OUTLINE

of

THE GEOLOGY AND MINERAL RESOURCES

OF

SCOTT COUNTY, VIRGINIA

by

Herbert P. Woodward

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[1937]

[Newark, New Jersey]

UNIVERSITY OF NEWARK
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Author's comments
re
Scott County Report

I have been somewhat puzzled as to the best form in which to prepare this report. It has been suggested that county reports of this type are designed specifically for use in the schools and by the laymen of the area concerned rather than for the geologic reader. For this reason I have attempted to avoid too much technicality, and have aimed somewhere between the complexity of the normal geologic report and an elementary presentation. My whole thesis is based upon the belief that the Survey wishes a straightforward description of the features of the county without flourishes or technical complication, but at the same time wishes a statement not without value for the professional geologist. Whether I have attained the happy medium between simplicity and complexity, I am unable to say. The report seems to me, however, to represent a fair attempt at a compromise.

I have not exactly followed the suggested outline, but have modified it slightly to gain what seems to me a little better coordination.

1. A uniform system of headings has been used in this manuscript to indicate the rank of various titles. This system is as follows:

INTRODUCTION	Rank 1.
LOCATION AND AREA	Rank 2
The Upland Level	Rank 3
Description	Rank 4
Character.-	Rank 5

This system should be considered of no significance save as it indicates the rank of the headings.

2. It is assumed that all line drawings, figures, and the outcrop map will be redrafted by a Survey artist.

3. I am less pleased with the photographic illustrations than in the case of the Natural Bridge report where the illustrations were uniformly good. I have a smaller number from which to choose for this report, and as most of the prints were not made until I returned from the field, I had no opportunity to replace a few which turned out poorly.

4. I have already submitted an outcrop map which should be in the Survey's files. This map was made from an original geologic map which

was prepared in the field as accurately as the base maps would permit. The various stratigraphic units mapped were replaced by lithologic units, and the whole affair was retraced to form the outcrop map. To show a copy of the map as properly reduced, I sent a photostatic reduction to page size. It is possible that the geologic map could be done in black and white and used on a reduced scale in the report in addition to the outcrop map; but I doubt if the narrow widths of many of the formational outcrops will stand reduction.

5. I do not have an adequate photograph of Natural Tunnel to use as a frontispiece. I am hoping that the Survey has such a picture, or can obtain it more readily than I can.

6. As I have poor facilities for typing, the manuscript is not in as good shape as I would wish. I think, however, that it is readable and accurate. My typist has made an especially poor job of inserting the references and footnote numbers, but I think I have corrected all of the important errors. Possibly her worst fault is in the division of words into syllables at the ends of lines. As I assume you will have the manuscript retyped after editing, I have assumed that any compenent stenographer will correct such errors without specific direction.

March 26, 1937.

Plate 2
(Frontispiece)

Natural Tunnel.*

* I should like to see a good picture of Natural Tunnel in this position as frontispiece, but none of the several which I took are at all adequate. Can the Survey obtain one from the owners of the property, or from its own files?

c

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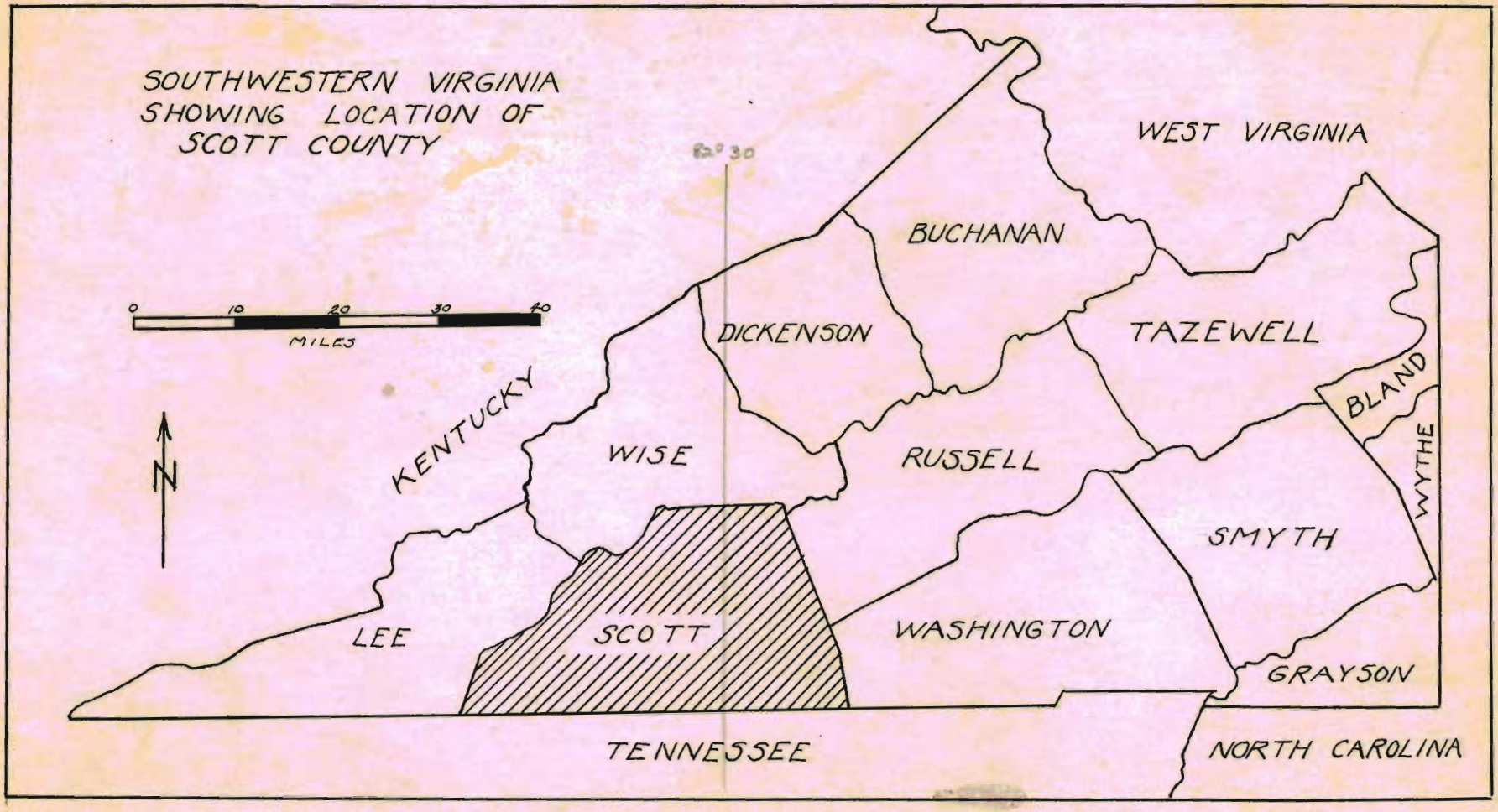

Figure 1, Index map of southwest Virginia showing the location of Scott County.

(Near manuscript page 1)

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INTRODUCTION

LOCATION AND AREA

Except for Lee County, Scott is the westernmost of ~~all~~ Virginia counties. It is located in southwestern Virginia where its greatest dimension - 39 miles - extends along the Tennessee boundary. (See Fig. 1.) Its longest north-south dimension is about 20 miles, ~~and~~ its area is 543 square miles or 347,520 acres. The shape of Scott County is roughly trapezoidal and its boundaries are drawn along surveyors' lines. The county is adjoined at the east by Washington and Russell counties, at the north by Wise County, and at the west by Lee County. Gate City, the county-seat, is situated at Lat. 36°38' N., and Long. 82°35' W.

NATURE OF THE REPORT

This report is an introductory statement of the geography, geology, and mineral resources of Scott County, Virginia. It is one of a series of county reports prepared for publication by the Virginia Geological Survey, a division of the State Commission on Conservation and Development. The report is especially designed to furnish the resident of Scott County with an up-to-date description of the natural features and mineral deposits of his county, and to serve as a manual of local geography and geology.

In the preparation of the bulletin, there has been a definite effort to exclude or simplify all topics which are chiefly of scientific interest, or which have significance mainly to the professional geologist. It is hoped through this editing that the report will take on added usefulness to the residents and in the schools of the county without losing its value to other readers as a preliminary statement of geologic features. The Survey will subsequently present descriptions of more technical detail in other publications.

The outcrop map (Plate 1) which accompanies this report indicates the general character of the bedrock throughout the county. Existing geologic maps, especially those prepared by Dr. Charles Butts for the Virginia Geological Survey 1/, and by Dr.

1. Butts, Charles, Geologic map of the Appalachian Valley of Virginia with explanatory text: Virginia Geol. Survey Bull. 42, 1933.

Marius R. Campbell for the United States Geological Survey, 2/,

2. Campbell, M.R., U.S.Geological Survey Geol. Atlas, Estillville (No.12) and Bristol (No.59) folios, 1894 and 1899.

have been revised and edited in the light of more recent field studies, and were used as the base from which the present outcrop map was prepared. A program of field work during the summer of 1935 furnished much of the data upon which the bulletin is based.

In its capacity as a public service bureau, the Virginia Geological Survey is undertaking to discover and examine the geologic, geographic, and economic features of the Commonwealth, and through the work of its technical staff, it is prepared to make this information both reliable and inclusive. Its publications, available without cost to all residents of Virginia, include both detailed scientific reports and less technical bulletins of which the accompanying report is an example.

ACKNOWLEDGMENTS

The author expresses his acknowledgments for the information concerning local rocks and mineral deposits which was furnished him by various residents of Scott County, and for the coöperation accorded him during the course of the field work. Mr. Patrick Kane of Gate City, Mr. T. C. Boyd of Dickensonville, Russell County, and Mr. Lathan Powers of Fort Blackmore were especially helpful in supplying data on mineral prospects that would otherwise have been difficult to obtain. With several members of the geologic staff of the Tennessee Valley Authority, especially Drs. Cullison and Eaton, and Messrs. Gildersleeve and Laurence, the author had the pleasure of exhanging views relating to the geologic features along the Tennessee-Virginia boundary. From the publications of Southwestern Virginia Inc., and from maps prepared by Dr. Charles Butts and Dr. Marius R. Campbell of the United States Geological Survey, valuable data have been freely taken for use in this report. Due credit is given in the text for this information, and acknowledgment of its value is herewith made. Mr. Robert L. Bates of Iowa City, Iowa, was an energetic and capable field assistant and junior associate.

GEOGRAPHY

GENERAL STATEMENT

Many varied topics are included in the geographic description of any region. The character of the land surface, its climate and soils, features of topography, relief and drainage, and their relations to man and vegetation all come within the scope of geography. In discussing these features it is convenient to consider human geography first, the relief, drainage, and physical geography second, and the climate and soils last. This order is followed in the next paragraphs which describe the geography of Scott County.

EXPLORATION AND DEVELOPMENT

Scott County, formed from adjacent counties in 1814, was named for General Winfield Scott, whose fame as a soldier in the War of 1812 inspired the ardent proponents of the new county. Judge Benjamin Estill, who sponsored the Assembly bill for the creation of Scott County, lent his name to the first county-seat, Estillville, now known as Gate City.

A century before the creation of the county, the local area of the Clinch and Holston river basins formed a prosperous Indian hunting ground that was not invaded by permanent settlers until about 1750. The early relations between the advancing pioneers and the irate Indians were far from friendly, and a period of hostility between 1754 and 1765 was accompanied by massacres and forays that were only temporarily halted by the treaty of Lochaber in 1770.

In consequence of this treaty, a trustworthy surveyor named John Donelson was commissioned to locate a line west of Clinch Mountain (Pl. 4,A) that was to set aside land for hunting purposes only; and an agreement was mutually reached that if the Indians would relinquish all claim to this land, the pioneers would refrain from settling in it. Donelson's line, now indicated by a historical marker, is crossed by U. S. Highway 58 about 2½ miles southeast of Gate City.

