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To the Graduate Council:

I am submitting herewith a thesis written by Charles R. Gass entitled "The Influence of Parent Materials Upon the Formation and Morphology of Some Soils of the Highland Rim and Brotherton Bench in Putnam County, Tennessee." I recommend that it be accepted for nine quarter hours credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agronomy.

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and recommend its acceptance:

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THE INFLUENCE OF PARENT MATERIALS UPON THE FORMATION AND
MORPHOLOGY OF SOME SOILS OF THE HIGHLAND RIM AND
BROTHERTON BENCH IN PUTNAM COUNTY,
TENNESSEE

A Thesis
Presented to
The Graduate Council of
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In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
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CHAPTER I

INTRODUCTION

On the Highland Rim and at a higher elevation on the Brotherton Bench in Putnam County, Tennessee are certain soils which have sola that are very similar, even though their substrata are variable. Each has a discontinuity in its profile at a depth of about 24 to 30 inches. The mantle thickness is greatest on smooth topography and diminishes rapidly with increased steepness. These observations make the soils appear to have formed, at least in part, from a deposit of transported parent material. The relationship of mantle thickness to topography at site 2 is shown in Figure 1. All of the sites have topography similar to this.

The physiography of the Highland Rim and Brotherton Bench along with the rest of the County is shown in Figure 2. The soils investigated in this study have tentatively been correlated Holston silt loam on the Brotherton Bench and Mountview silt loam on the Highland Rim.

The remarkable similarity and uncertain genesis of the upper parts of the profiles need explanation before the soils can be thoroughly understood and accurately classified. The objectives of this investigation were to determine the nature and origin of the parent material from which the upper horizons of these soils were formed and to compare properties of Mountview silt loam and Holston silt loam.

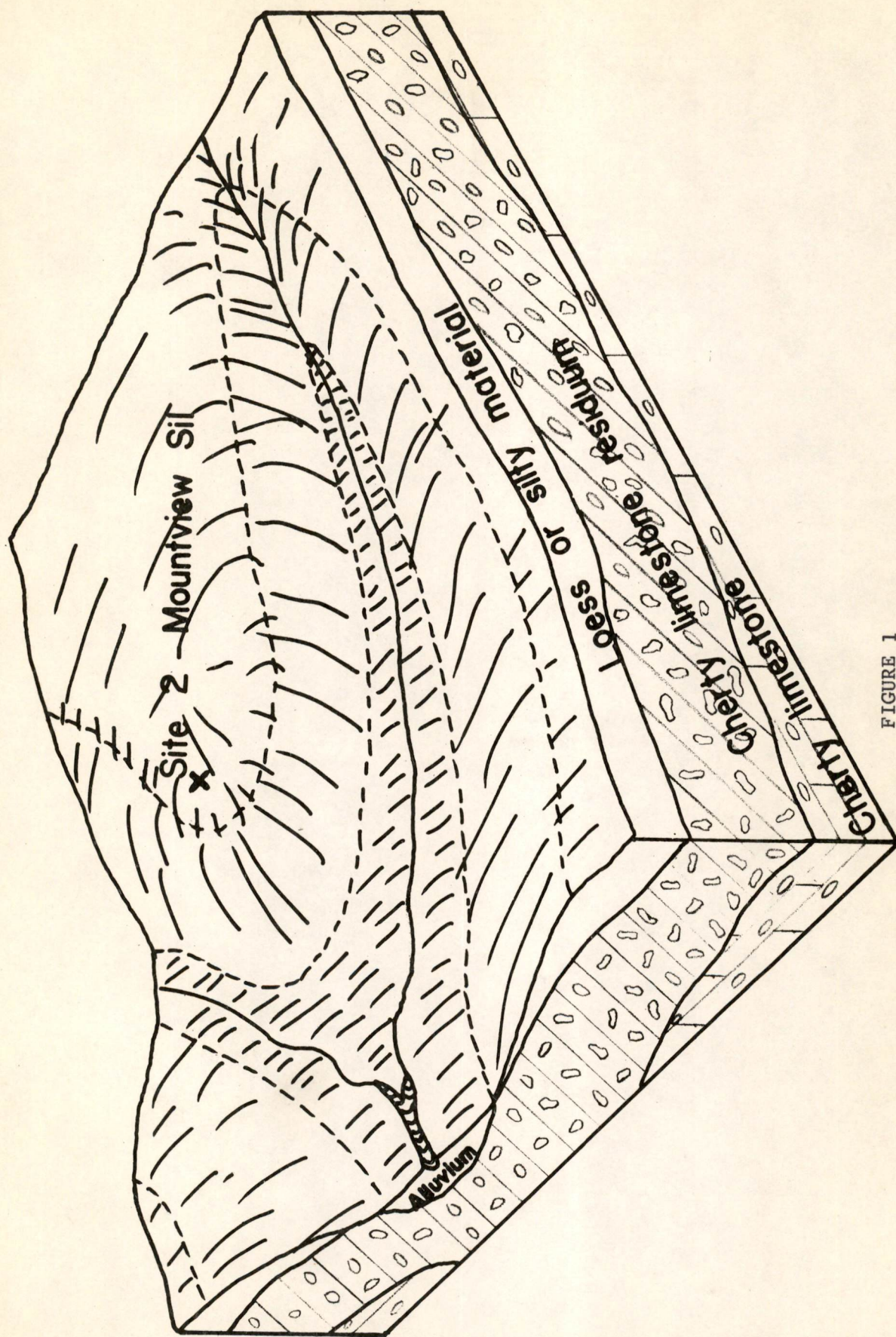


FIGURE 1

Block diagram showing the relationship of parent materials and soils to topography.

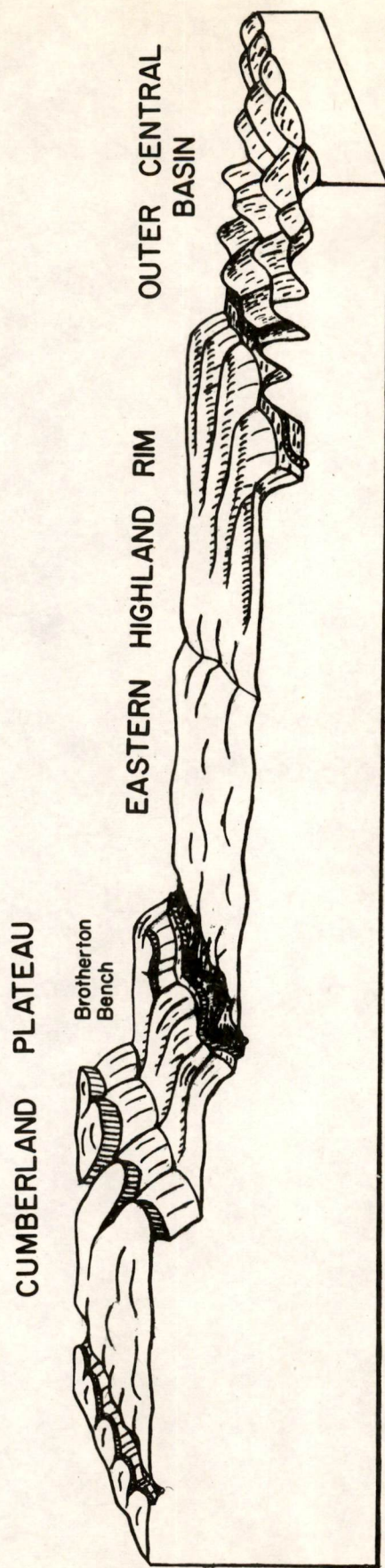


FIGURE 2

Block diagram showing physiographic features of Putnam County, Tennessee

CHAPTER II

REVIEW OF LITERATURE

Location and extent of the area

Putnam County is located approximately 65 miles east of Nashville and 40 miles south of the Kentucky line. It is bounded on the northeast by Jackson County, on the northwest by Overton and Fentress counties, on the east and south by Cumberland County, on the south by White County, on the southeast by DeKalb County, and on the west by Smith County (9).

There are three physiographic divisions in Putnam County. The Cumberland Plateau lies in the eastern third of the county. The central portion is occupied by the Highland Rim which joins the Central Basin in the western part of the county (17). In Putnam County the approximate above sea level ranges in elevation for these divisions are as follows: Cumberland Plateau, 1100 to 2000 feet; Highland Rim, 800 to 1100 feet; Central Basin, 500 to 800 feet (21).

Safford (12) reports the Highland Rim to be the largest natural division of Tennessee, occupying about 9,300 square miles, or nearly two-ninths of the State. He presents a rather unique description of the Central Basin, Highland Rim, and Cumberland Plateau:

Could the reader be elevated 2,000 or 3,000 feet above Nashville or rather above Murfreesboro, he would see below and around him the Basin, oval in form lying within the limits of Tennessee, yet reaching a little obliquely nearly across the State. He would see too, further off, the Highland Rim rising up first in bold walls - terrace like - all around the Basin, and then extending off, in every direction in great plains.

Far to the east and southeast, would be seen the western escarpment of the Cumberland Table-land, presenting the appearance, at this distance, of a long, straight, uniform bank or ridge, resting upon the Highlands, but in every other direction the eye would roam over the plains, with nothing to limit the view.

Geology

Putnam County is underlain by rocks of the Pennsylvanian, Mississippian, and Ordovician ages. In the eastern part of the County are rocks of Pennsylvanian age while those of the west are of Ordovician age. Between these and occupying a greater part of the County are rocks of Mississippian age. The rocks of Pennsylvanian age are largely sandstone and shale, while those of the Mississippian and Ordovician are mostly limestone (9).

All sites of this investigation are located on Mississippian formations.

