (63 to 92 cm).

2Cr1 92 to 135 cm; light olive brown (2.5Y 5/6) and brown (10YR 4/3) feldspathic sandstone saprolite stratum; very firm; dusky red (2.5YR 3/4) iron coatings on most fragment faces; few fine roots; common pores.

2Cr2 135 to 160 cm; reddish brown (5YR 5/3) and dusky red (2.5YR 3/2) mudstone saprolite; extremely firm; no roots.

2Cr3 160 to 180 cm; gray (5GY 5/1) interbedded siltstone and reddish black (10R 2/1) mudstone; some fragment surface are oxidized to a lighter shade; some faces with red (10R 4/8) iron plasma; firm and very firm in-place material.

Note: This pedon has a very well expressed cambic or a weakly expressed argillic horizon formed in the creep materials. The upper 30 cm of the pedon formed in creep materials. Strata are gently dipping at this site.

Soil no.: 7D.

Location: Roane County, ORR upper sub-watershed basin of Gum Branch. First watershed south of Pin Hook Branch on west side of Gum Branch Road.
Classification: Typic Hapludults; clayey, mixed, thermic.
Physiography: Upland.
Geomorphic position: Mid-sideslope.
Slope and aspect: 24% south.
Parent material(s): Rome feldspathic fine-grained sandstone and siltstone.
Vegetation: Pines and hardwoods.
Described by: Lietzke.
Date: September 30, 1986.
Sampled by: Lietzke, Ammons, and Timpson.
Date: April 14, 1988.

Soil Description

Oi 4 to 0 cm; root mat plus surface needles and leaves.

E1 0 to 13 cm; dark grayish brown (10YR 4/2) in the upper 2 cm and brown (10YR 5/3) very fine sandy loam beneath; weak fine granular structure; very friable; few medium and fine roots; many pores; less than 5% fragments; clear wavy boundary.

E2 13 to 25 cm; pale brown (10YR 6/3) very fine sandy loam; weak fine granular structure; very friable; light gray (10YR 7/2) skeletans on some ped faces and in streaks; few medium and fine roots; many pores; less than 5% fragments; clear wavy boundary.

B/E 25 to 36 cm; strong brown (7.5YR 4/6) B part, and yellowish brown (10YR 5/4) E part, very fine sandy loam; moderate medium subangular blocky structure; friable; common fine roots; many pores; less than 5% fragments; clear wavy boundary.

Bt 36 to 65 cm; strong brown (7.5YR 4/6) silty clay loam; moderate medium subangular blocky structure; firm; thin continuous brown (7.5YR 5/4) clay films on ped faces; common fine roots; many pores; less than 5% fragments; clear wavy boundary.

BC 65 to 100 cm; strong brown (7.5YR 4/6) and yellowish red (5YR 5/6) gravelly silty clay; moderate medium subangular blocky structure; firm; thin continuous reddish brown (5YR 5/4) clay films on ped faces and lining old root channels and cracks; red (2.5YR 4/6) iron materials on rock fragment faces; few fine roots; many pores; 15 to 25% soft sandstone fragments; gradual irregular boundary.

Cr 100 to 173 cm; soft reddish gray (5YR 5/2) and yellowish brown (10YR 5/6) saprolite from Rome arkosic sandstone that crushes to very gravelly silt loam or very fine sandy loam; firm; thick continuous reddish brown (5YR 5/4) clay films in cracks and coating fragment faces in upper most part; few fine roots in cracks; common pores. (Auger observation. Only the upper part of this horizon was sampled for characterization.)

Note: Ped interiors in BC horizon have remnant rock-controlled colors and rock structure. Parent materials are very fine grained sandstone and siltstone with a steep southwest dip almost parallel to the slope.

Stop 17. Rome and Chickamauga Colluvial Soils

Soil no.: 16.