Unfortunately for the truce, hunters from Abb's Valley and the east found the restricted land desirable for settlement, and many overstayed the hunting seasons to take up "corn rights" west of Donelson's line. Repeated violations of the treaty incensed the Indians and in 1774 a new outbreak of hostilities culminated in Dunmore's War, with many local skirmishes at Fort Blackmore, Dorton's Fort, and Carter's Fort. Dorton's Fort (Pl. 3,A)

Plate 3
(near manuscript page 7)

A. Dorton's Fort, 2 miles south of Nickelsville, near Copper Creek. Robin Kilgore formerly lived here. (See pages 6-7.)

B. View looking north through Big Moccasin Gap. Moccasin Creek, which is hidden from view, has cut its valley through the hard Clinch sandstones of Clinch Mountain. Soft shales form the area of the foreground and distant background. (Compare with Pl. 8, A.) (See pages 7, 8, and 19.)

still stands near Copper Creek, 2 miles southwest of Nickelsville. Fort Blackmore, the first white settlement in Scott County, was established about 1771. Although repeatedly attacked by Indians, it was never captured. Carter's Fort in Rye Cove, was part of a line of defenses along the Daniel Boone Trail which led from Moccasin Gap through Big Stone Gap into Kentucky.

Repulsed in 1774 by the defiant frontiersmen, the Indians reluctantly withdrew northward, and new settlers began to occupy the region. Many were Irish or Scottish Protestants from eastern Virginia, who, by an act of the House of Burgesses, had become exempt from taxes on the promise of settling in southwest Virginia.

In 1776 the Cherokee Indians were induced to help dislodge the settlers beyond Donelson's line, and both Carter's Fort and Fort Blackmore again became local garrisons against Indian attack. Nearly 20 years of skirmishes ensued between the pioneers and Indians until the last vengeful Indian leader, a half-breed Shawnee known as Benge, was slain in 1794.

Thereafter, the settlement of the area continued in peace. The first county court met in 1815 at the house of Benjamin Hollins, which was situated in Moccasin Gap, 2 miles south of Faris' Tavern, a station on the Boone Trail. A county seat was soon established near the tavern and was later named Estillville in honor of Judge Estill. With the coming of the Southern Railway in 1887, the use of Moccasin Gap as a gate-way through Clinch Mountain suggested the new name Gate City for the town Estillville, which had already encountered confusion with Eastville in Northampton County. Big Moccasin Gap, 1/, now occupied by Moccasin Creek, the Southern Railway, and U. S. Highways 23-58, has played an important part in the settlement of southwest Virginia. (See Pls.3, B and 8, A.)

1. Little Moccasin Gap is a much higher pass across Clinch Mountain between Russell and Washington counties.

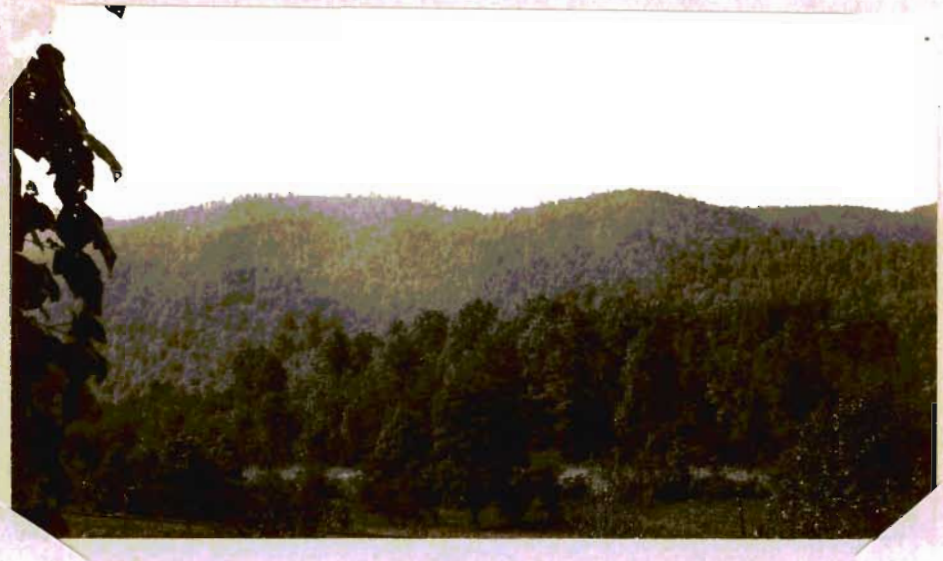
The county now contains approximately 25,500 inhabitants of which more than 98 percent are native-born whites. The average density of population is about 46 persons per square mile, and the greater portion of the county is sparsely settled. About one-third of the area has been cleared for pasturage, and it is now known that approximately 14 percent of the county, or 75 square miles, is underlain by coal-bearing rocks. There are 9 political divisions and 25 postal communities within the county.

Gate City, located 1 mile north of Moccasin Gap (Pls. 3,B and 8,A), is both the county-seat and the largest settlement, having a community population of about 1,600 inhabitants. (See Fig. 2.) Other towns include Dungannon, population 400; Nickelsville, population 400; Fort Blackmore, population 300; and Clinchport, population 240. Duffield, Speer Ferry, Rye Cove, and Hilton are smaller community centers. Camp TVA-1, Company 335, of the Civilian Conservation Corps is located on Clinch River near Clinchport.

Transportation facilities include the Southern Railway and the Clinchfield Railway. The former enters the county from the north and makes use of Natural Tunnel (Pl.9) and Moccasin Gap (Pl.3,B). Its route extends southward into Tennessee and eastward to Bristol, Virginia-Tennessee; Gate City is its chief local station. The Clinchfield Railway follows Clinch River from St. Paul, Wise County, to Clinchport, whence its tracks turn south to pass under Clinch Mountain by means of a tunnel between Speer Ferry and Kermit (Cassard Post Office), continuing into Tennessee.

Plate 4

(near manuscript page 10)



A. The rugged wooded slope of Clinch Mountain north of Hilton, viewed from the south. (See pages 6, 10, 13, 36, and 50 .)

B. View looking north along U.S. Highway 58 toward Holston Bridge. This prominent watergap through Pine Mountain enables one to look across Poor Valley at Clinch Mountain in the background. Mississippian limestones are exposed in the road cut in the foreground; Pine Mountain is formed by basal Mississippian sandstones (Price formation); Poor Valley is developed on weak Devonian shales; and Clinch Mountain is a ridge of Silurian (Clinch) sandstone. (See pages 8, 10, 50, 54, and 78 .)

U. S. Highway 58 (Pl. 4,B) connects Gate City with Bristol and with Cumberland Gap. U. S. Highway 23 extends north from Kingsport, Tennessee through Gate City and Clinchport to Big Stone Gap, Norton, and points in Kentucky. With the exception of a short distance between Duffield and Pattonsville, both Federal highways are hard-surfaced roads. Their routes coincide between Moccasin Gap and Duffield.

Other roads, in fair repair, connect Gate City with Nickelsville and Lebanon, Russell County (State Highway 71), Pattonsville with Dungannon and St. Paul, Wise County (State Highway 70), Fort Blackmore with Norton, Wise County (State Highway 73), Dungannon with Coeburn, Wise County (State Highway 72), Hilton with Holston, Washington County (State Highway 42), and Snowflake with Hansonville, Russell County (State Highway 74). There are approximately 700 miles of public roads in Scott County, but many of them have been so little improved as to render automobile travel difficult after hard rains.

The meridian 82°30' is the theoretical boundary between Eastern and Central Standard Time. Although two-thirds of Scott County and all of Lee County lie west of this meridian (Fig. 1), Eastern Standard Time is used to conform with the remainder of the State.

For other data concerning the industrial development of Scott County, the reader is referred to "An industrial survey of Scott County" by R. L. Humbert and others, published in 1929 for Southwestern Virginia Inc., by the Engineering Extension Division, Virginia Polytechnic Institute, Blacksburg, Virginia.

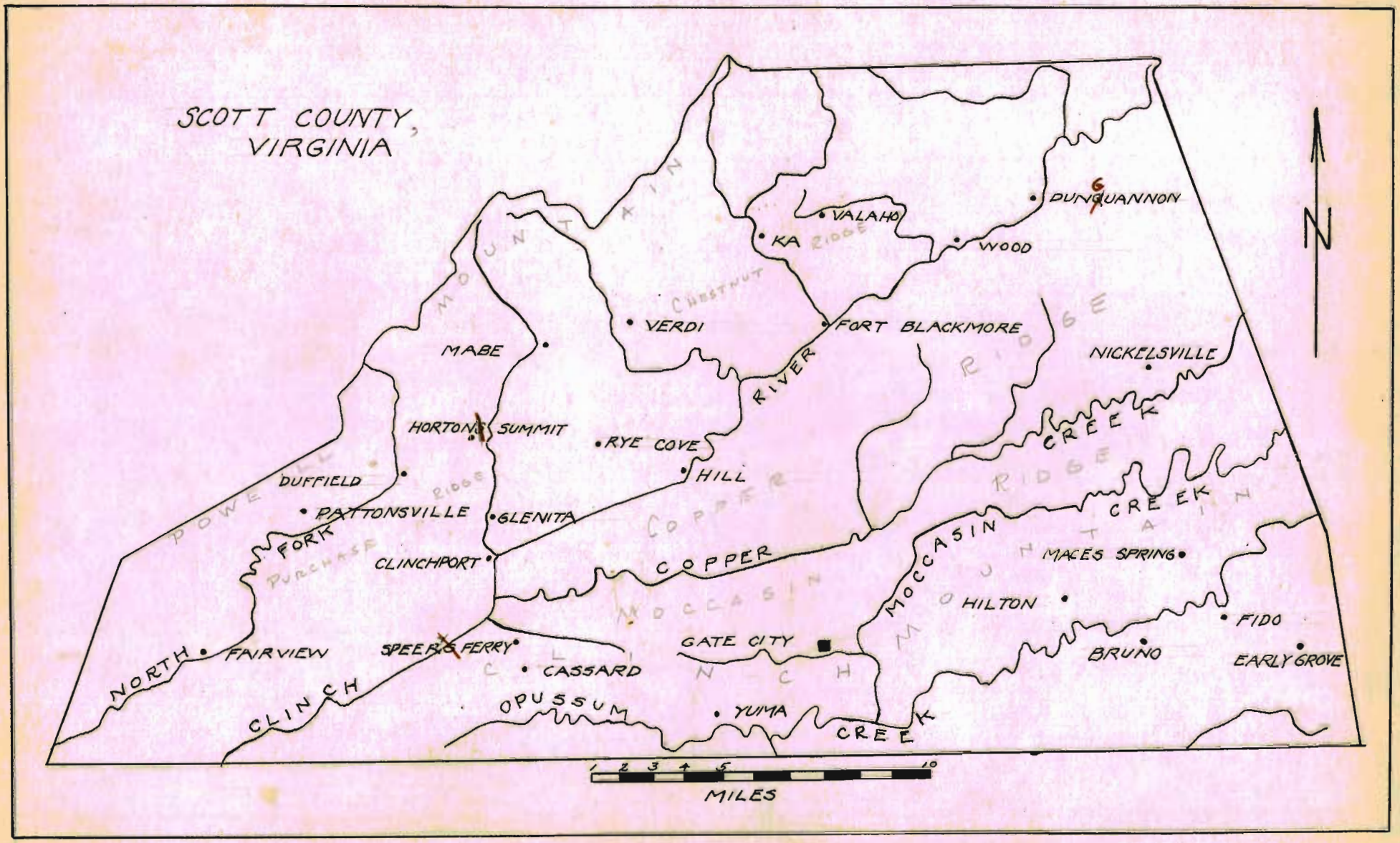


Figure 2, Sketch map of Scott County.