The Mississippian formational boundaries on the Cookeville East quadrangle are listed below:¹

Cypress	1400 feet
Casper-Saint Genevieve.	1180 feet
Saint Louis	1080 feet
Warsaw.	1000 feet
Fort Payne.	970 feet

Climate

The climate of Putnam County is not uniform. The elevation is considerably lower in the west than in the east. With such a range in

¹Statement by Stewart Maher, personal communication.

topography the climatic data presented in Table 1 for Cookeville should not be interpreted to be representative of all parts of the County.

Average temperature decreases from extreme west to extreme east by about 4° F. The growing season (from the last spring to first fall temperature of 32° F. or lower) varies from about 200 days in the west to about 175 days on the Plateau in the east.²

Average potential evapotranspiration, estimated by the Thornthwaite method, for the years 1931-1952 for Cookeville, and for the years 1931-1955 for Crossville is shown in Figures 3 and 4. Dickson (1) pointed out that potential evapotranspiration, estimated by the Thornthwaite equation is a function of temperature, latitude, and time of the year. During computations of actual evapotranspiration, he assumed that evapotranspiration is limited by soil water content and that available water at field capacity is equal to 4 inches.

The silty mantle

In an early soil survey report of Putnam County, Waldrop (17) reported the soils on the Highland Rim in Putnam County to be largely Clarksville silt loam. He called most of the soils on the Brotherton Beach, DeKalb silt loam. He described DeKalb silt loam as "a gray to pale yellow silt loam 8 to 10 inches deep, underlain by a yellow, friable silt loam to silty clay loam, which generally extends to a depth of 3 feet or more." He described Clarksville silt loam as "a gray to pale yellow silt loam, 10 to 12 inches deep, underlain by a grayish-yellow to yellow silty clay

²Jackson, G. T., Bacon, S. R., Cox, B. C., and Gass, C. R. Unpublished soil survey--Putnam County, Tennessee. 1961.

Table 1.--Average monthly and annual precipitation in inches, Cookeville and Crossville^a

	Length of Record (Yrs.)	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Annual
Cookeville	24	5.65	4.05	5.64	4.38	4.50	4.25	4.97	4.60	2.98	3.57	4.08	4.71	53.38
Crossville	27	5.36	4.32	5.75	4.64	4.10	4.44	5.39	5.17	3.01	3.48	3.43	5.03	54.17

^aFrom "Climate and Man," USDA Yearbook, 1941.

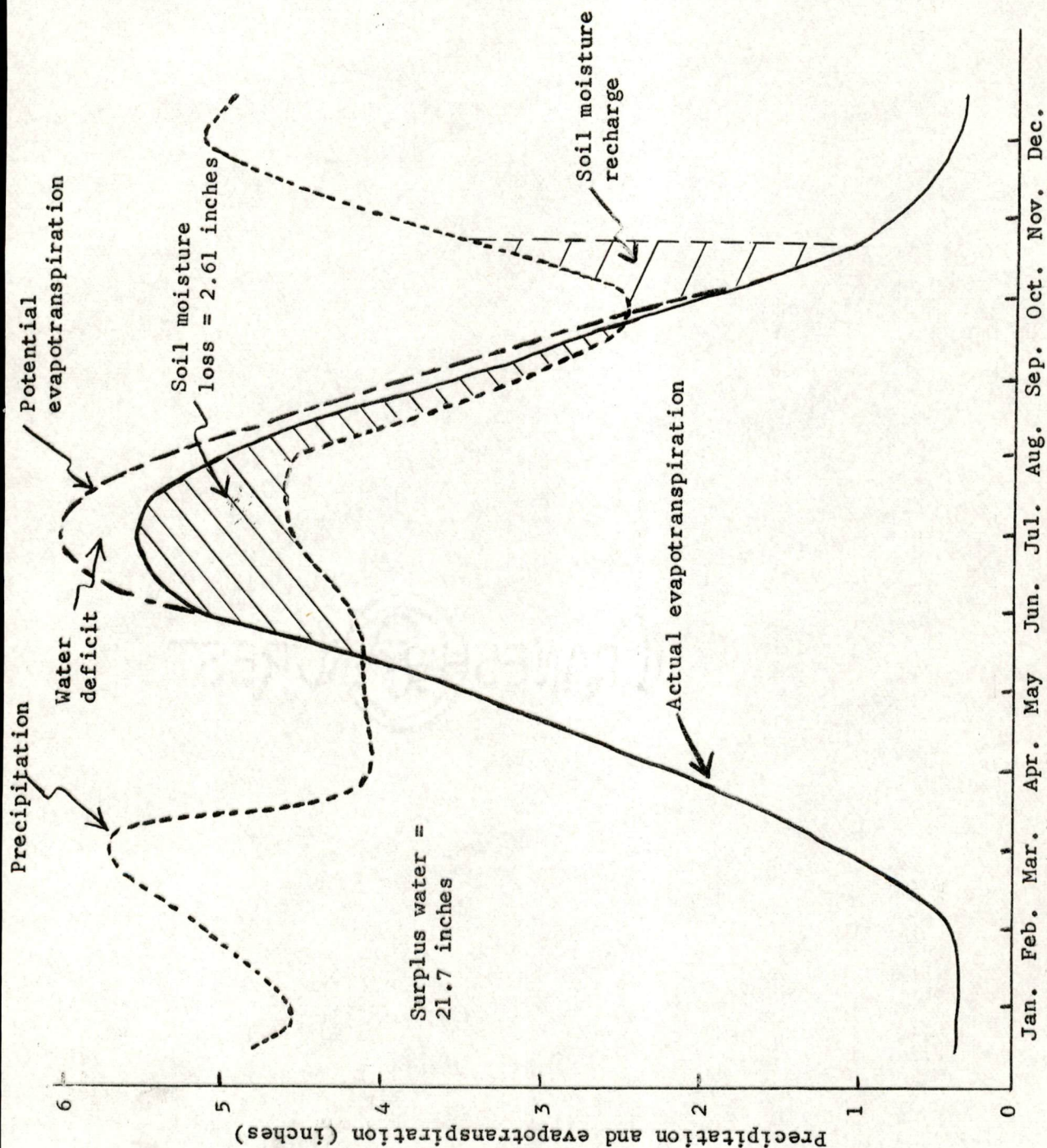


Figure 3--Average potential evapotranspiration and precipitation through the year at Cookeville for the period 1931-1952 (Data furnished by Dickson, R. R., Tennessee State Climatologist, U. S. Weather Bureau).

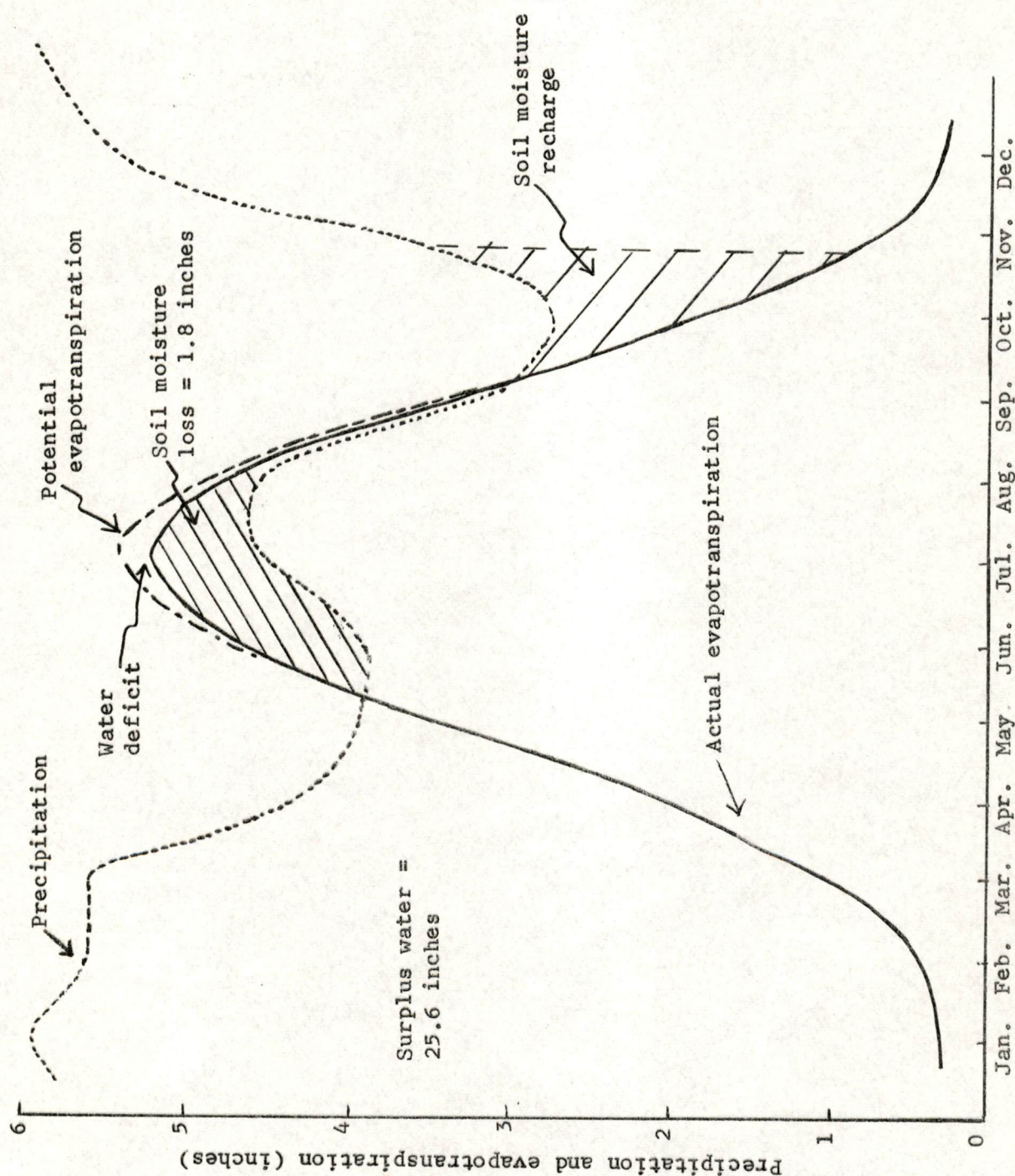


Figure 4--Average potential evapotranspiration and precipitation through the year at Crossville for the period 1931-1955 (Data furnished by Dickson, R. R., Tennessee State Climatologist, U. S. Weather Bureau).

loam of a moderately friable structure." He described the DeKalb as a residual soil formed from sandstone and Clarksville as a residual soil formed from both chert-free and cherty limestone.