Location: ORR. Intersection of Midway Road and Hot Yard Road, and then about 50 m south across low area and up onto slope. North end of drill road transect.
Classification: Typic Hapludults; fine-loamy, mixed, thermic. (Mapped as Shouns in Anderson County.)
Geomorphic position: Lower edge of mudflow. Very close to or in fault zone.
Slope and aspect: 12 to 25% northwest.
Parent material(s): Young Rome mudflow over old clayey Rome mudflow
Vegetation: Cutover area with pines and brush.
Described by: Lietzke.
Date: April 22, 1988

Soil Description

Ap 0 to 25 cm; dark brown (10YR 3/4) silt loam or loam; moderate fine granular structure (platy in lower 10 cm); very friable; many fine roots; 5 to 10% sandstone fragments; many pores; abrupt wavy boundary.

BE 25 to 43 cm; strong brown (7.5YR 4/6) silt loam or loam; moderate medium subangular blocky structure; very friable; common fine roots; 5 to 10% sandstone fragments; many pores; gradual wavy boundary.

Bt1 43 to 83 cm; dark brown (7.5YR 4/4) light silty clay loam or clay loam; moderate medium subangular blocky structure; very friable; patchy strong brown clay films on ped faces; common fine roots; 5 to 10% sandstone fragments; many pores; gradual wavy boundary.

Bt2 83 to 117 cm; reddish brown (5YR 4/4) silty clay loam or clay loam; moderate fine subangular blocky structure; very friable; dark reddish brown (5YR 3/4) clay flows on most ped faces; some manganese splotches and ped coatings in lower part; few fine roots; 5 to 10% sandstone fragments; many pores; abrupt irregular boundary. (Base of younger colluvium.)

2Bt3 117 to 161 cm; reddish brown (5YR 4/4) very gravelly loam; weak coarse subangular blocky structure; firm; dark reddish brown (5YR 3/4) clay flows on most ped faces; many manganese splotches, fragment coatings and ped coatings; few fine roots; 35 to 50% sandstone fragments; many pores; gradual wavy boundary.

3Bt4 161 to 211 cm; reddish brown (5YR 4/4) very gravelly silty clay loam; weak coarse subangular blocky structure; firm; dark reddish brown (5YR 3/4) clay flows on most ped faces; many manganese splotches, fragment coatings, and ped coatings; yellowish red (5YR 5/4) flow zones surrounded by a goethite reaction zone; few fine roots; 35 to 50% sandstone fragments; many pores; gradual wavy boundary. (Base of intermediate colluvium. Truncated older colluvial paleosol below.)

4Bt5 211 to 250 cm; yellowish brown (10YR 5/6) clay; moderate medium angular blocky structure with common pressure faces; very firm; strong brown (7.5YR 4/6) clay flows on many ped faces; few fine roots; common pores; gradual wavy boundary. (Bottom of pit. Auger observations below.)

4Bt6 250 to 270 cm; yellowish brown (10YR 5/6) clay; very firm; many light olive brown (2.5Y 5/4) mottles; many manganese splotches and hard manganese nodules throughout.

4BC 270 to 325 cm; yellowish brown (10YR 5/4) clay; very firm; many light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/6) mottles; many manganese splotches and manganese plugged zones; basal gravels (?) in lower part.

5CB 325 to 350 cm; reddish brown (5YR 4/4) clay (saprolite?); very firm; black manganese materials throughout.

Note: In this area on the back side of the secondary Pine Ridge, there are Rome colluvial materials of three ages. The colluvial mudflow that extends out the farthest is the oldest and has the highest clay content. There are areas where the oldest colluvium has been covered with younger colluvium and a fragipan has formed at the contact. The next oldest colluvium, of greatest extent, has a high proportion of dusky red Rome mudstone fragments. The youngest Rome colluvium is minor in extent and is located in drainageways. Rome colluvium extends out to and onto the Whiteoak Mountain Fault. Most of the fault is covered by Pleistocene, Holocene, or Modern alluvium.

Soil no.: 152.