(near mid page 10)

RELIEF AND DRAINAGE

The greater portion of Scott County consists of a mountainous or rolling upland broken by long parallel valleys. The most conspicuous topographic feature is Clinch Mountain, which extends northeastward from Tennessee across the southeastern portion of the Scott County. It is a steep narrow ridge, rising to its highest local summit, Big Knob, elevation 3,217 feet above sealevel, 6 miles northeast of Gate City. For most of its length, Clinch Mountain stands more than 1,400 feet above the parallel valleys that bound it on north and south. (See Pl. 4.) The ridge is broken near Gate City by a striking watergap, occupied and produced by Moccasin Creek and known as Big Moccasin Gap. (See Pls. 3,B and 8,A.) Except for the tunnel of the Clinchfield Railway between Kermit (Cassard Post Office) and Speer Ferry, all intercourse between the southern and northern portions of the county makes use of Moccasin Gap, which is the only water-level passage along the entire length of Clinch Mountain. (See pp. 19-20.)

North Fork of Holston River and Opossum Creek drain the area south of Clinch Mountain; they join near Moccasin Gap to flow southward into Tennessee. (See Fig. 2.) An irregularly dissected upland which occupies the southeastern corner of the county south of Holston River extends eastward into Washington County and southward into Sullivan County, Tennessee. The long ridge of Pine Mountain (Pl. 4,B.) which extends parallel to Clinch Mountain bounds Poor Valley on the south. (See Pl. 6,A.)

Moccasin Ridge extends across the county north of

Clinch Mountain from which it is separated by a deep valley. This ridge is narrow at the southwest, but widens and increases in height toward the northeast. (See Pl. 11,B.) It is irregularly dissected by streams into a broad wooded divide that extends northeastward between Moccasin and Copper creeks into Russell County. West of Gate City, the open valley between Clinch Mountain and Moccasin Ridge is occupied by Little Moccasin and Troublesome creeks.

In the central portion of Scott County, the wide upland of Copper Ridge (Pl. 7,B.) separates Copper Creek and Clinch River. This wooded ridge stands nearly 1,000 feet above Clinch River, toward which it presents a bold front (Pl. 7,A); the southeastern slope to Copper Creek is less pronounced. Clinch River crosses the ridge through a watergap between Clinchport and Speer Ferry, and a series of irregular hills, called the River Knobs, follows the river from Speer Ferry into Tennessee.

The northern portion of Scott County is irregular and contains a number of disjointed ridges and upland belts. The northwestern county-line follows the crest of Powell Mountain, which is broken north of Duffield by the watergap of North Fork of Clinch River. Several short but prominent ridges intervene between Powell Mountain and Clinch River, including Stony, Newman, and Purchase ridges to the west and Chestnut Ridge and Stone Mountain to the east. These hills are separated from one another by narrow linear valleys, of which the most prominent is Hunter Valley between Stone Mountain and Chestnut Ridge.

Plate 5

(near manuscript page 12)

A. View of Clinch Valley near Hill Station. The steep northern edge of Copper Ridge at the left of the river and the rugged shale country north (to the right) of the river indicate the assymetry of the valley. (See pages 12, 20, and 78 .)

B. Copper Creek, 3 miles north of Gate City. (See pages 12, 48, and 132 .)

A broad circular basin known as Rye Cove, occupies the area north of Clinch River and east of Natural Tunnel.

The elevations along Powell Mountain range from 2,500 to 4,000 feet above sealevel, and the highest summit, High Knob, which is 4,158 feet above sealevel, commands an excellent view of southwestern Virginia. The watergap of North Fork of Clinch River between Duffield and Jasper forms a convenient entrance into Lee and Wise counties and is in line with Big Stone Gap, a similar passage leading into Kentucky. Because of the gap of Clinch River through Copper and Moccasin ridges and the gorge of Moccasin Creek through Clinch Mountain at Big Moccasin Gap, the county affords a direct natural passage through the entire western Appalachian ridges.

All of the drainage of Scott County south of Clinch Mountain is carried by North Fork of Holston River, which follows a meandering course across the southeastern corner of the county to meet South Fork at Kingsport, Tennessee, 4 miles south of the State boundary. Big and Little Moccasin creeks drain southward through Moccasin Gap into Holston River; south of Clinch Mountain, the chief tributaries of the Holston are Opossum, Cove, and Timbertree creeks. (See Fig. 2.)

Most of the county drains into Clinch River (Pl. 5,A) or its two main tributaries, North Fork and Copper Creek. (See Pl. 5,B) The former joins the main river a short distance beyond the southwestern corner of Scott County; Copper Creek enters Clinch River near Speer Ferry. Both Clinch and Holston rivers lie in the Tennessee basin of the Mississippi River system.

PHYSICAL GEOGRAPHY

Geographic Provinces

Areas of the earth's surface that are delimited by natural boundaries are commonly known as geographic provinces when they contain similar or closely related topographic features. Inasmuch as political areas do not necessarily conform to obvious natural boundaries, it is common to find that a political unit such as Scott County lies within two or more distinct geographic provinces. A brief description of the local area will serve to indicate the strong differences which occur between adjacent portions of Scott County.

A wide rolling lowland stretches eastward and southward from Clinch Mountain to the foot of the Blue Ridge. This valley, known as the Tennessee Valley in Tennessee and the Abingdon Valley in Virginia, is a persistent lowland that skirts the west foot of the Blue Ridge from Tennessee to Pennsylvania and merits its familiar name, the Great Valley. Although its floor is scarcely level, the lowland character is in strong contrast to the ridges that bound it on west and east.

The floor of the Abingdon Valley stands from 1,800 to 2,000 feet above sealevel and rises gently toward the northeast. Its larger streams are now entrenched from 100 to 300 feet below the main valley level, and its hills rise correspondingly above the average elevation. Probably its most conspicuous elevation is Walker Mountain, which divides the valley lengthwise into two sections. A small portion of the northernmost valley section extends into the southwestern

Plate 6

(near manuscript page 14)

A. Looking east along Poor Valley near Hilton, one can see the dip slope of Clinch Mountain at the left, and the irregular summits of Pine Mountain at the right. (See pages 15, 29, 53, 61, 102, and 129.)

B. The Alleghany Front viewed from Copper Ridge near Dungannon. (See pages 14 and 20.)

corner of Scott County. Clinch Mountain (Pl. 4, A) and Moccasin, Copper and Chestnut ridges form a series of parallel ridges separated by intervening valleys in the geographic unit known as the Appalachian Valley and Ridge province. (See Pl. 7,A)

Except for its northern portion, Scott county lies mainly within the folded ridges and valleys of the Appalachian Mountains. The northern part of the county, however, contains a portion of the Alleghany Plateau province, to which much of Wise County and all of Dickenson County belong. A straight line from Duffield on North Fork of Clinch River, to the northeastern corner of Scott county (See Fig. 2) would approximate the boundary between the Alleghany Plateau and the Valley and Ridge belt. This boundary is marked by a strong southeastward slope that is known as the Alleghany Front. (See Pl. 6, B)

Plate 7

(near manuscript page 15)

A. The "Valley and Ridge" country as shown by Copper Ridge (at left), Clinch Valley in center, and shale ridges to the right (north). The Rome shales underlie the northern ridges and Clinch Valley; the Rutledge, Rogersville, and Maryville formations form the lower slope and cliffs of Copper Ridge; the Nolichucky shale forms the upper slopes of Copper Ridge. (See pages 11, 14, 38, 43, 123, and 132.)

B. The broad upland of Copper Ridge, viewed from the crest of Moccasin Ridge north of Snowflake. The valley of Copper Creek lies in the shadows of the foreground. (See pages 11, 28, 45, and 46.)

Erosion Levels

Wind, waves, ice, and running water are the most influential agents in the sculpture of the land. Their work, known as erosion, is accompanied by the action of weather and climate, known as weathering, and the two processes are jointly responsible for many of the features of the scenery. In Scott County, erosion by streams has been the dominant geographic agency, although certain passive factors--such as vegetation, the varying character of the bedrock, and land elevation--have assisted in producing the wide variety of local topographic features.

River erosion, however active, is subject to at least one limitation, it can not reduce valley slopes to a point lower than the mouth of the river. Hence the level of the body of water into which any river flows is a baselevel to all erosional processes. If an area is drained by a number of streams all of which have the same baselevel, the land will gradually be worn down toward this baselevel, and the surface will become more and more free of irregularities. Erosion surfaces of this type, although not commonly apparent to the casual observer have considerable geographic importance.

Given a sufficiently long time and a stable land, the agents of erosion and weathering will eventually reduce all elevations to a common level, and this ultimate erosion level, known as a peneplane, will be an approximately smooth surface. It is possible to determine that the present area of Scott County,

together with much of the Appalachian region, was once reduced to such a peneplane, worn smooth by weathering and erosion. This ancient surface was produced during a long era when the land stood at a much lower elevation than at present and maintained an unchanging position with respect to sea-level. Although alternating belts of hard and soft rock crossed the area from southwest to northeast, all had been brought down to a minimum of relief. It can also be determined that the epoch of planation was followed by a gentle uplift of the entire region; that the streams on the erosion surface were rejuvenated and given steeper gradients; and that they were forced to attack the peneplane previously produced. In consequence of this renewed attack, the belts of soft rock were deeply eroded by the rejuvenated drainage, and all trace of the earlier plane surface was destroyed upon their outcrops. The belts of hard rock more successfully resisted the erosion which was unable to destroy all remnants of the old flat surface from their summits.

Although the more obvious characters of the former peneplane were obliterated by subsequent erosion, it is still possible to determine that the summits of Clinch (Pl.4,A) and Powell mountains are relatively level and that they stand at similar elevations. It is apparent if the intervening country were filled to the level of the mountain summits, that a broad rolling plane would result. Because its remnants now occur only upon upland areas, the old erosion surface has been called the Upland peneplane[1]. Despite its present inconspicuous position,

1. Stose, G. W., and others, Manganese deposits of the west foot of the Blue Ridge, Virginia: Virginia Geol. Survey Bull. 17, p. 34, 1919.

the Upland level has been an important factor in governing the scenic development of Scott County.

The erosion, which largely destroyed the Upland peneplane, proceeded fastest along the belts of weak and soluble rocks, where small valleys grew deeper as uplift of the land forced streams to regrade their slopes. It must have been a long erosional epoch that followed the Upland peneplanation, if one can properly judge its length from the depth of the valleys and the present slow rate of valley deepening.

It is clear that the erosion was dependent upon a progressive uplift of the land; yet it is equally clear that for a time the uplift must have temporarily ceased. The evidence for this conclusion is found in the floors of the valleys, where occurs a well-defined erosional level that must have been produced when the streams were widening, rather than deepening, their courses. The broad relatively level area of Rye Cove and the flat country near Nickelsville were produced at this time, as were terraces, or benches, that occur along Clinch River and on Copper and Moccasin creeks. An appropriate name for these lower erosion surfaces is the Valley-floor peneplane.[1]

1. Op. cit., p. 39.

The streams of today, however, stand from 200 to 400 feet below the Valley-floor levels, and this lower position testifies to a renewal of uplift and down-cutting that has continued to the present time. (See Pls. 10,A and 16,B.)

In summary, one may recognize two major erosional levels in Scott County, of which the Upland level, now 2,000 to 4,000 feet above the sea, is the older and has been more fully obliterated. Its remnants may now be found only on the tops of the higher ridges. The other erosional surface, known as the Valley-floor level, is much lower and was produced during a temporary halt in the dissection of the higher surface; its remnants now stand between 1,500 and 1,800 feet above sealevel. As a result of recent uplift and renewed erosion, present drainage is entrenched from 200 to 400 feet below the Valley-floor surface. Belts of resistant rock have determined the position of the present ridges, and the lower areas of the county are mainly developed upon belts of weaker rock. The details of the present scenery are readily explainable in terms of the development of these erosional surfaces.