Love (8) described the Highland Rim as having over most of it a silt mantle ranging from a thin film to a layer about thirty inches thick. He suggested that it was not known whether this mantle was a deposit of windblown material or residuum from rock. Fox (2) reported the Highland Rim to have remnants of a loessal or loesslike silt mantle over much of its area.

The Soil Survey Laboratory³ presented four hypotheses concerning the origin and development of this silty mantle in Coffee County, Tennessee. These four hypotheses are listed below.

1. The silty surface was aeolian in origin and deposited on limestone residuum during the Pleistocene Epoch. The source of the loess was unknown on the basis of present information.
2. The original material was limestone residuum and clay was removed from surface horizons by eluviation, leaving a silt loam surface and heavier-textured lower horizons.
3. The original material was limestone residuum, and through weathering chemical destruction of the clay has taken place, with consequent leaching of the weathered products in solution or finely-divided colloidal suspension. This process would also leave silt in the surface without necessarily developing a textural B horizon.
4. The original material was limestone residuum and the chert has weathered in surface horizons to silt size, thus diluting the clay and resulting in a silt loam textured material.

It was also suggested that the occurrence of more than one of these processes in combination could develop a silty mantle.

³Soil Survey Laboratory. Characterization report of selected soils from Coffee County, Tennessee. S. C. S., U. S. D. A. Beltsville, Md. 1959.

Largely on the strength of a petrographic analysis of the sand and coarse silt fractions of Pembroke silt loam, it was concluded that the silty mantle was probably aeolian in origin.

Wascher et al. (19) studied loess deposition in the Mississippi Valley and found loess as far east in Tennessee as they sampled, namely the Western Highland Rim. They described the loess in that area, the Western Highland Rim, as being mostly about two feet thick. They further described this loess as commonly being mixed with the underlying materials whenever it was less than three feet thick.

Red-Yellow Podzolic soils

Thorp and Smith (16) have presented the following definition of the Red-Yellow Podzolic Group:

A group of well developed, well drained, acid soils having thin organic (Ao) horizons over a light colored bleached (A2) horizon, over a red, yellowish red or yellow more clayey (B) horizon. Parent materials are more or less siliceous. Coarse reticulate streaks or mottles of red, brown, and light gray are characteristic of deep horizons of the Red-Yellow Podzolic soils where parent materials are thick.

Simonson (14) suggested that the dominant processes in the genesis of Red-Yellow Podzolic soils are the formation of silicate minerals in the deeper horizons and destruction of those minerals in the upper horizons. He postulated that the A horizons are too thin to have supplied the clay accumulation in the B. He further stated that since Gray-Brown Podzolic soils tend to accumulate clay minerals in the solum, formation or destruction of clay minerals in the solum is a far better way than illuviation and eluviation to distinguish Red-Yellow Podzolic from Gray-Brown Podzolic soils.

On the other hand, McCaleb (10) presented evidence which showed that clay moves from the A to the B horizon largely by physical means. He also pointed out that if the C horizons have large concentrations of clay relative to the solum, it is more reasonable that they are associated with materials unlike those which apparently gave rise to the profile or that they have developed from shales or fine-grained sediments.

Fragipans

Each of the five soil profiles studied have some degree of fragipan development.

Winters (20) listed the following conditions as favorable for the development of fragipans:

1. Smooth to moderate topography.
2. Imperfect to slow drainage.
3. Silty textured parent material.
4. Moderate to long time for development.
5. Climate with seasonal drought periods.

The soil survey manual (15) defines a fragipan mainly on the basis of certain physical properties: high bulk density, relatively low clay percentage, massiveness, and a pronounced reversible induration.

Grossman et al. (4), in reference to fragipans in Illinois, would add to this two additional morphological features: "(1) the fragipan is found within the lower sequum of a bisequal solum and (2) the occurrence in the lower sequum of a polygonal network of gray silt loam that extends downward from the A2 horizon and delineates prismatic structural units."

They found that the bisequal nature and expression of the fragipan increased with decreasing loess thickness and with latitude from north to south. They found maximum expression of fragipans in the low, moderately well-drained positions and suggested that the fragipan soils of Illinois are part of an interstate sequence extending southward to Mississippi within the loess-derived soils of the Mississippi Valley.

CHAPTER III

METHODS AND PROCEDURES

Field Methods

The soils sampled for study were located at five sites in Putnam County. Two of the sites were located on the Highland Rim and were correlated Mountview silt loam. The other three sites were located on the Brotherton Bench which lies at a level intermediate in height between that of the Highland Rim and that of the Cumberland Plateau and were correlated with Holston silt loam. The sites were widely spaced, and each was well within forested areas. No erosion could be detected at any of the sites nor was there any accumulation of soil from local sources. The soil profiles were described in situ from the faces of excavations. Bulk samples were collected in clean cloth bags after descriptions of the profiles had been made. All Munsell color notations were noted on moist soil. Contamination of horizons was avoided by sampling upward from the bottom of the profile.

Laboratory Procedures

The soil samples were air-dried, rolled, quartered and a suitable subsample was passed through a two mm. round-hole sieve and stored in quart cartons in the laboratory.

All determinations except mineralogical ones were made in duplicate.

Mechanical analyses were made by the pipette method as described by Kilmer and Alexander (7). Coarse fragments were weighed air dry and calculated on a weight basis. pH was determined on a soil paste with a Beckman pH meter. Organic matter content was determined by the chromate oxidation method (wet combustion) as described by Walkley and Black (18) with modifications by Peech et al. (11). Cation exchange capacity was determined by distillation of adsorbed ammonia on the soil after leaching with neutral normal ammonium acetate, as described by Peech et al. (11). Exchangeable bases were estimated in 0.2 N ammonium chloride solution with a Beckman Model DU flame spectrophotometer, with No. 9200 flame attachment and No. 4300 photomultiplier assembly, as outlined by Shaw and Veal (13). Available phosphorus was extracted with 0.05 N sulfuric acid containing 1.0% ammonium sulfate, soil-solution ratio of 1 to 4, and was determined colorimetrically with a Beckman Model B spectrophotometer. Total nitrogen was determined by the method outlined by Jackson (6).

Heavy and light minerals were separated by the method described by Haseman and Marshall (5) with the following modification: After the samples were separated by centrifuging, the centrifuge tubes, containing the separated minerals in tetrabromoethane (density 2.95), were placed in a one-gallon ice cream carton containing dry ice and left until barely frozen. The light minerals were then washed from the surface of the frozen tetrabromoethane with acetone.

Light minerals were identified by the method described by Gabriel and Cox (3) with the following modification: Plagioclase feldspars were identified by staining them with malachite green.

CHAPTER IV

RESULTS

Description of the Soil Profiles

SITE-1

Soil profile: Holston silt loam

A ₀₀ , A ₀	1-0 inches	Leaf litter of deciduous origin and partly decomposed organic residue.
A ₁	0-1 inches	Dark grayish brown (10 YR. 4/2) silt loam; weak fine granular structure; very friable; extremely acid; abrupt and wavy boundary; numerous roots well distributed.
A ₂	1-7 inches	Yellowish brown (10 YR. 5/4) to light yellowish brown (10 YR. 6/4) silt loam; weak medium granular structure; very friable; very strongly acid; gradual and wavy boundary; roots numerous and well distributed.
B ₁	7-12 inches	Yellowish brown (10 YR. 5/4) silt loam; weak fine subangular blocky structure; friable; very strongly acid; gradual and wavy boundary; roots numerous.
B ₂₁	12-19 inches	Yellowish brown (10 YR. 5/6) silt loam; weak medium subangular blocky structure; friable, very strongly acid; gradual and wavy boundary;

		few pores; abundant fine roots.
B ₂₂	19-24 inches	Yellowish brown (10 YR. 5/4) silt loam; weak medium subangular blocky structure; friable; very strongly acid; clear and wavy boundary; pores are common; few fine roots.
B ₃	24-31 inches	Yellowish brown (10 YR. 5/6) loam, mottled with pale brown (10 YR. 6/3) and dark brown (7.5 YR. 4/4); mottles are common, medium, distinct; weak medium angular blocky structure to nearly massive; firm, brittle; very strongly acid; clear and wavy boundary; a few thin patchy clay films; a few sandstone and siltstone fragments.
D _u	31-48 inches	Strong brown (7.5 YR. 5/6) clay loam, variegated with yellowish red (5 YR. 4/6), brownish yellow (10 YR. 6/5), and grayish brown (10 YR. 5/2); variegations are many, coarse, prominent; moderate medium subangular and angular blocky structure; friable, firm in place; very strongly acid. Abrupt and wavy boundary; few to common partly weathered sandstone and siltstone fragments; conspicuous clay films.
D _r	48 + inches	Fractured fine grained sandstone.
Topography:		Broad gently sloping bench top; slope gradient 1-3%.