Location: ORR. Intersection of Midway Road and Hot Yard Road and 3 m south of road. Last pit on drill road transect.
Classification: Typic Hapludults; fine-loamy, mixed, thermic.
Geomorphic position: toeslope.
Slope and aspect: 12 to 25% southwest.
Parent material(s): Chickamauga and East Fork Ridge (Upper Chickamauga, Silurian, Devonian, and Mississippian) colluvium.
Vegetation: Brush-cutover area.
Described by: Lietzke
Date: April 22, 1988

Soil Description

Oi 2 to 0 cm; leaf litter.

Ap 0 to 20 cm; brown (10YR 4/3) silt loam; moderate fine granular structure; very friable; many fine and medium roots; many pores; less than 5% olive-yellow shale and brown silurian sandstone fragments; abrupt wavy boundary.

Bt1 20 to 40 cm; strong brown (7.5YR 5/4) silty clay loam; moderate medium subangular blocky structure; friable; brown (7.5YR 4/4) clay flows on ped faces; common fine and medium roots; many pores; less than 5% shale and silurian sandstone fragments; gradual wavy boundary.

Bt2 40 to 75 cm; strong brown (7.5YR 5/4) silt loam; weak medium subangular blocky structure; friable; brown (7.5YR 4/4) clay flows on most ped faces; few fine roots; many pores; less than 5% shale and silurian sandstone fragments; gradual wavy boundary.

BC 75 to 103 cm; yellowish brown (10YR 5/4) silt loam; weak medium subangular blocky structure; friable; brown (7.5YR 4/4) clay flows on a few ped faces; few fine roots; many pores; less than 5% shale and silurian sandstone fragments; abrupt wavy boundary.

2Bt1' 103 to 150 cm; yellowish brown (10YR 5/4) silty clay loam; moderate coarse and medium subangular blocky structure; firm; thick strong brown (7.5YR 4/6) clay flows on most ped faces and in filled pores; many fine strong brown (7.5YR 5/8) plus light brownish gray (10YR 6/2) and pale brown (10YR 6/3) mottles; few fine roots; many pores; 5 to 15% chert and sandstone fragments; gradual wavy boundary.

2BC 150 to 200 cm; highly mottled yellowish brown (10YR 5/4) and light brownish gray (10YR 6/2) silty clay loam; weak coarse subangular blocky structure; firm; many firm manganese plugged splotches with goethite zones around them and light brownish gray on the outside. (Auger boring hit gravels at 200 cm and could go no farther.)

Stop 18. Hazardous Waste Management Research Sites

A demonstration of in situ vitrification (ISV) technology for the stabilization of radioactively contaminated soil sites at the Oak Ridge National Laboratory (ORNL) was successfully completed during July 1987. This demonstration is the first application of the ISV process to be performed outside the Hanford Site, where the technology was developed and patented by Pacific Northwest Laboratory (PNL). The joint ORNL-PNL pilot-scale demonstration was performed on a 3/8-scale trench (2 m deep x 1 m wide x 10 m long) that was constructed to simulate a typical seepage trench used for liquid low-level radioactive waste disposal at ORNL from 1951 to 1966. The contaminants of most interest are cesium and strontium. In the ISV process, electrodes are inserted around a volume of contaminated soil, power is applied to the electrodes, and the entire mass is melted from the surface of the soil down through the contaminated zone. The process creates a glassy-to-microcrystalline waste form that incorporates the contaminants. Gases produced during the melting are collected, treated, monitored, and released through an off-gas process trailer. In the ORNL demonstration, a 20-t mass of melted rock approximately 1.2 m thick x 1.2 m wide x 4.9 m long was formed during 110 h of operation that consumed approximately 29 MWh of power. It was found that the volatilization of cesium and strontium were acceptably low in this test (>99.9% retention within the melted mass). The glass formed is a high-calcium glass. The gray, crystalline material results from the crystallization of the glass in areas of slow cooling and is also associated with nucleation sites unidentified as of yet. The crystalline material is a mixture of wollastonite and anorthite in a spherulitic texture. Leach tests on the materials suggest that the durability of both the glass and the crystalline phases is at least as good as the durability of typical glass waste forms proposed for use in isolating high-level radioactive wastes.

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