Topographic Features

Many of the special topographic features which occur in Scott County are related to the production of the erosion levels previously described. The peculiar pattern of the local drainage has such a relationship. As shown in Figure 2, all of the larger streams are roughly parallel to one another and occupy valleys that trend northwestward. This parallelism, which also involves the interstream divides, although most conspicuous in western Scott County, is evident in nearly all portions of the area. As it is obviously related to the trend of the bedrock, it must have made its first appearance in the topography when the bevelled edges of weak and hard rocks guided the initial erosion of the old Upland level. As the belts of softer rock were subjected to active stream erosion, they became the main lines of surface drainage, while the intervening belts of harder rocks retained part, at least, of their original elevation. Comparative differences in elevation became magnified as erosion progressed, but the parallel arrangement was never destroyed.

The two largest streams, Clinch River and North Fork of Holston River, have inherited not only their present position but also their winding courses from the period of Upland peneplanation when they were the master streams of the erosional surface upon which they developed broad meandering courses. Later, when uplift of the region rejuvenated their gradients, the streams gained new velocity and added erosional power, but

were not forced out of their previous curving courses which were eroded downward into the bedrock as lasting features of the rivers.

Big Moccasin Gap (Pls. 3, B and 8, A), a conspicuous scenic feature of Scott County, is likewise the result of drainage development on the Upland surface. At the time when the flats at the top of Clinch Mountain were part of the continuous Upland surface, Moccasin Creek flowed readily across the present sandstones of Clinch Mountain to join Holston River. When the land subsequently rose, the Holston and its tributaries began to wear away the softer rock on either side of the sandstone belt, forcing the active Moccasin Creek to cut deeply into the bedrock in order to keep pace with the rest of the drainage system. At first thought, it may seem impossible for flowing water to erode rock as hard as that of Clinch Mountain; but the stream, grinding with sand, pebbles, and boulders, and concentrating its power on a small section of hard sandstone, was able, through a great length of time, to cut a gap through the rock barrier as the land slowly rose. In the meantime, removal of softer rocks on both sides of the sandstone belt left a ridge standing in bold relief with a great gash cut through it. Although the gap has continued to get deeper as the land has risen higher, the hard rock of Clinch Mountain, originally forming rapids in Moccasin Creek, has prevented the upper portion of the Moccasin drainage from reaching the level that Holston River attained. Thus the gap is the original passage of the creek across the sandstone belt,

maintained, deepened, and widened while erosion of the region and uplift of the land produced the ridge and its conspicuous height above the surrounding country.

It is possible to detect that for all east-west valleys, such as those of Clinch River, Moccasin and Troublesome creeks, and North Fork of Clinch River, the southern side is steeper than the northern side. This feature is due to the inclination or dip of the underlying rocks, which is mostly toward the south, thereby allowing the streams to slide southward down the dip, or slope, of the rocks. Whereas their northern banks are more gentle and tend to conform somewhat with the rock inclination, the southern banks of these rivers, actively hewn into the edges of tilted strata, stand with steep angles. Correspondingly the slopes of the intervening ridges--Moccasin, Copper, Purchase, and Chestnut--are more gentle than their northern slopes. (See Pls. 5, A and 11, B.)

Some of the most beautiful scenery of Scott County occurs in the more or less inaccessible country north of Stone Mountain along the steep slope which descends from the Alleghany Plateau (Pl. 6, B). The deep ravines at the headwaters of Stony Creek, Straight, Chimney, Grady, and Mountain forks have been eroded to depths several hundred feet below the plateau level. Little Stony Creek has similarly developed a deep, narrow gorge which is followed by the main road from Dungannon to Coeburn. The resistance of a hard sandstone ledge to stream erosion is conspicuously shown about 2 miles above Dungannon, where the creek emerges through a high wall of vertical sandstone cliffs, (See Pl. 17, A.).

The flat plateau surface is well exhibited along the county-line south of Coeburn at an elevation of about 2,300 feet above sealevel.

Through the activity of its many headwaters, Stony Creek has been furnished with a larger burden of gravel and rock debris than it can readily transport to Clinch River. It has distributed the surplus material along the floor of its valley to build up a narrow, but deep, alluvial fan between Ka and Lano.

In the short distance between Riggs (Duncan Mills) and Clinch River, Cove Creek exhibits several meanders that are excellent examples of the broad sweeping curves which a quiet stream develops upon level ground. The meanders, however, were produced at some time in the past, for Clinch River has cut down nearly 100 feet since their formation. The lowering of the main river has given Cove Creek additional vigor, and the meanders have become entrenched into the bedrock. In at least one place below Duncan Mills, the creek is attempting to shorten its course by cutting a new channel from one meander to the next; possibly the valley now followed by the country road may ultimately become a creek channel. Fine meanders are also present along the middle reaches of Copper, Moccasin, and Opossum creeks.

There is evidence of abundant underground drainage in Scott County. The valley of Sinking Creek between Dungannon and Brewster, Russell County exhibits unusual features of subsurface drainage. Originally the creek was a normal surface

stream that entered Clinch River at Dungannon. As such, it developed a deep narrow valley in descending from Copper Ridge to Clinch Valley. However, the greater erosive ability of the main river enabled the Clinch to lower its valley faster than could Sinking Creek, and in the process of downcutting, Clinch River apparently intersected a fissure in the limestone bedrock. Eventually the waters of Sinking Creek found access to this channel and, abandoning their former surface course, sank underground. The old surface channel of the creek underwent little additional erosion below the sink into which the creek drained, although normal surface-lowering continued above the point where the stream disappeared below ground. An unusual basin was thus developed that has no surface outlet. If, by chance or plan, the underground outlet to Clinch River should become clogged, it is probable that a small lake would collect in this basin until it overflowed the old surface channel and fed directly into Clinch River. Only the immediate area at the present underground outlet is underlain by limestone bedrock; the main portion of the basin of Sinking Creek is developed on soft insoluble shale.

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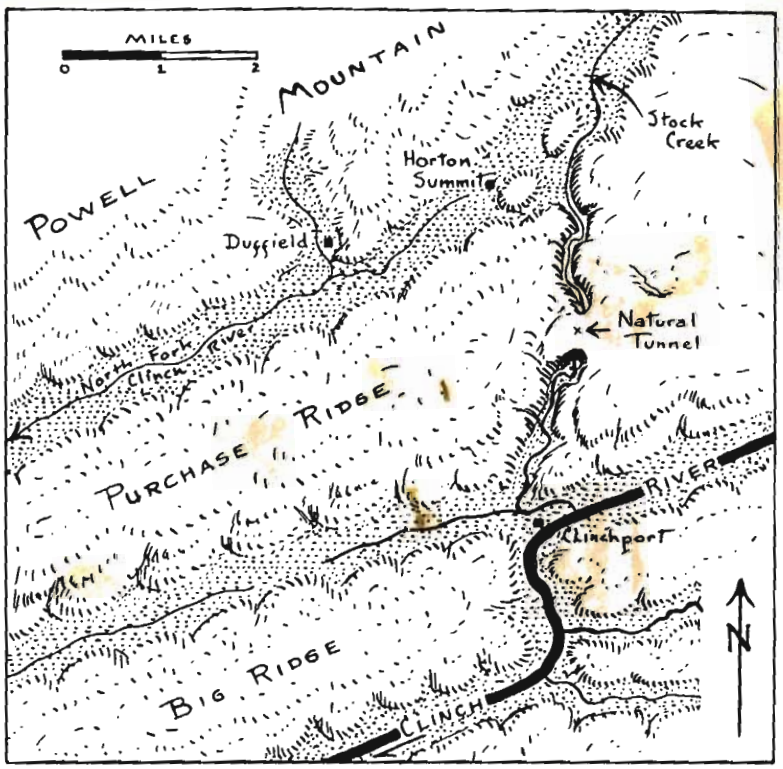


FIG. 3.—Sketch map of the vicinity of Natural Tunnel, ~~Virginia~~

Plate 8

(near manuscript page 23)

A. Big Moccasin Gap, viewed from the north. (Compare with Pl. 3,B .) (See pages 7, 8, and 19 .)

B. The spectacular crater-like gorge of Stock Creek below Natural Tunnel is more than 400 feet deep. The stains on the rock walls are the result of underground water seeping out along bedding planes in the Nittany dolomite. (Compare with Pl. 9 .) (See pages 24, 45, and 70 .)

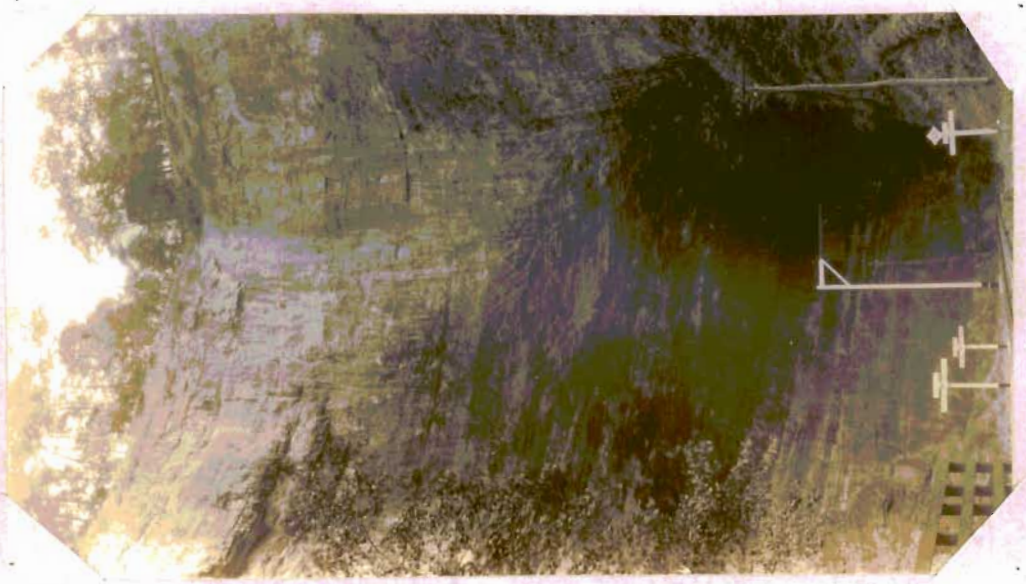
Natural Tunnel

Natural Tunnel is situated in the west-central portion of Scott County, 3 miles north of Clinchport and about 12 miles northwest of Gate City. It is a short distance east of U. S. Highway 23 with which it is connected by a short privately maintained road. Stock Creek, which enters Clinch River at Clinchport, and the tracks of the Southern Railway pass through the tunnel; a country road makes use of its overhead arch to cross the gorge of Stock Creek.

The curiosity of a natural tunnel led Indians and the early settlers of southwest Virginia to travel for considerable distance to see it, and there are several Cherokee legends based upon incidents connected with the tunnel. The historic Daniel Boone trail from the Carolinas into Kentucky passed nearby, and the old path leading to Carter's Fort in Rye Cove crossed the tunnel arch. Because of its inaccessibility, the tunnel not widely known until the coming of the railroad in 1882 when the South Atlantic and Ohio Railway made use of the tunnel from Clinch Valley northward. Tracks are now maintained through the tunnel by the Southern Railway. The construction of the paved highway from Gate City to Big Stone Gap has likewise improved access, and the unique phenomenon of a natural tunnel has brought an increasing stream of visitors.

The tunnel is a cavernous opening at creek level through a spur of Purchase Ridge. (See Fig. 3.) The roof averages 75 feet in height above the creek for the 900 feet of its length. It is considerably higher at the southern end than near the

Plate 9
(Near manuscript page 24)



A. The southern entrance to Natural Tunnel. The rock near the floor is Copper Ridge dolomite; the roof and upper cliffs are Nittany dolomite. (See page 24.)

B. The northern entrance to Natural Tunnel. (Compare with Pl. 9, A.)

northern end, where the natural roof is only a few feet above water level. The width of the tunnel averages 130 feet, and the underground passage is gently sinuous. The southern end opens into a spectacular amphitheater, or "crater", formed by the gorge of Stock Creek. (See Pls. 8, B and 9, A.) The walls of this gorge rise more than 500 feet above the creek and are nearly perpendicular except at the southern rim where the creek passes through. A similar, but less striking amphitheater, occurs around the northern end of the tunnel. (See Pl. 9, B.)