Vegetation:

Largely deciduous with chestnut oak and hickory predominating. Other species that are common include white oak, black oak, southern red oak, northern red oak, scarlet oak, red maple, sugar maple, dogwood, sourwood, black gum, and red cedar.

Lesser vegetation: laurel (*Kalmia*), greenbrier, and *Viburnum*. Woods show evidence of fairly recent fire.

Location:

One mile north of Brotherton about fifty feet into the woods of the Bilbrey farm. This is the northern most bench in the county.

Remarks:

Soil is not modal Holston. It appears to be slightly intergrading to Monongahela.

SITE-2**Soil profile: Mountview silt loam**

A ₀₀ , A ₀	1-0 inches	Loose leaf litter of deciduous origin and partly decomposed organic residue.
A ₁	0-1 inches	Dark grayish brown (10 YR. 4/2) silt loam; weak fine granular structure; very friable; very strongly acid; boundary clear and smooth; many roots well distributed.

A ₂	1-7 inches	Light yellowish brown (10 YR. 6/4) silt loam; weak medium to coarse granular structure; friable; very strongly acid; clear and smooth boundary; few pores; many roots.
B ₁	7-12 inches	Yellowish brown (10 YR. 5/6) silt loam, weak medium to fine subangular blocky structure; friable; very strongly acid; gradual and wavy boundary; few pores; abundant roots.
B ₂	12-22 inches	Yellowish brown (10 YR. 5/6) silt loam; moderate medium subangular blocky structure; friable; very strongly acid; gradual and wavy boundary; few pores; abundant roots; very few patchy clay films.
B ₃₁	22-28 inches	Variegated yellowish brown (10 YR. 5/6), dark brown (7.5 YR. 4/4), pale brown (10 YR. 6/3) silt loam; variegations are common, medium, distinct; moderate medium angular blocky structure; friable to firm; very strongly acid; gradual and wavy boundary; few roots; few patchy clay films; chert fragments common.
B ₃₂	28-33 inches	Variegated yellowish brown (10 YR. 5/6), yellowish red (5 YR. 4/8), dark brown (7.5 YR. 4/4) cherty silty clay loam; variegations are common, medium, distinct; moderate medium and fine angular blocky structure; firm; strongly acid; gradual and

irregular boundary; common patchy clay films; chert and shale fragments common.

D_u 33-48+ inches Variegated yellowish red (5 YR. 4/8), strong brown (7.5 YR. 5/6), light reddish brown (2.5 YR. 6/4) silty clay; variegations are many, coarse, prominent; moderate medium and coarse angular blocky structure; firm, strongly acid; many thick clay films; few chert and weathered shale fragments. Tongues of B extending into the D are paler in color and siltier in texture than the D. They extend into the D as much as ten inches; clay films are on horizontal faces.

Topography:

Slope gradient ranges from 2-4% near the end of the projection of a broad gently sloping ridge-top.

Vegetation:

The forest had been heavily cut over. Oaks such as white oak, black oak, scarlet oak, northern red oak, southern red oak, and post oak are prevalent. Other abundant trees include sweetgum, red maple, tulip poplar, mockernut hickory, dogwood, sourwood, and blackgum.

Lesser vegetation: largely sawbrier, little bluestem, persimmon, sassafras, and many tulip poplar seedlings.

Location: About 1/4 mile east of the community of Thomas, one hundred yards south into the woods near a very tall isolated poplar tree.

Remarks: Chert fragments are distributed throughout the profile. There are a few in the A and B horizons and common to many in the D. Weathered shale fragments in the D are also common. The D horizon exhibits some platiness. There are prominent clay films on the horizontal faces in the D.

SITE-3

Soil profile: Holston silt loam

A00, A0	1-0 inches	Loose leaf litter of deciduous origin and partly decomposed organic residue.
A1	0-1 inches	Dark grayish brown (10 YR. 4/2) silt loam; weak fine granular structure; very friable; extremely acid; clear and wavy boundary; many roots well distributed.
A2	1-8 inches	Brown (10 YR. 5/3) silt loam; moderate medium and coarse granular structure; friable; very strongly acid; clear and wavy boundary; few pores; many roots.
B1	8-12 inches	Yellowish brown (10 YR. 5/4) silt loam; weak fine subangular blocky structure; friable; very

strongly acid; gradual and wavy boundary; pores common; many roots.

- | | | |
|-----------------|--------------|--|
| B ₂₁ | 12-18 inches | Yellowish brown (10 YR. 5/6) silt loam; moderate fine subangular blocky structure; friable; very strongly acid; gradual and wavy boundary; few pores; many roots. |
| B ₂₂ | 18-26 inches | Yellowish brown (10 YR. 5/6) silt loam; moderate medium subangular blocky structure; friable; very strongly acid; clear and irregular boundary; few pores; roots common. |
| B _{3m} | 26-31 inches | Yellowish brown (10 YR. 5/6) silt loam mottled with light grayish brown (10 YR. 6/2) and dark brown (7.5 YR. 4/4); mottles are common, medium, distinct; moderate medium angular and subangular blocky structure, firm, brittle; very strongly acid; diffuse and irregular boundary; very few roots. |
| D _{u1} | 31-42 inches | <p>Variegated yellowish red (5 YR. 4/6), yellowish brown (10 YR. 5/6), dark brown (7.5 YR. 4/4) loam; variegations are many, medium, prominent; moderate angular blocky structure; friable, somewhat brittle; very strongly acid; diffuse and irregular boundary, common patchy clay films.</p> <p>Tongues of B_{3m} extend well into D.</p> |

Du2 42-96+ inches Variegated red (2.5 YR. 4/8), strong brown (7.5 YR. 5/8), yellowish red (5 YR. 4/6) clay loam, variegations are common, medium, prominent; moderate medium angular blocky structure; friable to firm; very strongly acid; thick clay films are common.

Topography: Gently sloping area near the edge of the slope break on an extremely broad bench.

Vegetation: Largely white oak, some chestnut oak, northern red oak, black oak, few hickories, tulip poplar, red maple, sugar maple, sweetgum, sourwood and beech. There are several huge chestnut stumps, most of which are about 3 feet in diameter.

Location: In Palk's woods on the southern most bench in the county, 100 feet southwest of first sharp turn in dirt road leading into the woods.

Remarks: Intermittent fragipan. Colors of horizons are uniform in the upper 26 inches but presence of pan makes profile only moderately well drained. The D horizon is probably buried B which may be old alluvium.

SITE-4

Soil profile: Holston silt loam

A00, A0	1-0 inches	Leaf litter of deciduous origin and partly decomposed organic residue.
A1	0-1 inches	Dark grayish brown (10 YR. 4/2) silt loam; weak fine granular structure; very friable; very strongly acid; clear and wavy boundary; many pores; many roots well distributed.
A2	1-6 inches	Pale brown (10 YR. 6/3) to brown (10 YR. 5/3) silt loam; weak medium granular structure; friable; very strongly acid; clear and smooth boundary; many pores; many roots well distributed.
B1	6-11 inches	Yellowish brown (10 YR. 5/4) silt loam; weak fine subangular blocky structure; friable; very strongly acid; gradual and smooth boundary; fine pores common; roots common.
B2	11-19 inches	Yellowish brown (10 YR. 5/6) silt loam; moderate fine and medium subangular blocky structure; friable; very strongly acid; clear and wavy boundary; few pores; roots common.
B31	19-22 inches	Yellowish brown (10 YR. 5/6) loam mottled with pale brown (10 YR. 6/3) and dark brown (7.5 YR. 4/4); mottles are common, medium, distinct; moderate medium subangular blocky structure; friable; very strongly acid; gradual and

- irregular boundary; few pores; few fine roots.
- B₃₂ 22-30 inches Dark brown (7.5 YR. 4/4) loam mottled with light grayish brown (10 YR. 6/2) and yellowish red (5 YR. 4/6); mottles are common, medium, distinct; moderate medium angular blocky structure; firm, brittle; very strongly acid; gradual and irregular boundary; thin continuous clay films.
- B_{21b} 30-40 inches Dark brown (7.5 YR. 4/4) clay loam mottled with yellowish brown (10 YR. 5/6); mottles are common, medium, distinct; moderate medium angular blocky structure; firm, nearly brittle; very strongly acid; gradual and irregular boundary; thin continuous clay films.
- B_{22b} 40-55 inches Mottled red (2.5 YR. 4/8), strong brown (7.5 YR. 5/8), and light gray (10 YR. 7/1) clay; mottles are many, medium, prominent; weak and moderate angular blocky structure; firm and brittle; very strongly acid; diffuse and irregular boundary; tongues of light gray silty material extending well into the horizon; thin patchy clay films.
- C_b 55-70 inches Mottled red (2.5 YR. 4/8), strong brown (7.5 YR. 5/8), and light gray (10 YR. 7/1) sandy clay loam; mottles are many, common, prominent; massive; friable; very strongly acid; partly weathered sandstone and shale fragments.

Topography: Slope gradient ranges from 1-4% on a gently sloping broad bench.

Vegetation: Heavily cut-over deciduous forest. Many tulip poplars, scarlet oaks, and cedars where canopy is open. Oaks such as white oak, black oak, and chestnut oak are common. Huge chestnut stumps about 3 feet in diameter are scattered throughout the immediate area. The sparseness of the understory is probably due to grazing.

Location: About $1\frac{1}{2}$ miles north of Rocky Point on a dead-end road. Site is about 200 feet north of the next to the last house on the road.