Stock Creek rises along Powell Mountain and flows southward through the tunnel into Clinch River at Clinchport, about 3 miles below Natural Tunnel. The creek is about 16 miles long, and its course may be separated into 2 portions of dissimilar character. The upper two-thirds occupies a broad subsequent valley which trends southwesterly toward Horton Summit (Sunbright Post Office). A short distance above Horton Summit, Stock Creek leaves this open valley to flow due south in a much narrower valley that becomes gorge-like in the vicinity of Natural Tunnel. The fall of the creek from a point near Horton Summit to Clinch River is about 300 feet in a distance of about 6 miles. The tunnel is located at the eastern end of Purchase Ridge, which separates the immediate drainage of Clinch River from that of its chief local tributary, North Fork. The latter joins the main stream in Tennessee, and its chief branch rises in the vicinity of Duffield, which is about 3 miles southwest of Horton Summit. Indeed, the valley occupied by the upper part of Stock Creek and that occupied by the headwaters of North Fork near Horton Summit are continuous, and only a low divide,

still capped with stream gravels, separates the two basins. (See Fig. 3.)

Natural Tunnel has been eroded in a series of limestones and dolomites. The tunnel itself is in the Copper Ridge formation of Ozarkian age (see pages 45-46); the cliffs above the tunnel are composed of Nittany dolomite, which is of Canadian ago. (See Pl. 8, B.) The rocks are essentially horizontal at the tunnel and in the cliffs above it, but minor faults and some close folding are evident. The tunnel is located near the southwestern end, and along the axis, of a broad shallow syncline, called the Rye Cove syncline. (See pages 61-62.) The syncline is separated from adjacent structures by thrust faults which strike southwesterly. Upper Stock Creek and North Fork occupy a subsequent valley located along the trace of an overthrust fault. (See pages 63-64.) Another fault crosses Stock Creek a short distance above its mouth.

The author has recently discussed the origin of Natural Tunnel, and has compared its development with that of Natural Bridge, Rockbridge County, Virginia.[1] He has suggested that

1. Woodward, Herbert P. Natural Bridge and Natural Tunnel, Virginia: Jour. Geology, vol. 44, pp. 604-616, 1936.

at the time of formation of the Valley-floor (Harrisburg) peneplane, the headwaters of Stock Creek did not flow directly into Clinch River as at present, but followed the rather wide open valley past Horton Summit to enter the basin of North Fork of Clinch River. That this open valley still continues from the Stock Creek to the North Fork basin is clear from the present topography; that the present divide was formerly

occupied by a stream is evinced by quantities of stream gravel and fluvial debris on the valley floor southwest of Horton Summit. It is a reasonable conclusion that the headwaters of North Fork once extended northeastward to include the upper portion of modern Stock Creek. The lower portion of the course of Stock Creek (below Natural Tunnel) was occupied by a small but vigorous tributary of Clinch River proper, which descended rapidly from the eastern slope of Purchase Ridge to the master stream.

The floor of the upper valley, then occupied by the elongated North Fork, was at least 300 feet higher than the level of Clinch River at the north of the small tributary. This difference in elevation, together with a soluble bedrock, enabled some of the upper drainage to seek a shorter underground route to baselevel. Possibly the water entered sinks that led to previously existing channels, or followed openings that had gradually been developed during the formation of the Valley-floor peneplane. Possibly new channels were formed and enlarged. At any rate, it is suggested that the upper portion of North Fork (now upper Stock Creek), became diverted underground to emerge in the valley of the small tributary of Clinch River. Gradually this transfer became more and more complete, until the headwaters of North Fork became entirely diverted from that stream and engrafted to the smaller tributary of Clinch River proper.

A similar explanation of the origin of the tunnel has been proposed by Wright.[1]

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1. Wright, Frank J., The Newer Appalachian of the South (Part 2): Denison Univ. Bull., Jour. Sci. Lab., vol. 31, pp. 129-130, 1936.

CLIMATE

The climate of Scott County is temperate and pleasant. In the northern portion, where the general elevation is high, the winters are more severe than in the sheltered valleys and lowlands of the southern and central belts. The mean annual temperature is about 50° F., and the average annual rainfall is about 50 inches. A dependable growing season extends from about April 25 to October 25. Gate City enjoys a mild climate with maximum summer temperatures that seldom exceed 100° F., and with winter extremes that rarely reach 0° F. The mildest climate of the county is that of the belt south of Clinch Mountain.

SOIL AND VEGETATION

Like most portions of southwest Virginia, Scott County is covered with a residual soil that has been derived by weathering from the underlying bedrock. Although a wide range of soils is expectable in view of the variety of units in the bedrock (Table 1), there are only a few main soil types in the county.

Much of the central portion of the county between Clinch Mountain and Clinch River is covered with a limestone soil that supports an excellent crop of bluegrass. Many varieties of limestone, dolomite, and limy shale contribute to this soil, which is commonly a red-clay loam that grades below ground into a red clay. It is sticky when moist, but plows readily and normally produces a solid bluegrass sod. It was sufficiently thick and fertile in colonial days so as to attract the "long hunters" who first undertook its culture. The area of its outcrop is a rolling, but not mountainous, range that supports a good stand of either timber or bluegrass; it is easily adapted to the cultivation of corn, wheat, and oats. (See Pl. 7,B)

Some of the underlying limestones produce large quantities of chert, or light-colored flint, which resists both erosion and decay. The accumulation of this material in local areas so contaminates the soil as to hinder profitable cultivation. Many portions of the slopes of Copper and Moccasin ridges are covered with chert fragments to such an extent that sections of the ridges have never been permanently cleared

nor successfully cultivated. (See Pl. 11, B) The larger number of cherty areas in Scott County, together with steeper mountain have resulted in smaller areas of workable farm land than in the neighboring Russell and Tazewell counties.

A limestone soil also underlies southeastern Scott County, south of Clinch Mountain and east of Holston River. The bedrock of this portion of the county, although calcareous, supplies a less productive soil than do the limestones of central Scott County, and the soil is neither as fertile nor as thick as the valley soils north of Clinch Mountain. It also contains greater quantities of chert, and its outcrop is more irregular and has steeper slopes than the limestone belts to the north.

Shale soils, which are well distributed throughout the county, occur along the northern slope of Clinch Mountain, and in linear belts along Moccasin, Copper, and Clinch rivers. As many of the shales are calcareous, their soils are correspondingly productive and support bluegrass or staple farm crops where properly cared for. Much of the shale area, however, although well adapted for range land, is too steep for profitable cultivation. (See Pl. 11, B) Most shale soil is red-brown and of average depth; it commonly contains tiny splinters of the bedrock from which it has been derived.

The black-shale soil of Poor Valley (Pl. 6, A) which occurs between Clinch and Pine mountains and in Hunter Valley, is the poorest and least fertile of Scott County soils. It is thin, loose, and sterile, and is frequently covered or intermixed with sandstone boulders from the adjacent ridges. In

Plate 10

(near manuscript page 30)

A. The Devonian shale lowland near Duffield. Notice the flat-topped terraces of a former valley floor now preserved on the central hill summits. (See pages 17, 30, 53, and 77 .)

B. Cliffs of interbedded Cambrian limestone and shale along the southern bank of Clinch River near Clinchport. (See pages 39, 43, and 113 .)

flat bottoms, it gains fertility, but its outcrops in Virginia are almost invariable "poor" country.

The coal-bearing rocks (See Fig. 7) of the northern portion of the country produce a sandy soil that is of little agricultural value. It occurs on slopes that are commonly too steep to permit profitable cultivation, and is deficient in nutritive material for plant growth. It does not favor the growth of bluegrass and is readily subject to wash and gullying. Too ambitious stripping of the meager timber has reduced many square miles of its area to "submarginal" land[1] in which any type of soil cultivation is difficult and unprofitable. A smaller belt of sandy soil is also found along Clinch and Powell mountains and in the region south of Holston River in the extreme southeastern portion of the county.

1. This term is used for land whereon the farmer's normal efforts to maintain a living fall below the necessary margin of successful profit.

Very little floodplain, or alluvial, soil occurs in Scott County. Small patches, however, along Clinch River (See Pls. 16, A and 11, A), and the lower reaches of Moccasin and Copper creeks are intensively cultivated. Floodplain soils consist of river sediment spread over the valley floors during times of high water. They are deep and rich, although of only local extent. Several areas of excellent alluvial soil, or "bottom lands", occur in the flats between Duffield and Pattonsville along North Fork of Clinch River (See Pl. 10, A), and between Maness and Fairview on North Fork of Holston River.

Approximately one-fourth of Scott County consists of cleared land upon which the original timber has been entirely removed, and a large proportion of the remainder has been cut

Plate 11

(near manuscript page 31)

A. The floodplain of Clinch River near the mouth of Cove Creek, viewed from the location of a drilling well for oil. The bedrock at this point is Cambrian shale. (See pages 30 and 98.)

B. The northern edge of Moccasin Ridge, 2 miles north of Snowflake. The farmer's plow has unwisely invaded the crest of this rugged spur, for land of this type might better be kept in timber. (See pages 10, 20, 28, 31, and 46.)

over many times. When the land was a hunting preserve, as in the days of Donelson's Line (pages 6-7), it is likely that all of the county, save isolated clearings in the valleys, was heavily timbered. Chestnut, oak, hickory, maple, poplar, walnut, and hemlock were the most common forest types,and they are still abundant in the second-growth forests of today. Thickets of rhododendron and natural clearings of bluegrass were likewise present in the original vegetation.

As settlements increased, the forest areas dwindled, and crop farms and cattle ranges became more numerous. It is not clear that this was everywhere a desirable change. Indeed, many cleared slopes are too steep for profitable agriculture,and their soils have been ravaged by ill-advised and unskilled cultivation. (See Pl. 11,B.) Such land, abandoned by the itinerant farmer--sometimes called a"three-cropper" to indicate his speedy destruction of the soil--has gone back to forest again; and a scraggly growth of timber now struggles to maintain a foothold where a sturdy forest formerly stood. Sub-marginal land of this type, partially destroyed of its usefulness,is being slowly renovated by judicial reforestration,and carefully controlled drainage channels. Properly directed, such renovation may restore some of the area to the acreage of useful land. Not for a long time, however, will the land regain its lost cover of soil to such an extent that it can be profitably tilled; for soil removal, unfortunately, can only be checked; there is no speedy way of replacing the lost soil.

Profitable farming has been carried on in most parts of the country, where, under adequate culture, natural soils have been enriched, soil erosion halted, and crop rotation practised. Corn,wheat,and oats,together with burly tobacco and potatoes, are the principal crops. Range land with fine bluegrass pasturage has likewise been preserved and maintained over large areas of the county.

GEOLOGY

GENERAL STATEMENT

Whereas the geographer is primarily concerned with the surface of the earth and the phenomena that take place thereon, the geologist deals with the entire earth, its materials, structure, history, and its life, both present and past. Adequately to describe the geology of an area, one must understand the character, origin, and subdivisions of the bedrock, the various structures which the rock formations assume, and the stages of geologic history during which both rocks and structures were produced. The following paragraphs treat of these features under 3 headings; Rocks, Geologic Structure, and Geologic History.

ROCKS

General Statement

Almost all geographic features are intimately related to the rock types which underlie the surface of the ground. Elsewhere in the Appalachian region, it is possible to separate the bedrock into the three major rock groups, sedimentary, igneous, and metamorphic. Metamorphic rocks, however, which result from intense heat and pressure, are not known in Scott County, nor do any igneous rocks - which result from the solidification of molten material - occur near the surface of the county, where all of the exposed rocks are of sedimentary origin.