Remarks: A few sandstone fragments throughout the profile. Almost no roots below 22 inches. No definite fragipan but polygons are present in B₃₁, B₃₂, B_{21b}, and B_{22b}. They are especially clear in B₃₂ and B_{21b}.

SITE-5

Soil profile: Mountview silt loam

A ₀₀ , A ₀	1-0 inches	Leaf and twig litter of deciduous origin and partly decomposed organic residue.
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A ₁	0-1 inches	Very dark grayish brown (10 YR. 3/2) silt loam; weak fine granular structure; very friable; extremely acid; clear and wavy boundary; many roots well distributed.
A ₂	1-6 inches	Brown (10 YR. 5/3) silt loam; weak fine subangular blocky structure; very friable; very strongly acid; clear and smooth boundary; few pores; many roots.
B ₁	6-10 inches	Yellowish brown (10 YR. 5/4) silt loam; moderate medium subangular blocky structure; friable; very strongly acid; gradual and smooth boundary; few pores; many roots.
B ₂	10-19 inches	Yellowish brown (10 YR. 5/6) silt loam; moderate fine subangular blocky structure; friable; very strongly acid; clear and smooth boundary; few pores; roots common.
B _{3m1}	19-24 inches	Yellowish brown (10 YR. 5/4) silt loam mottled with dark grayish brown (10 YR. 4/2) and light gray (10 YR. 7/1); mottles are many, medium, distinct; moderate medium angular blocky structure; hard brittle peds rupture to friable mass; very strongly acid; gradual and irregular boundary; few pores.
B _{3m2}	24-32 inches	Dark brown (7.5 YR. 4/4) clay loam mottled with yellowish brown (10 YR. 5/6) and light gray

(10 YR. 7/1); mottles are many, common, prominent; moderate fine angular blocky structure; firm and brittle; very strongly acid; gradual and irregular boundary; thin patchy clay films; few roots.

- B_{3m3} 32-40 inches Yellowish red (5 YR. 4/6) clay loam mottled with light yellowish brown (10 YR. 6/4); mottles are common, coarse, prominent; moderate medium angular blocky structure; firm, slightly brittle; very strongly acid; diffuse and irregular boundary; clay films thin on old peds and thick on new ones.
- D 40-48+ inches Dark red (2.5 YR. 3/6) clay mottled with yellowish red (5 YR. 4/8), light yellowish brown (10 YR. 6/4), and light brownish gray (10 YR. 6/2); mottles are common, medium, distinct; moderate medium angular blocky structure; firm; strongly acid; patchy clay films.

Topography:

Slope gradient ranges from 2-4%, located near the end of the projection of a broad gently sloping ridgetop.

Vegetation:

Largely an oak forest that was heavily cut over several years ago. Most of the large trees are post oak, scarlet oak, and northern red oak. Understory species are mostly dogwood, sourwood, and blackgum. Also there are several white oaks,

pignut hickories and scaly bark hickories in the sapling stage. Lesser vegetation is mainly greenbrier and sumac.

Location: On Buffalo Valley Road about 2 miles south of Baxter, 40 or 50 feet into the woods north of the road.

Remarks: A few fine concretions and quartz pebbles in the A and B horizon. Quartz pebbles common in the underlying material. A discontinuous fragipan is present with tongues extending well into the D. In parts of the County soils similar to this have been mapped Holston silt loam.

Results of Laboratory Determinations

Particle size distribution of the different horizons in the five soil profiles are presented in Table 2. Each profile had such a small amount of very coarse, coarse, and medium sand that these fractions are reported as particles ranging in diameter from 2 to 0.25 mm. Even when reported together, these fractions make up less than 2% of the content of the profiles at sites 1, 3, and 4. The profiles at sites 2 and 5 had a somewhat larger amount of such sand, most of which was in the 0.5 to 0.25 mm. range. Fine sand and especially very fine sand formed the major part of the sand fraction in all the profiles except at site 5 where there was about an equal amount of fine and very fine sand in each of its horizons.

Table 2.--Particle size distribution in percent for the horizons of the five soil profiles from the Highland Rim and Brotherton Bench

Profile No.	Horizon	Depth (in.)	Coarse Fragments		Sand					Silt			Clay		Textural class
			> 2 mm. ^a	2-0.25 mm.	0.25-0.1 mm.	0.1-0.05 mm.	0.05-0.02 mm.	0.02-0.002 mm.	<0.002 mm.						
1	A1	0-1	0.3	0.4	6.0	24.6	17.8	40.8	10.4				10.4		sil
	A2	1-7	0.1	1.4	4.9	23.9	16.3	44.2	10.1				10.1		sil
	B1	7-12	0.1	0.9	3.9	21.8	14.1	45.9	13.0				13.0		sil
	B21	12-19	0.2	0.9	3.2	18.9	17.2	41.4	17.3				17.3		sil
	B22	19-24	0.1	0.6	4.3	29.3	7.5	40.3	18.0				18.0		sil
	B3	24-31	0.1	0.5	4.4	30.1	8.2	31.4	25.4				25.4		l
	Du	31-48	0.0	0.6	3.7	34.8	8.5	19.7	32.7				32.7		cl
2	A1	0-1	6.8	0.8	4.4	25.5	20.0	40.8	8.5				8.5		sil
	A2	1-7	10.2	4.0	8.8	14.4	20.5	42.8	9.5				9.5		sil
	B1	7-12	6.8	2.1	6.7	10.8	16.6	53.8	10.0				10.0		sil
	B2	12-22	7.9	2.1	5.7	10.2	16.4	41.9	23.7				23.7		sil
	B31	22-28	11.0	1.7	5.4	10.1	13.2	42.6	27.0				27.0		sil
	B32	28-33	25.8	2.9	4.9	9.9	10.9	37.7	33.7				33.7		chsicl
	Du	33-48	7.3	6.5	3.4	8.4	6.7	28.2	46.7				46.7		sic
3	A1	0-1	0.2	1.1	10.7	14.4	14.9	48.0	10.9				10.9		sil
	A2	1-8	0.1	0.9	8.7	13.5	16.1	50.2	10.6				10.6		sil
	B1	8-12	0.1	0.9	8.1	13.0	15.1	49.5	13.4				13.4		sil
	B21	12-18	0.3	1.0	8.1	12.4	14.1	46.6	17.8				17.8		sil
	B22	18-26	0.3	1.2	8.6	13.1	12.7	41.5	22.9				22.9		sil
	B3m	26-31	0.3	1.3	10.3	16.6	14.3	38.2	19.3				19.3		sil
	Du1	36-42	0.2	1.1	11.2	17.1	11.9	34.8	23.9				23.9		l
	Du2	42-96	0.1	1.2	9.5	15.5	8.9	28.6	36.3				36.3		cl

^aBased on whole soil.

Table 2 (CONTINUED)

Profile No.	Horizon	Depth (in.)	Coarse Fragments >2 mm.a	Sand				Silt		Clay mm.	Textural class
				2-0.25 mm.	0.25-0.1 mm.	0.1-0.05 mm.	0.05-0.02 mm.	0.02-0.002 mm.	<0.002 mm.		
4	A1	0-1	0.2	1.1	10.0	19.4	18.7	41.5	9.3	sil	
	A2	1-6	0.3	1.1	9.2	18.9	18.2	42.6	10.0	sil	
	B1	6-11	0.4	1.2	7.9	16.9	16.4	42.4	15.2	sil	
	B2	11-19	1.1	1.4	7.1	16.7	15.2	38.4	21.2	sil	
	B31	19-22	0.2	1.1	8.1	18.8	13.6	35.6	22.8	l	
	B32	22-30	0.3	1.2	8.3	19.4	12.5	32.2	26.4	l	
	B21b	30-40	0.1	0.8	8.7	20.7	12.1	23.2	34.5	cl	
	B22b	40-55	-	0.5	6.7	26.3	9.4	15.5	41.6	c	
	Cb	55-70+	-	0.7	10.8	46.0	8.9	11.1	22.5	scl	
5	A1	0-1	1.3	6.3	10.9	10.4	19.6	44.2	8.6	sil	
	A2	1-6	1.3	7.1	10.5	9.8	15.5	47.4	9.7	sil	
	B1	6-10	1.1	5.8	8.9	8.8	16.5	46.4	13.6	sil	
	B2	10-19	2.1	6.0	8.6	8.7	15.1	42.8	18.8	sil	
	B3m1	19-24	2.1	6.8	9.9	9.7	14.2	42.1	17.3	sil	
	B3m2	24-32	1.7	6.3	9.1	9.7	12.7	34.3	27.9	cl	
	B3m3	32-40	0.9	6.1	9.3	9.7	10.2	28.8	35.9	cl	
	Du	40-60+	0.9	7.7	9.4	9.7	8.3	22.8	42.1	c	

^aBased on whole soil.

The silt content in all five profiles was rather uniform. Each site had on the average about 60% silt in the A and upper part of the B horizons. Silt content decreased with depth to a fairly abrupt break in the lower part of the B or at the D horizon. The amount of fine silt was 2 to 3 times greater than coarse silt in every horizon of all five profiles.

The clay content showed an inverse relationship with silt content in the solum at all of the sites. The A horizons were low in clay content ranging from a low of 8.5% at site 2 to a high of only 10.6% at site 3. Each profile showed a gradual increase in clay content with depth until, as was the case of the silt content, a break occurred at the lower part of the B or upper part of the D horizons. At this point the clay was relatively high.

Soil pH, percent organic matter, percent total nitrogen, cation exchange capacity, amount of exchangeable calcium, magnesium and potassium, percent base saturation, and available phosphorus in each of the five soil profiles are presented in Table 3. The pH in each horizon at all five sites was either very strongly acid or extremely acid. There was in general a very slight increase in pH with depth. All organic horizons were extremely acid.