Sedimentary rocks include all those which were produced by processes of weathering and erosion and were deposited as sediments. The common products of erosion, therefore, such as gravel, sand, and mud, are the chief constituents of sedimentary rocks, and from them are formed respectively conglomerate, sandstone, and shale. Limestone and dolomite, also classed as sedimentary rocks, are composed respectively of calcium carbonate and impure magnesium carbonate. Gradational varieties, such as limy shales, shaly sandstones, and magnesian limestones are equally as common as the 5 basic sedimentary types.

Inasmuch as most sediments were originally deposited in beds, or strata, sedimentary rocks are commonly stratified (Pl. 12,A) and a continous series of similar strata is known as a formation. The latter is the common unit for the detailed description of the bedrock, and each formation is usually given a geographic name. Thus, there is a recognizible series of mudrocks (Pl. 12,B) and limestones which is well exposed near Moccasin Gap. It is convenient to call this series the Moccasin formation, even though it

Table 1

GEOLOGIC COLUMN FOR SCOTT COUNTY

AGE	FORMATIONS	THICKNESS: N. of Clinch R.	THICKNESS: ~~Bet. R & Mtn~~ Between Clinch River and Clinch Mountain	THICKNESS: S. of Clinch Mtn	MAP UNITS
Pennsylvanian	Norton formation	1450 feet	Absent	Absent	Coal-bearing sandstone & shale
	Lee formation	1600			
Mississippian	Pennington shale	1100		1000	Sandstone & shale
	Glen Dean-Cove Creek ls.	350		1000	Shaly limestone
	Fido sandstone	Absent		0-50	
	Gasper limestone	300		1000	
	Ste. Genevieve limestone	300		1300	
	St. Louis limestone	200		125	Impure limestone
	Warsaw limestone	Absent		500	
	Maccrady shale	10		60	Shale
	Price-Pocono sandstone	300		800-1200	Sandstone & shale
	Big Stone Gap shale	0-335		0-40	
Devonian	Chemung formation	0		0-10	
	Brallier shale	600		300-1500	Shale
	"Romney" shale	Absent		100-600	
	(Onondaga limestone)			Absent	Absent
	Helderberg limestone	50-100		50	Impure limestone
Silurian	Tonoloway limestone	0-200		Absent	
	Wills Creek sandstone	25			Sandstone & shale
	Clinton formation	200		400	
	Clinch sandstone	100	100-75	75	Massive sandstone
Ordovician	Juniata shale	300	300	300	Sandstone & shale
	Martinsburg shale	600-900	1600	1800	Shale
	Moccasin-Lowville form.	600	725	Absent	Shaly limestone
	Ottosee limestone	200	200		
	Holston limestone	300	400		Pure limestone
	Lenoir limestone	50	50		
	Mosheim limestone	50	25		
	Murfreesboro limestone	0-125	75		Impure limestone
Canadian	Bellefonte dolomite	150	200		Pure dolomite
	Nittany dolomite	400	1000	800-1000	Impure cherty dolomite
Ozarkian	Stonehenge limestone	Absent	Absent	20-40	
	Chepultepec limestone			20-30	
	Copper Ridge dolomite	1200	1200	1200	
Cambrian	Nolichucky shale	500	500	500	Shale
	Honaker dolomite: Maryville dol.	500	400	1200-1600	Mag. ls (Impure dolomite)
	Honaker dolomite: Rogersville sh.	1000-0 1200	500-0 1200		Shale (Impure dolomite)
	Honaker dolomite: Rutledge ls.	200	200		Mag. ls (Impure dolomite)
	Rome formation	1200	1100	1000	Shale

(near manuscript page 34)

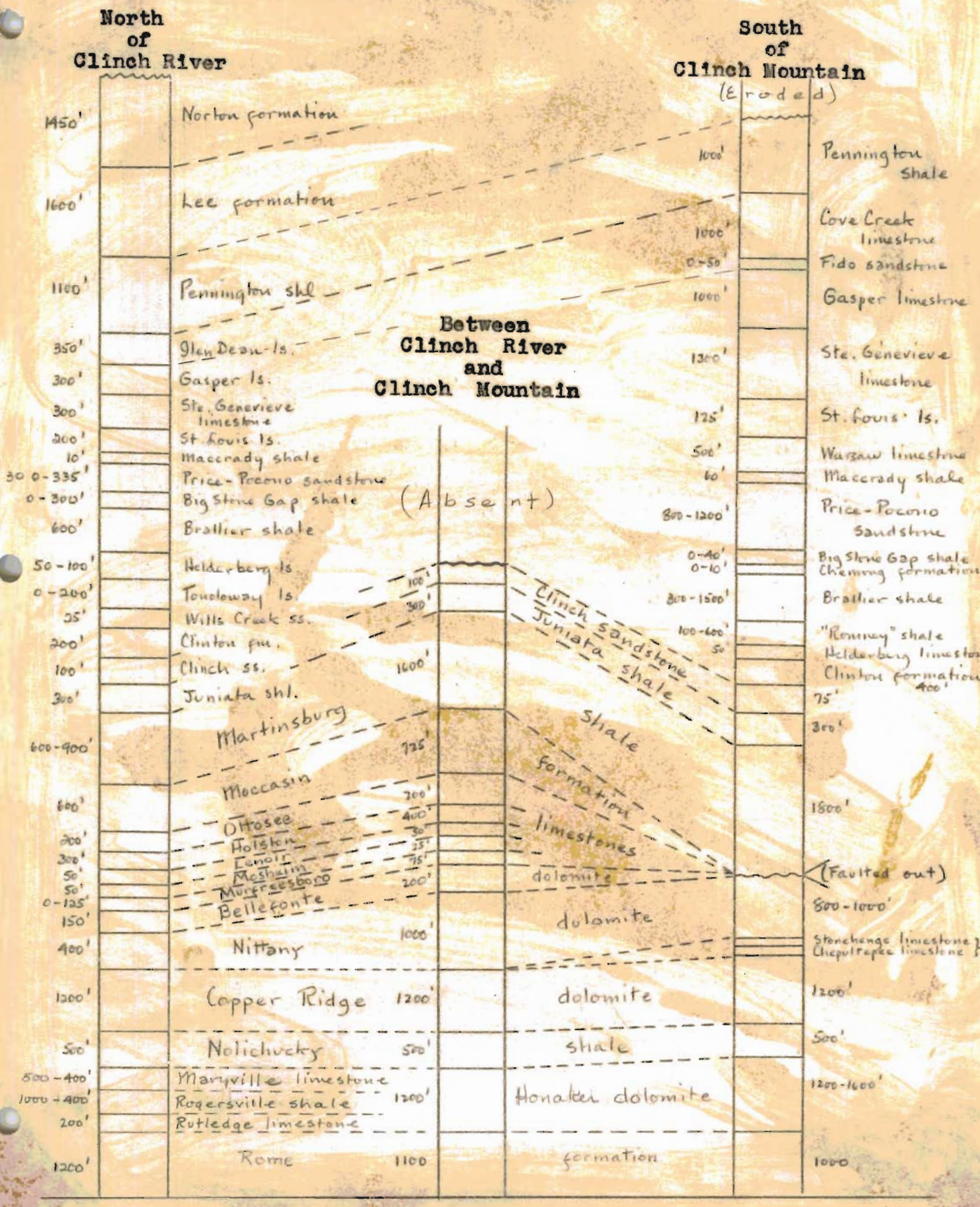
extends far north and south of Scott County. Indeed, wherever it can be specifically identified, it is known by this name. Many of these formations contain fossil shells or other indications of the life that existed when the sediment was deposited. As the fossils of each unit differ in some manner from those of other units, it is possible to identify an unknown rock formation by comparing its fossils with those of familiar rocks. When the fossils of many adjacent rock formations are studied, broad relationships become apparent throughout various groups of formations; and these relationships, also manifest in the rock characters, indicate that the related formations were more or less continuously deposited under approximately the same geographic and environmental conditions. It is possible in this manner to establish a grouping of associated formations, and to characterize the corresponding time periods of their deposition into eras, periods, and epochs of earth history.

All members of the exposed bedrock of Scott County were deposited in the Paleozoic era, which was a long portion of earth history that came to an end with the formation of the Appalachian Mountains. The era is subdivided into a number of smaller divisions, or periods, and all but the last or latest period of the Paleozoic are locally represented by one or more rock formations.

In listing the rock formations of any region, it is customary to prepare a table in which the various units are arranged in proper chronological order with the oldest at the bottom and the top. Table 1, which follows, shows the thickness, geologic name, and age of each bedrock formation is listed. (Insert Table 1 here.) As the units do not maintain the same thickness throughout all parts of the county, the table shows the succession and thickness

Figure 4

COLUMNAR SECTIONS IN SCOTT COUNTY, [redacted]



(near manuscript page 35)

Table 2

ROCK TYPES IN SCOTT COUNTY

Rock Types	Formational Name							
	Cambrian	Ozarkian	Canadian	Ordovician	Silurian	Devonian	Mississippian	Pennsylvanian
Sandstone					Clinch			
Sandstone and shale				Juniata	Wills Creek Clinton	Chemung	Fido Pennington Price-Pocono	
Shale	Nolichucky Rogersville Rome			Martinsburg		Brallier "Romney"	Maccrady Big Stone Gap	
Coal-bearing sandstone and shale								Norton Lee
Pure limestone				Holston Lenoir Moshein				
Impure limestone				Murfreesboro	Tonoloway	Helderberg	St. Louis Warsaw	
Shaly limestone				Moccasin Ottosee			Glen Dean Cove Creek Gasper Ste. Genevieve	
Magnesian limestone	Maryville Rutledge							
Impure dolomite	Honaker	Chepultepec Copper Ridge	Nittany Stonehenge					
Pure dolomite			Bellefonte					

Near manuscript page 35

of the formations in 3 different portions of the area. Corresponding map units are also indicated.

Figure 4 shows the same data arranged in columns in which the thickness of the several formations are drawn approximately to scale. Table 2 shows a rearrangement of the local formations into the various rock types whose areas are delimited on the accompanying rock map. (See Pl. 1.) (Insert Table 2 here.)

The rocks of Scott County will be briefly described (1) in terms of the various sedimentary types which occur within the area, and (2) in terms of their geologic arrangement into rock formations and systems; the latter term represents all of the units produced during a single period of geologic time.

Types of Scott County Rocks

Sandstone

Sandstones are fragmental rocks made up of cemented grains of sand. As most sand consists of tiny grains of quartz, the most abundant constituent of any sandstone is quartz, although mica, feldspar, and a few other minerals may also be present. The grains of a sandstone are cemented together by silica or by some form of iron oxide. The latter gives the weathered rock tints of yellow or red; sandstones cemented by silica are commonly white or gray and are superior in hardness to other types. Although it is porous rock through which underground water can readily pass, sandstone is stubbornly resistant to both weathering and erosion (Pls. 14 and 17, A), and its siliceous varieties commonly form ridges of the first magnitude. The few fossils which occur in sandstones are chiefly plant fragments in fresh-water sands, and shells in marine sandstones.

Quartz, the main constituent of sandstone, is an extremely hard mineral; hence, a piece of sandstone, if firmly held, will scratch glass or steel. Although this simple test will readily identify any sandstone, a granular or sugary texture is also an distinguishing character. The familiar term "freestone" generally refers to sandstone.

The outcrops of Scott County sandstones (Plate 1) are hilly, thinly covered with soil, and rarely cleared of timber. Their areas can be cultivated only with great difficulty, and are constantly subject to rain-wash and gullying. With the exception of a few beds

on Clinch Mountain (Pl. 4, A) that supply glass and foundry sand (pages 129-131), the local sandstones are not reserves of potential economic value.

A conglomerate is an extremely coarse sandstone containing rounded pebbles and other fragmental material which has not been reduced to fine size. There is no essential distinction between a conglomerate and a sandstone save in size of grain. No single formation in the county is wholly conglomeratic, although individual beds in several units are described as conglomerates. This rock type, like the sandstone, is resistant to erosion and produces rough country that seldom supports a thick or productive soil. The rock of Stone Mountain, and certain of the ledges of both Powell and Clinch mountains, show the "pudding-stone" texture of the true conglomerate.