The organic matter content decreased rapidly with depth at all sites. Most of the organic matter was in the A₁ and A₂ horizons. The A₁'s ranged from 4.2% at site 5 to 7.1% at site 1. There was a small amount of organic matter in the B horizons but almost none in the substrata.

Both total nitrogen and organic matter decreased rapidly with depth with most of the nitrogen being in the A horizon. Upper horizons had C/N

ratios ranging from 12 to 20; the lower ones ranged from 5 to 10.

All five sites had similar cation exchange capacities. Each profile had a relatively high cation exchange capacity in the A1, dropped sharply to a minimum in the A2 or B1, and gradually increased with depth.

Exchangeable basic cations were consistently low throughout the profile at each of the five sites. For the most part the content of each basic cation in each horizon was less than one milliequivalent per 100 grams of air-dry soil. The only exceptions were the A1 horizons at sites 2, 4, and 5, where there was slightly more than one milliequivalent of calcium. Potassium was least abundant of the exchangeable bases and generally decreased with depth. Generally, calcium also decreased with depth; however, at sites 1, 2, and 3 there was a slight increase in calcium in the substratum. Unlike calcium and potassium, magnesium generally increased with depth, especially in the B horizon.

Percent base saturation was quite low in each of the soil profiles. Extremes in these values were 3.6% in the D horizon at site 1 and 27% in the B2 at site 5.

Available phosphorus was very low in all horizons.

Results of a heavy and light mineral separation on the 0.05-0.02 mm. silt fraction are shown in Table 4. Generally, a larger amount of heavy minerals was found in the upper horizons than in the lower ones.

Results of the light mineral examination show the potassium feldspar content of the upper horizons to be quite high relative to the lower horizons.

Table 3.--Chemical properties of five soil profiles from the Highland Rim and Brotherton Bench

Profile No.	Horizon	Depth In.	pH	Organic Matter %	Total Nitrogen %	C.E.C. me./100 g.	Exchangeable Cations			Base Saturation %	P ppm.
							Ca	Mg	K		
							me./100 g.	me./100 g.			
1	A00, A0	1-0	4.4	-	-	-	-	-	-	-	-
	A1	0-1	4.6	7.1	0.243	15.5	0.58	0.45	0.16	7.7	2
	A2	1-7	4.9	2.3	0.102	5.7	0.17	0.12	0.10	7.1	tr.
	B1	7-12	4.8	0.9	-	4.0	0.15	0.12	0.11	9.5	tr.
	B21	12-19	4.7	0.4	0.042	4.7	0.17	0.25	0.10	11.1	tr.
	B22	19-24	4.7	0.3	0.032	5.2	0.16	0.31	0.09	10.9	tr.
	B3	31-36	4.8	0.03	-	9.2	0.08	0.32	0.13	5.8	tr.
	Du	36-48	5.0	0.02	-	14.5	0.225	0.205	0.102	3.6	tr.
2	A00, A0	1-0	4.4	-	-	-	-	-	-	-	-
	A1	0-1	4.6	5.5	0.256	12.4	1.05	0.70	0.10	14.9	3
	A2	1-7	4.8	1.4	0.058	4.7	0.27	0.12	0.02	8.7	2
	B1	7-12	4.8	0.6	-	6.4	0.22	0.16	0.08	7.2	tr.
	B2	12-22	4.8	0.4	0.033	8.5	0.12	0.41	0.06	6.9	tr.
	B31	22-28	4.9	0.3	0.028	10.1	0.17	0.78	0.09	10.3	tr.
	B32	28-32	5.2	0.1	0.025	13.1	0.22	0.70	0.13	8.0	tr.
	Du	33-48	5.2	0.1	-	19.0	0.25	0.57	0.25	5.6	tr.
3	A00, A0	1-0	4.3	-	-	-	-	-	-	-	-
	A1	0-1	4.2	4.5	0.126	9.1	0.97	0.41	0.25	17.9	6
	A2	1-8	4.9	1.8	0.061	5.0	0.25	0.29	0.15	13.8	3
	B1	8-12	4.8	0.8	-	4.3	0.25	0.41	0.13	18.4	2
	B21	12-18	4.7	0.5	0.028	5.0	0.27	0.29	0.13	13.8	1
	B22	18-26	4.6	0.4	0.025	7.6	0.25	0.98	0.18	18.5	1
	B3m	26-31	4.5	0.1	-	6.1	0.10	0.49	0.11	11.5	1
	Du1	31-42	4.5	0.1	-	8.0	0.10	0.41	0.11	7.7	1
	Du2	42-96	4.9	0.1	-	12.4	0.22	0.20	0.14	4.5	1

Table 3 (CONTINUED)

Profile No.	Horizon	Depth In.	pH	Organic Matter %	Total Nitrogen %	C.E.C. me./100 g.	Exchangeable Cations			Base Satura- tion %	P ppm.
							Ca	Mg	K		
4	A00, A0	1-0	4.2	-	-	-	-	-	-	-	-
	A1	0-1	4.5	5.0	0.201	16.7	1.25	0.41	0.16	10.9	4
	A2	1-6	4.7	2.0	0.060	4.8	0.17	0.08	0.04	6.0	2
	B1	6-11	4.6	0.6	-	4.9	0.2	0.20	0.05	9.2	2
	B2	11-19	4.8	0.4	0.030	7.0	0.17	0.29	0.05	7.3	1
	B31	19-22	4.9	0.2	-	8.3	0.15	0.33	0.05	6.4	1
	B32	22-30	4.9	0.2	0.016	10.0	0.17	0.29	0.05	5.1	1
	B21b	30-40	5.1	0.2	-	12.4	0.17	0.29	0.04	4.0	Tr.
	B22b	40-55	4.9	0.1	-	14.9	0.20	0.29	0.07	3.7	Tr.
	Cb	55-70	4.7	0.02	-	9.4	0.12	0.29	0.08	5.2	Tr.
	A00, A0	1-0	4.0	-	-	-	-	-	-	-	-
	A1	0-1	4.3	4.2	0.159	9.4	1.30	0.25	0.14	18.0	4
5	A2	1-6	4.8	1.3	0.054	4.1	0.27	0.08	0.06	10.0	2
	B1	6-10	4.8	0.8	-	4.6	0.47	0.37	0.08	20.0	2
	B2	10-19	4.7	0.6	0.036	5.7	0.75	0.70	0.09	27.0	1
	B3m1	19-24	4.8	0.3	-	6.2	0.30	0.29	0.05	10.3	1
	B3m2	24-32	5.0	0.2	0.036	9.8	0.30	0.33	0.10	7.4	1
	B3m3	32-40	5.0	0.2	-	11.8	0.27	0.37	0.13	6.5	1
	Du	40+	5.2	0.1	-	12.2	0.25	0.37	0.06	5.6	1
	A00, A0	1-0	4.0	-	-	-	-	-	-	-	-
	A1	0-1	4.3	4.2	0.159	9.4	1.30	0.25	0.14	18.0	4
	A2	1-6	4.8	1.3	0.054	4.1	0.27	0.08	0.06	10.0	2

Table 4.--Composition of some minerals in percent of the 0.05-0.02 mm. silt in five profiles from the Highland Rim and Brotherton Bench

Profile No.	Horizon	Depth In.	Heavy Minerals ^a	Feldspars in Light Fraction ^b	
				Potassium Feldspar	Plagioclase Feldspar
1	B ₁	7-12	-	3.4	0.0
	Du	31-48	-	0.0	Tr. ^c
2	B ₁	1-8	-	5.2	0.0
	Du	33-48	-	Tr.	Tr.
3	A ₂	1-8	1.67	5.7	Tr.
	B ₂₁	12-18	2.24	6.2	Tr.
	B _{3m}	26-31	2.03	2.8	Tr.
	Du ₁	31-42	1.80	Tr.	Tr.
	Du ₂	42-96	1.00	Tr.	Tr.
4	B ₁	6-11	-	4.0	Tr.
	B _{22b}	40-55	-	Tr.	Tr.
5	A ₂	1-6	1.89	5.3	Tr.
	B ₂	10-19	1.63	6.8	Tr.
	B _{3m2}	24-32	1.89	Tr.	Tr.
	B _{3m3}	32-40	1.22	0.0	Tr.
	Du	40+	1.64	0.0	Tr.

^aDensity > 2.95; % of 2 g. sample.

^bAt least 500 grains from each sample were counted.

^cVery rare but present. Presence of plagioclase in deeper horizons is doubtful. Probably aluminum from clay coated on some of the quartz grains reacted with malachite green, causing them to appear blue.

CHAPTER V

DISCUSSION

Profile descriptions in Chapter IV reveal remarkable similarities among all five profiles, even though they represent both the Mountview and Holston series. Soils at all five sites are well to moderately well drained and are permeable to air, water, and roots to a depth of about 24 inches, where there is some degree of fragipan development. Profiles 1, 2, and 4 have only an intermittent fragipan, whereas 3 and 5 have a more pronounced one. These fragipans are at the lower sequum of a bisequal solum and show to some degree a polygonal network of gray silty material which extends downward into the D horizon. Similar observations have been reported by Grossman et al. (4) in their study of fragipans in Illinois.

Considering the chemical properties of these soils, there is little difference between properties of any of the soils. The organic matter and nitrogen content are naturally high in the A horizons, especially in the A₁, as a result of the virgin condition of the soil.