Plate 12

(near manuscript page 38)

A. Stratified magnesian limestone of the Copper Ridge formation in the Glenita quarry near Clinchport. The flat layers, or strata, of the rock are plainly shown. (Compare Pl. 17, B .) (See pages 33, 45, 59, 70, and 127 .)

B. Well-preserved mud cracks such as these in the Moccasin formation near Speer Ferry clearly indicate the shallow-water origin of some of the local rocks. (See pages 33, 38, 48, 70, and 119 .)

Shale

Fine erosional debris, such as clay, silt and mud, consolidates under pressure to produce shale. The resulting rock is invariably fine textured, soft, and easily split. (See Pl. 13, A.) Indeed, it is the property of being cleavable or fissile, which commonly identifies a shale. Most shales are easily eroded, and quickly disintegrate under the attack of weathering. Their outcrops, therefore, produce low ground or form the slopes rather than the crests of hills. A local exception occurs in the shales that follow the valley of Clinch River. The belt of these shales is adjoined on both sides by limestones which are more soluble than shales. Hence the limestone belts have been lowered faster than the shale outcrop which is covered with small rounded or conical hills. (See Pl. 7, A.)

Shales occur in many colors, of which red, gray, and black are the most common. Although less fossiliferous than the local limestones most of the shales in Scott County contain fossil shells or other remains of ancient life. All local shales are thin bedded and slabby, and most are of marine origin. Some show unmistakeable evidence of deposition in shallow water where mud cracks (Pl. 12, B.), ripple marks, and rain prints could be preserved in soft sediments.

Limestone

Limestone is a familiar sedimentary rock that is rich in calcium carbonate or "lime". Commonly it is a gray or blue-gray rock which occurs in fairly massive beds. Its surface is discolored by weathering, and may be rounded or corroded by solution. (See Pl. 13, B.) Most limestone soils are red or red-brown, and they are invariably more fertile than sandstone or shale soils. The high calcium-carbonate composition (~~see~~ Tables 6, 7, and 8) of all limestones renders them readily soluble by underground water, and aids in their rapid erosion and weathering. As a result, most limestone outcrops form low ground in which sinks, caves, and abundant springs testify to an extensive underground circulation. (See Pl. 8, B.) With admixture of clay, limestones grade into calcerous shales that are soft, slabby, and weather readily. Fossils, usually those of marine shells, are common in many limestones.

Although most limestones are gray and fine textured, other colors and textures are not uncommon. Some limestones are dark or black; others may be brown, and a few are red. Granular textures characterize some limestones, while others may be so coarsely crystalline as to warrant the name marble (~~see~~ pages 127-128); still others may show almost glassy surfaces. Flint or chert, which is a very hard non-crystalline form of quartz, occurs in many of the local limestones where its presence interferes with the normal fertility of limestone soil. Some of most fertile areas of the county occur upon limestone outcrops, where bluegrass and farm crops alike find rich nourishment. (See Pl. 1.) Except

where it underlies steep hill slopes (Pl. 10, B), or where the rock is unusually cherty, the local limestone outcrop may be profitably cultivated.

Nearly all limestones in Scott County will furnish agricultural lime if properly burned. To verify the identification of limestone, one may resort to a simple chemical test, for a fresh limestone surface will bubble gently, or effervesce, when moistened with a drop of hydrochloric acid (HCl). The latter may be obtained at a drug-store, and will not injure the skin; it should not be used internally, nor put in contact with cloth which it will ultimately corrode.

Scott County's limestones are valuable rocks. They now supply material for road metal, cement, and building stone, and the few quarries already opened indicate large reserves of usable stone. The county is fortunate in containing so many belts of this valuable material. More detailed information about the development and use of limestone occurs on pages 115-122.

Dolomite

Dolomite superficially resembles limestone with which it is commonly confused. It is a massive, light-colored calcareous rock that is soluble in underground water. Its chemical composition, which is chiefly impure magnesium carbonate, differs from that of a true limestone, although there are all gradations from pure limestone (composed of calcium carbonate) to pure dolomite (composed of calcium-magnesium carbonate). (See Tables 6 and 7.)

An important difference between limestone and dolomite is the fact that the former can be burned to produce lime, whereas it is difficult to "burn lime" from a dolomite. Lenses of limestone occur in dolomitic formations, and magnesian limestones approach the composition of dolomites. Indeed, intermediate varieties are more common than either pure limestone or pure dolomite.

The dolomites that occur in Scott County produce hilly outcrops that commonly exhibit an abundance of irregular, jagged boulders of chert or flint. (See Pl. 1.) It is not yet known whether the chert was an original constituent of the bedrock, or whether it was produced during subsequent exposure and weathering. Many chert fragments are cavernous or are stained with iron oxides. Occasionally, cherty fragments of brown iron ore occur on the dolomite outcrops. Although the presence of chert tends to impair the fertility of dolomite soils, it does not deter the successful use of the soil for pasturage.

Rock Formations of Scott County

It is not sufficient for the geologist to group the elements of the bedrock solely on the basis of types of material; he must also group them in terms of their age, fossil content, and historical relationships. Such a consideration calls for their description in true chronologic sequence, and it is customary to describe rock formations in the order of their deposition, the oldest first, and the youngest, last. (See Fig. 4, and Tables 1 and 2)

All bedrock formations in Scott County belong to the Paleozoic group of rocks, and may be arranged as follows:

	SYSTEM	THICKNESS
PALEOZOIC GROUP	Pennsylvanian	3,000 + feet
	Mississippian	2,800 +
	Devonian	700 - 2,000
	Silurian	550
	Ordovician	3,000 +
	Canadian	1,200 ±
	Ozarkian	1,200 ±
	Cambrian	3,200 ±

The names of these 8 rock systems are also the names of the periods of the Paleozoic era during which the local rocks were laid down as sediments, and the following paragraphs describe the individual formations contained in each system. No bedrock older than the Cambrian, nor younger than the Pennsylvanian, is now exposed in the county. Permian rocks, comprising the latest Paleozoic system, if ever present, are now removed by erosion.

Cambrian Rocks

The Cambrian system begins with the shaly Rome formation (Pl. 15, A) which crops out chiefly in the central and western portions of the county. Its base is nowhere exposed, for a series of major displacements, or faults (pages 63-65), has removed the surface outcrop of the bottom of the system. In the region south of Copper Ridge, the Rome formation is overlaid by the Honaker dolomite; north of the ridge, the Rutledge limestone, Rogersville shale, and Maryville limestone replace the Honaker dolomite and overlie the Rome formation. The thickness of the Honaker and its equivalent series is more than 1,000 feet. The top of the Cambrian is formed by the gray Nolichucky shale with a thickness of about 500 feet. All of the Cambrian shales are fossiliferous and contain many fragments of trilobites in their thin limestone beds. The topmost member of the Nolichucky is a thin series of interbedded limestones and dolomites that corresponds in lithology and position to the Maynardsville formation of the Thorn Hill section of Tennessee[1].

1. Oder, C. R. L., Preliminary subdivision of the Knox dolomite in east Tennessee: Jour. Geology, vol. 42, pp. 475-76, 1934.

The several Cambrian shales, including the Nolichucky, Rogersville, and Rome formations, crop out in various local belts. A wide outcrop of Rome shale extends along Clinch River from Russell County to Clinchport (Pl. 10, B); parallel belts of the Nolichucky and Rogersville shales flank Copper (Pl.7,A) and Moccasin ridges on the north. Other belts occur (1) between Fairview and Dona; (2) along the slopes of Newman Ridge; (3) in the belt of the River Knobs; and (4) in isolated areas along the Tennessee boundary east of Holston River. All of these shales are characterized by interbedded limestones

as well as by somewhat stiffer and more resistant shales than are found in other local shaly units. The Cambrian shale outcrops are marked by rows of conical knobs (Pl. 7, A) that form conspicuous hills--the River Knobs--along Clinch River in western Scott County.

Although they are classified as magnesian limestones, the Maryville and Rutledge formations grade into, or are replaced by the true dolomites of the Honaker formation. Their chief outcrop is a long, narrow belt along Clinch River on the northern slope of Copper Ridge; this outcrop also extends southwestward into Tennessee. The two formations are separated from one another and from adjacent formations by intervening shales, and consist of dark-colored, fine- textured dolomitic limestones. Few, if any, fossils may be found in them. Although their soil is fertile, it is poorly located for cultivation (Pl. 10, B), and is best used for pasturage.

Ozarkian and Canadian Rocks

The topmost member of the Cambrian system--the Nolichocky shale--is overlain by a thick assemblage of dolomitic rocks of Ozarkian and Canadian age. This series includes the Copper Ridge and Chepultepec formations of the Ozarkian system, and the Stonehenge, Nittany, and Bellefonte formations of the Canadian system. The Copper Ridge (Pl. 12, A) and Nittany dolomites (Pl. 8, B) are the most widespread, for the Stonehenge and Chepultepec formations crop out only in a small area southeast of Walker Mountain; the Bellefonte outcrop is also small. Out of a total thickness of 2,200 feet for this calcareous assemblage, the Bellefonte dolomite is the only member to possess potential economic value, although all of the units produce a fertile and productive soil under the proper topographic condition.

The areas of Copper, Moccasin, Chestnut, Purchase, and Big ridges (Plate 1) are underlain by the impure cherty dolomites of the Copper Ridge and Nittany formations which also crop out in isolated belts elsewhere in the county. (See Pl. 7, B.) The dolomites are thick bedded, fine grained, and very dense; most of them are gray to gray-black and, upon weathering, their surfaces assume a drab color in which a faint brownish hue is apparent. A few of the light-colored rocks are coarse-grained; some are sugary. Scattered limestone beds are also present. Few fossils occur in this series, although cross-sections of coiled snail-like shells are occasionally visible on the smooth surface of weathered dolomite ledges, while casts of similar shells occur sparingly in chert boulders. Thin brown-weathering sandy

zones are also present, especially in the Copper Ridge formation.

The pure dolomites of the Bellefonte formation occur in the valleys of Copper and Moccasin creeks, where they show a pinkish color, are high in magnesium, and are largely free from chert. The stone is attractive when fresh, and its polished surfaces approach the character of a marble. (See pages 127-128.) As the formation is not more than 400 feet thick, its outcrop is narrow, and is adjacent to and parallel with the belts of impure cherty dolomites.

Dolomite soils are deep and commonly brownish red. They are fertile and support a good stand of bluegrass, being responsible for the large pasture areas of the county. (See Pl. 7, B.) Excessive quantities of chert on the higher ridges locally render the soil unsuited for cultivation, and steep slopes prevent profitable agriculture. (See Pl. 11,B.) Elsewhere, dolomite land is as desirable as true limestone ground. Ozarkian and Canadian rocks contain an adequate supply of stone for any type of rough construction, and material for use as road netal is universally present in the formations. Some of the purer beds, such as those of the Bellefonte, have potential value for decorative purposes. (See pages 127-128.)

Ordovician Rocks

The Ordovician system is represented in Scott County by 8 separate formations, chiefly shaly limestones, that intervene between the massive dolomites of the Canadian system and the rugged Clinch sandstone of Silurian age. In ascending order above the Canadian dolomites are the Murfreesboro, Mosheim, Lenoir, Holston, Ottosee, and Moccasin limestones, and the Martinsburg and Juniata shales. The total thickness of the Ordovician system is more than 3,000 feet. (See Fig. 4.) Ordovician formations older than the Martinsburg shale are absent in the region south of Clinch Mountain.

A few thin beds belonging to the Murfreesboro limestone immediately overlie the Bellefonte dolomite, and are successively overlain by the Mosheim, Lenoir, Holston, and Ottosee limestones. From these limestones of early Ordovician age, there is available a considerable supply of valuable limestone which constitutes an important economic reserve of the county. The limestones total more than 700 feet in thickness, and are well exposed along Moccasin and Little Moccasin creeks. Distinctive fossils characterize most of the beds.