The soil reaction is either extremely acid or very strongly acid in all of the horizons. This comes as no surprise since each site is located well within forested areas and has never been limed. Under the type of weathering to which these soils are subjected, most of the bases have been leached out of the profile. Exchangeable calcium, magnesium, and potassium are quite low, for the most part less than one millequivalent per 100 grams of air-dry soil, which along with low pH, low percent base saturation, and inverted calcium/magnesium ratios in deeper horizons indicate an advanced degree of weathering.

The cation exchange capacities are well correlated with the clay and/or organic content of the soil. The high cation exchange capacities in the A horizons are attributed to the colloidal organic matter, while the rest of the horizons have cation exchange capacities which parallel their clay content.

The results of the particle size distribution analyses listed in Table 2 are similar to those reported by the Soil Survey Laboratory for Mountview and related soils in Coffee County.⁴

In all the profiles except at sites 3 and 4, the upper five horizons are silt loams. At site 3, whose solum is the thickest, the upper six horizons are silt loams; site 4 has the shallowest solum, and therefore, only the upper 4 horizons are silt loams. The uniformly high silt content in the upper part of the profiles suggests the possibility that if the silty mantle is transported material, its origin is likely to be aeolian. All the soil profiles contain larger amounts of sand or chert than most soils derived from loess. However, considering the original depth of overlay to be about 20 inches, one would expect mixing during soil formation by such things as animals, tree fall, and physical processes.

An examination of clay distribution with depth indicates an apparent migration of clay minerals into lower horizons. There has been enough migration of clay from the A horizon into the B to place these soils into the Red-Yellow Podzolic Group, but the lack of clay coatings

⁴Soil Survey Laboratory, op. cit.

on the soil particles and aggregates in the middle and upper part of the B horizons indicates a small amount of illuviation in the B relative to that in the deeper horizons. Conversely, there is a large amount of clay and also clay films on the aggregates in the D horizons. Clay films on the aggregates at this depth indicate some illuviation of clay into these horizons largely by physical means. Considering two of the four hypotheses advanced by the Soil Survey Laboratory (page 10) the large clay accumulation in the lower part of the profiles and the lesser amount in the sola support to some extent the hypotheses that the clay was removed from the surface horizons by (1) eluviation and (2) chemical destruction, leaving silty-textured surface horizons and finer-textured lower horizons in the substrata.

An examination of the ratios of the various size particles to each other offers the first concrete evidence that the soil in the upper horizons was not formed entirely from the residual parent material. A graphical illustration of the ratio of very fine sand to fine sand and silt to very fine sand at various depths is shown in Figure 5. Except for the A₁ horizon of profile 2 the curves showing the ratio of very fine sand to fine sand have no break at any depth. This ratio in the profile at site 1 increased greatly with depth, probably because of the relative nearness of the sandstone bedrock to the solum. The ratio of silt to very fine sand, however, shows a definite break in each of the profiles. This is highly significant, for it indicates contamination of the upper parts of the profile with silt from an outside source. There has been considerable mixing of this transported silt with the underlying soil, therefore,

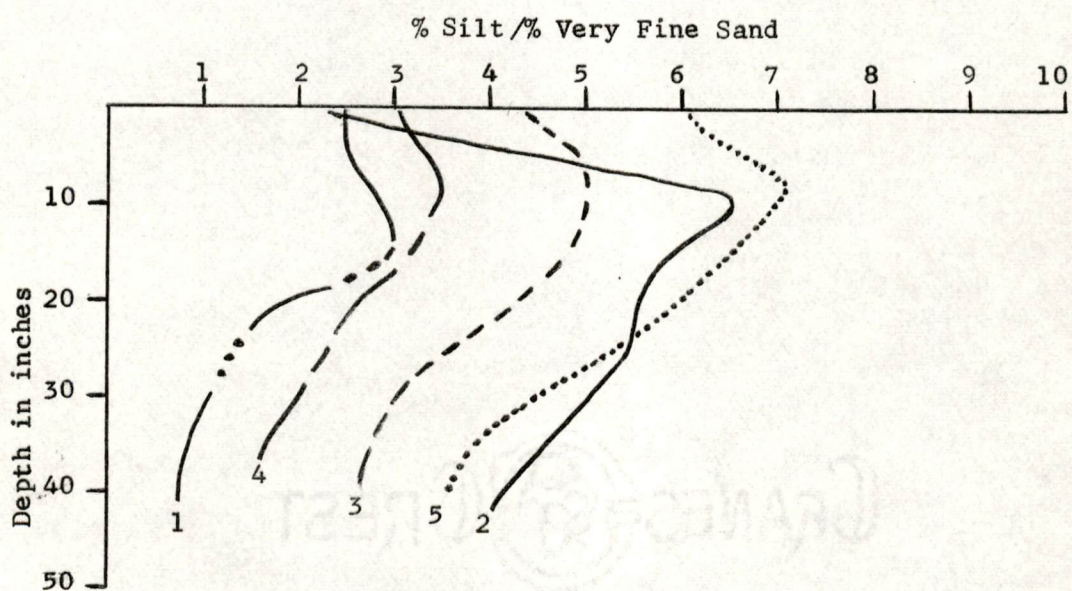
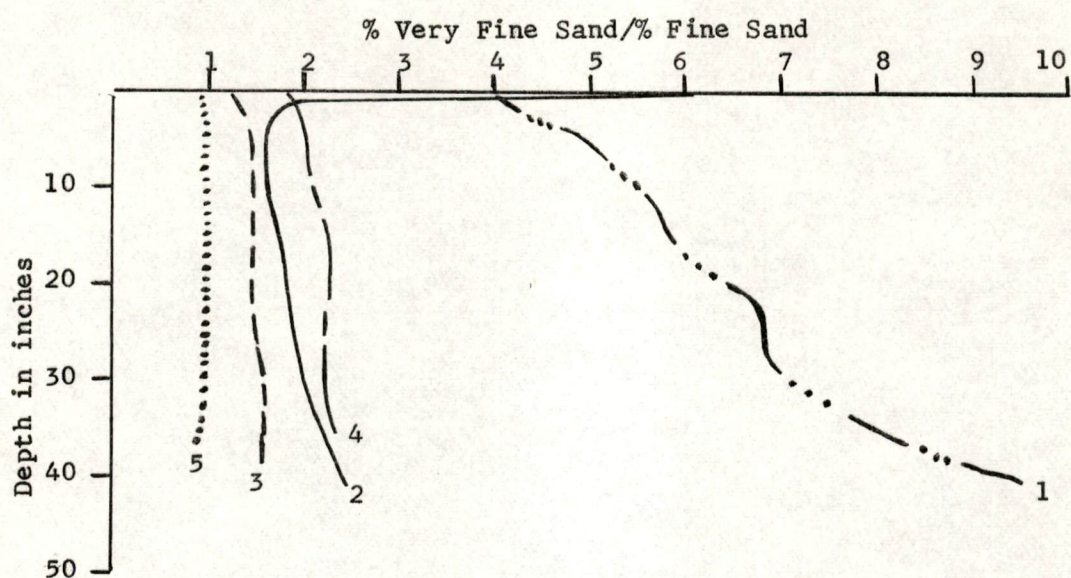


Figure 5--Ratios of certain size particles in five profiles from the Highland Rim and Brotherton Bench.

making it difficult to determine the exact depth of silt deposition.

The uniformity of the sola and variability of the substrata is good evidence that the soils were not formed entirely from the underlying residuum. Profile descriptions in Chapter IV show profile 1 to be underlain by bedrock of fine-grained sandstone, profile 2 by cherty limestone residuum, and profiles, 3, 4, and 5 possibly by old alluvium. Figure 6 clearly shows the similarity of the sola and dissimilarity of the substrata. The upper parts of the profiles are strikingly similar even though their substrata are variable.

Petrographic examination of the coarse silt fraction (0.05-0.02 mm.) revealed some chert in the upper horizons but not enough to produce a silty mantle 20 inches thick. Therefore, the hypothesis which suggests that these soils developed silty sola as a result of chert weathering to silt size can be ruled out.

This leaves only one of the four hypotheses advanced by the Soil Survey Laboratory, i.e., the hypothesis which suggests that the silty mantle is of loessal origin. To these hypotheses one other can be added: The silty mantle is of alluvial origin.⁵

Results of heavy and light mineral separations of the 0.05-0.02 mm. silt from two of the sites - one on the Brotherton Bench and the other on the Highland Rim - are shown in Table 4. Indications are that the heavy mineral content of the deeper horizons is less than that of the upper horizons. These data, however, are not conclusive.

Results of a mineralogical examination of the light minerals of the coarse silt fraction, shown in Table 4, are on the other hand con-

⁵Ibid.

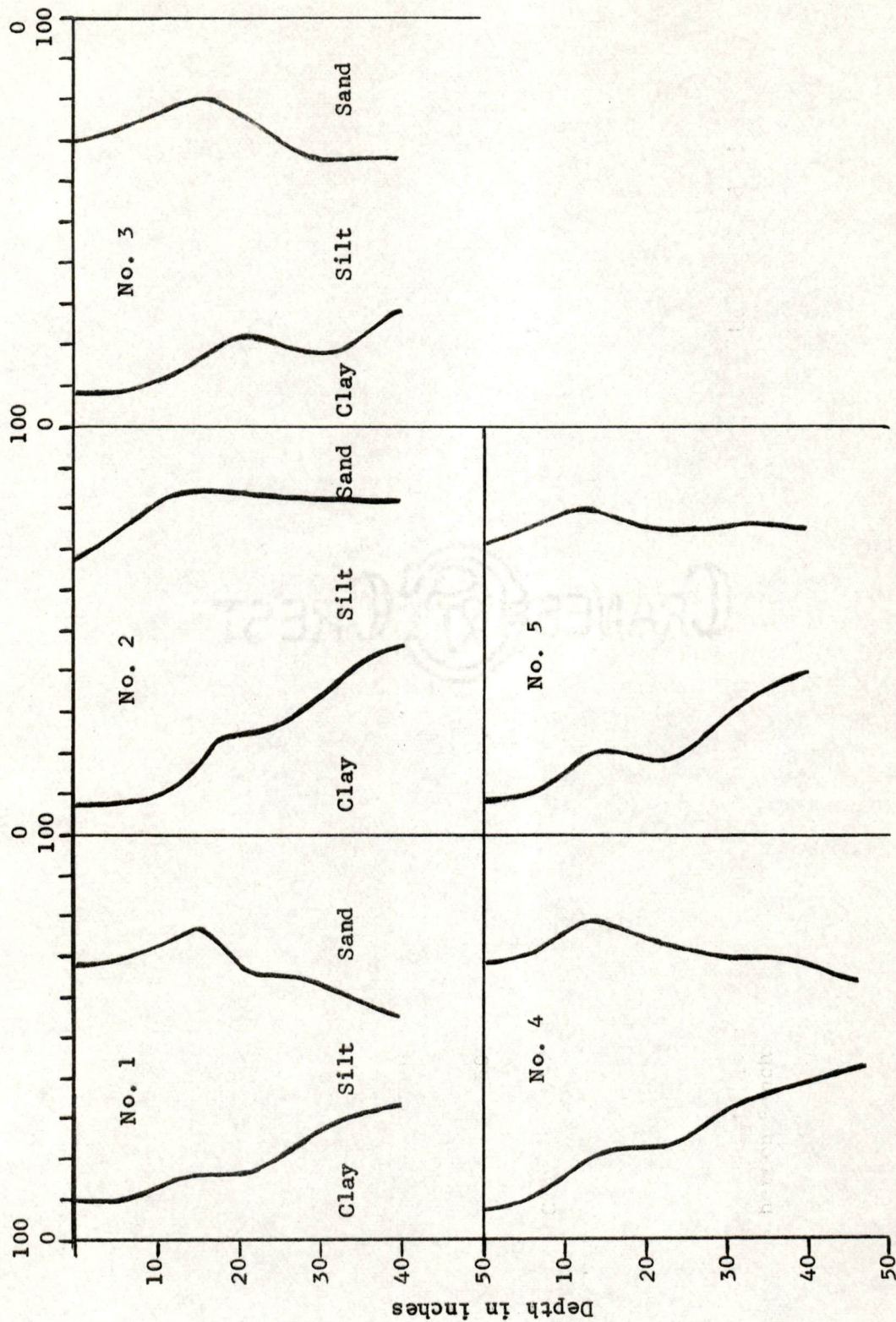


Figure 6--Particle size composition in percent for five profiles from the Highland Rim and Brotherton Bench.

clusive. The potassium feldspar content of the upper horizons is considerably higher than that of the lower horizons. Considering the normal course of weathering in these soil profiles, one would expect the weathering intensity to be greater in the upper horizons. If these soils were entirely residual, the feldspar content would be lowest in the upper horizons and would increase with depth; instead, the opposite relationship exists. This, it would seem, means but one thing: The upper horizons have been influenced by transported parent material different from the parent materials of the substrata.

Now the question arises as to the nature of this material. Mineralogical examination of the light minerals of the very fine sand fraction revealed only traces of feldspars in all of the horizons. Apparently, the mineralogy of the sands is the same in each of the horizons. Since the silt mineralogy differs between the upper and lower horizons and the ratios of sand to silt have distinct breaks, while those of the sands do not (Figure 5), it seems obvious that the transported parent material which contributed to the development of the upper part of these soils was of silt size. Considering the methods of transportation, this silt material could only be of alluvial or aeolian origin. If it was alluvium, it would have had to come from a local source. Since the rocks and soils from which alluvium would have come are highly weathered, the source of the transported silt must therefore be aeolian.

The similarity of these two soils, especially in their sola, raises the question as to whether they should be separated into two series. The Soil Survey Manual (15) defines a soil series as "a group of soils having

soil horizons similar in differentiation characteristics and arrangement in the soil profile except for the texture of the surface horizon, and developed from a particular type of parent material." The problem of classifying these soils is complicated because each soil was formed from two distinctly different kinds of parent material. All the sola have a common parent material which is loess, while the substrata vary from residuum of cherty limestone and sandstone to old alluvium. The question which must be answered is: Should these soils be placed in different series because their substrata have different parent materials, or should they be kept in the same series on the basis of the common genesis of their sola? If the thickness of the common parent material was only 5 or 6 inches, they should be separated; if the thickness was 3 or 4 feet, they should not. On these soils, a decision as to whether or not to consolidate them into one series is hard to make. The so-called silty mantle is approximately 30 inches thick. The mixing of the loess with the surface horizon of the buried soil has not significantly changed the properties of this mantle. Therefore, it would seem that the most consistent way to classify these soils would be to place them in the same series and designate substrata differences at the phase level. This would conform to the series distinction and eliminate errors in classification brought about when soils are placed in separate series even though the genesis of their sola is the same.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Field and laboratory studies were made on Mountview silt loam and Holston silt loam in Putnam County, Tennessee. Five profiles were described and sampled at forested sites.

Mineralogical and morphological properties of these soils indicate that transported material of silt size contributed to their formation on the Highland Rim and Brotherton Bench. They also indicate that the transported material which covers the Brotherton Bench is the same as that which covers the Highland Rim. The presence of significant quantities of feldspars in the sola and the absence of them in the substrata indicates the sola to be largely of loessal origin. The thickness of the loess is believed to have been about 20 inches.

Mountview silt loam and Holston silt loam commonly are on gentle topography. On steeper slopes where the loess was too thin to affect the properties of the soils, their formation was influenced almost entirely by residuum or alluvium.

The soils are characterized by medium-textured sola which overlie variable substrata. Only minor amounts of eluviation and illuviation have taken place in the A and upper portion of the B horizons relative to that of the deeper horizons. The fact that all the soils are extremely acid to very strongly acid, have low cation exchange capacities, low content of exchangeable bases, and are very low in phosphorus make them even more similar. Their reaction and percent base saturation indicate that they have reached an advanced stage of weathering.

All have the characteristics listed by Winters (20) and Grossman et al. (4) necessary for fragipan formation. Sites 3 and 5 have a weakly developed fragipan and sites 1, 2, and 4 are in the process of developing one.

All the soils are Red-Yellow Podzolics with sola of common genesis, and in view of their remarkably similar properties, it is suggested that they be separated at the phase rather than at the series level.

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APPENDIX

APPENDIX A

STAINING METHOD FOR IDENTIFYING CERTAIN FELDSPAR MINERALS

Reagents:

Adhesive: Mix about one part of black weather stripping cement as used by automobile manufacturers with two parts of amyl acetate. Shake thoroughly and centrifuge.

Hydrofluoric acid: 45-52%.

Sodium cobalti nitrite: 40 g. dissolved in 50 ml. of distilled water.

Malachite green: 0.5 g. dissolved in 100 ml. of distilled water.

Procedure:

1. On a clean microscope slide add one drop of black adhesive and let stand until almost dry. It is better for the adhesive to be too dry than too wet.
2. Sprinkle the grains of silt or sand over the adhesive until about 75% of it is covered. Be sure the grains are stuck to the cement but not buried in it.
3. Invert the slide over a bottle of hydrofluoric acid and allow the fumes to etch the grains. Observe the slide in reflected light about every 15 seconds. A correct exposure will produce a narrow band of etched glass surrounding the patch of black adhesive.
4. Cover the grains on the slide with one or two drops of sodium cobalti nitrite.
5. After about 45 seconds, wash the slide with distilled water.

6. To the wet slide add one or two drops of malachite green, and after 30 seconds wash thoroughly with distilled water.
7. Dry the slide at a safe distance from a bunsen burner.
8. Examine the prepared slide under a binocular or low powered microscope. The potassium feldspars are stained by sodium cobalt nitrite and will appear yellow; the plagioclase feldspars are stained by malachite green which reacts with aluminum to produce a blue color.

APPENDIX B

COMMON AND SCIENTIFIC NAMES OF MAJOR VEGETATION AT FIVE SITES ON THE
HIGHLAND RIM AND BROTHERTON BENCH

Beech	<u>Fagus grandifolia</u>
Blackgum	<u>Nyssa sylvatica</u>
Black Oak	<u>Quercus velutina</u>
Chestnut	<u>Castanea dentata</u>
Chestnut Oak	<u>Quercus prinus</u>
Dogwood	<u>Cornus florida</u>
Greenbrier	<u>Smilax rotundifolia</u>
Laurel	<u>Kalmia latifolia</u>
Little Bluestem	<u>Andropogon scoparius</u>
Mockernut Hickory	<u>Carya tomentosa</u>
Northern Red Oak	<u>Quercus rubra</u>
Persimmon	<u>Diospyros virginiana</u>
Pignut Hickory	<u>Carya glabra</u>
Post Oak	<u>Quercus stellata</u>
Red Cedar	<u>Juniperus virginiana</u>
Red Maple	<u>Acer rubrum</u>
Sassafras	<u>Sassafras albidum</u>
Sawbrier	<u>Smilax glauca</u>
Scaleybark Hickory	<u>Carya ovata</u>
Scarlet Oak	<u>Quercus coccinea</u>
Sourwood	<u>Oxydendrum arboreum</u>

Southern Red Oak

Quercus falcata

Sugar Maple

Acer saccharum

Sumac

Rhus sp.

Sweetgum

Liquidambar styraciflua

Tulip Poplar

Liriodendron tulipifera

White Oak

Quercus alba