Three adjacent formations, the Holston, Lenoir, and Mosheim, should be classified as pure limestone. Their joint outcrop forms two continuous belts that cross the southern portion of the county. (See Plate 1.) One belt, which follows the valley of Copper Creek, crosses Clinch River at Speer Ferry, and continues into Tennessee about 1 mile north of, and parallel to, the river. Another follows the valleys of Moccasin and Little Moccasin creeks;

it passes beneath Gate City, continues toward Speer Ferry whence it extends southwestward about 1 mile south of Clinch River.(See Fig. 7.)

The Holston formation contains the largest local volume of pure limestone. (See Table 5.) Its coarsely crystalline gray or brown beds are easy to identify, and have actual and potential economic value. They have been opened in the large Marcem quarry(Pl. 18) 1 mile west of Gate City where rock is extracted for many uses. A thickness of at least 300 feet of Holston limestones occurs in Scott County, and the formation overlies the black knobby Lenoir limestone portions of which are also usable for lime and cement purposes. The Mosheim limestone, consisting of about 50 feet of pure dove-colored rock, occurs below the Lenoir. All 3 formations, in view of their use for lime, cement rock, and other purposes, form one of Scott County's most valuable natural resources.(See pages 115-122.)

The Moccasin and Ottosee formations qualify as shaly limestones. Their main outcrop lies along the north foot of Clinch Mountain (Pl. 4, A) near the Holston limestone. Another belt crops out near Copper Creek (Pl. 5, B) in central Scott County,and a large oval outcrop occurs in Rye Cove north of Clinch River. Both formations consist of interbedded shaly limestones and true shales, with a joint thickness ranging from 500 to 600 feet. Some of the limy members of the Ottosee are high in calcium carbonate, and the shaly rock is suitable for use as cement material. (See pages 119-120.) The Moccasin consists of an aggregate of red and yellow mudrocks (Pl. 12, B) together with interbedded blue limestones, some of the latter having potential value for cement. A good development of the Moccasin and overlying Martinsburg formations occurs on the

northern slope of Clinch Mountain where it occupies from 1,500 to 2,300 feet of the local rock column.

The Martinsburg shale is somewhat more limy in Scott County than in adjacent counties to the north and east, but it is less calcareous than in its exposures in Powell Valley to the west. Its outcrop on Clinch Mountain, although located on steep slopes, has been cleared for farms and pastures. The formation is more limy near the base of the mountain than in the middle slope, where the rock is largely a true shale. The upper beds become increasingly sandy as the top of the mountain is approached. Although its outcrop is narrow--scarcely 1 mile in width--it supports a good stand of bluegrass where cleared of timber. The formation abounds with fossil shells of many kinds.

The top of the Ordovician system is formed by the Juniata shale which consists chiefly of red sandstone and shale. The most accessible exposures of the formation occur along the road across Clinch Mountain from Fugates Hill in Russell County to Mendota in Washington County, Repair of this road in 1935 was being made from red shale of nearby Juniata beds.

Silurian Rocks

Local Silurian rocks, which overlie the Ordovician system and occur below the Devonian system, include the Clinch sandstone, Clinton formation, Wills Creek sandstone, and the Tonoloway limestone in ascending order. Their total maximum thickness is about 550 feet. (See Fig. 4) The Wills Creek and Tonoloway formation have been recognized only in the area north of Clinch River.

The crest of Clinch Mountain (Pl. 4) is everywhere formed by massive ledges of gray resistant sandstone from 75 to 100 feet thick, known as the Clinch sandstone. Its gray-white lichen-covered ledges are familiar to anyone who has climbed the mountain. Broken fragments of this rock lie along the slopes of the ridge, and rounded boulders are common to every nearby stream bed. Near Silica and Cassard are great scars on the mountain-top which represent quarries where the rock has been extracted for glass-sand. (See pages 129-131.) The crest of Powell Mountain, north of Pattonsville, is also capped by Clinch sandstone.

The Clinton formation consists of red and brown sandstones interbedded with yellowish shales. It is exposed along the southern slope of Powell and Clinch mountains, and is well developed near Stony Ridge in western Scott County where it contains a number of deep-red to brick-red sandstones that resemble iron ores. (See pages 101-102.) These are conspicuous near Flag Pond in the gap between Sandy Ridge and Powell Mountain, where the formation produces a sandy soil that is unproductive because of its arenaceous character and hillside position. The total thickness of the Clinton formation is about 300 feet. The Wills Creek sandstone and

Tonoloway limestone are exposed along U. S. Highway 23 near the Lee county-line, but do not appear to be present in the Clinch Mountain section. The former is a brown-stained sugary sandstone; the latter is a slabby gray limestone. Neither is of economic value.

Devonian Rocks

The Devonian system which overlies the Silurian rocks includes 4 main members, which are, in ascending order, the Helderberg limestone, "Romney" and Brallier shales, and the Chemung formation. The Helderberg limestone is comparatively thin, and is rarely exposed. The Chemung formation, which is less than 10 feet thick, has no distinctive topographic expression. Hence, most of the area of Devonian rocks is formed by the outcrop of the "Romney" and Brallier shales, which reach a total thickness of more than 2,000 feet south of Clinch Mountain, but are only 600 feet thick north of Clinch River, where the "Romney" shale is probably absent. No Devonian rocks occur between Clinch River and Clinch Mountain where they have been cut out by faulting.

An exposure of arenaceous Helderberg limestone occurs near Horton Summit and along the valley of North Fork of Clinch River. The formation is absent or concealed in the Clinch Mountain belt, and the limestone-chert phase of the Onondaga formation which is present near Mendota, Washington County, 1/, is absent in Scott

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1. Butts, Charles, Geologic map of the Appalachian Valley of Virginia with explanatory text: Virginia Geol. Survey Bull. 42, pp. 30-31, 1933.

County. The Helderberg limestone does not have potential use as a commercial limestone. Its most conspicuous exposure is along U.S. Highway 23 near Duffield and in the low hill southeast of Pattonsville. Sandy and clayey beds form common impurities in the rock, which, however, is sufficiently calcareous to supply agricultural lime for local use. Shales and thin interbedded sandstones compose the "Romney" and Brallier formations of Devonian age which crop out

in the Powell Mountain, Poor Valley, and Holston Valley regions, where they reach a total thickness of from 800 to 2,000 feet. The shales are soft and thin-bedded, producing a sterile soil which neither supports bluegrass nor adapts itself readily to cultivation. They are somewhat sandy and vary in color from yellow and red to gray or black. As they are readily reduced by erosion and weathering, their outcrops produce low ground. (See Pl. 10, A.) Poor Valley, situated between Clinch and Pine Mountains, owes its unproductive soil and appropriate name to the barren outcrop of the "Romney" shales. (See Pl. 6,A.)

There are no useful economic materials to be obtained in the local Devonian rocks, although the "Romney" and Brallier shales produce an excellent soft rock for the surfacing of country roads. Both Devonian shales are sparingly fossiliferous.

Mississippian Rocks

Scott County contains a good exhibit of Mississippian rocks[1] which occur (1) southeast of Holston River, (2) along the

1. Butts, Charles, Oil and Gas possibilities at Early Grove, Scott County: Virginia Geol. Survey Bull. 27, pp. 5-17, 1927.

valley of Opossum Creek, and (3) near Horton Summit. The system begins with a black shale, named from Big Stone Gap, that is difficult to distinguish from the underlying Devonian shales. Indeed, the Big Stone Gap shale may possibly belong to the Devonian sequence. It crops out in Hunter Valley and in the lowland between Pattonsville and Duffield. (See Pl. 10, A.)

Immediately south of Clinch Mountain is a low but persistent ridge, known as Pine Mountain (Pls. 4,B and 6,A.) It forms the northern wall of the valley of Opossum Creek west of Moccasin Gap, and it is equally prominent east of Moccasin Gap, where it separates the Hilton (Poor) and Holston valleys. (See Pl. 6,A.) The ridge is produced by a series of sandstones and sandy shales belonging to the Price formation of early Mississippian age. Its underlying rocks are reddish brown and their superior hardness to the nearby shales and limestones is responsible for the ridge. Fragmental fossils of plants and rare shells may be found near Holston Bridge where U. S. Highway 58 passes through the ridge. (See Pl.4,B.) A small thickness of red shales, known as the Maccrady shales, overlie the Price formation. The latter is prominently exposed in the Powell Mountain region north of Horton Summit where it attains a maximum thickness of more than 1,200 feet.

Plate 13

(near manuscript page 55)

A. A shaly portion of the Lee formation north of Dungannon. Note the blocky sandstone at the top;of the cliff and the vertical joints which produce the blocks. (See pages 38, 57-60, and 87.)

B. Ledges of Cove Creek (Mississippian) limestone along U.S. Highway 58 east of Holston Bridge show a prominent rounded surface and have a distinctive yellow-white color. (See pages 39 and 55.)

The Price-Maccrady formations are overlain by an impressive series of limestones which includes, in ascending order, the Warsaw, St. Louis, Ste. Genevieve, and Glen Dean-Cove Creek limestones. A thin red sandstone, named from Fido, separates the Ste. Genevieve and Cove Creek limestones in the vicinity of Holston River, where the yellow-white beds of the latter are conspicuous along U. S. Highway 58 near Cove Creek. (See Pl.13,B.) The top of the Mississippian system is formed by the Pennington shale.

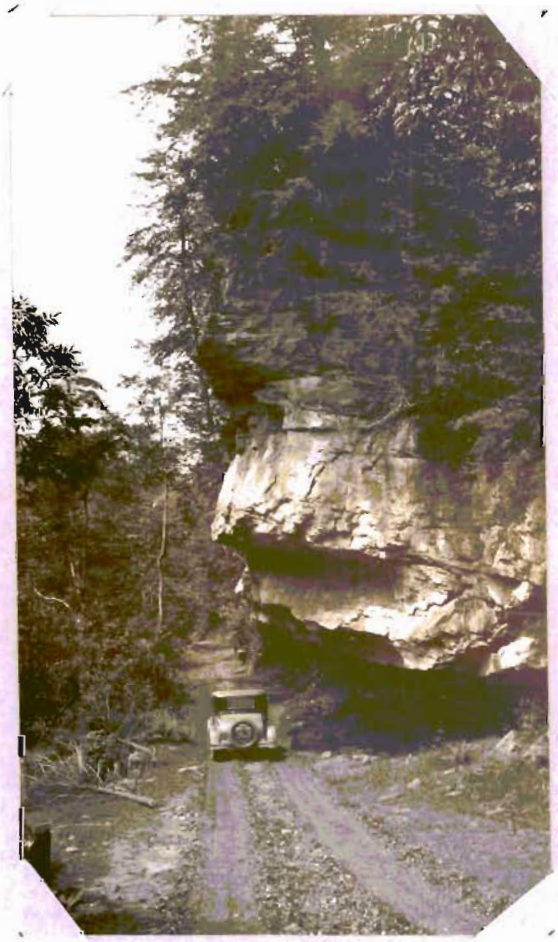
Although they are somewhat impure limestones, the St. Louis and Warsaw formations contain many beds of good limestone. They crop out (1) along Holston River, (2) in a belt immediately south of Pine Mountain, and (3) in a curving belt north of Horton Summit. Except for the prevalence of black chert which impairs their purity and soil, they could be classified as valuable limestones. In total thickness, the St. Louis and Warsaw limestones exceed 600 feet near Holston River, and reach 200 feet near Horton Summit, where the Warsaw member appears to be absent. Both are dark-colored, massive, thick-bedded rocks. The overlying Ste. Genevieve and Gasper formations are much lighter in color and belong to the category of shaly limestones. Their outcrops parallel those of the St. Louis-Warsaw limestones which lie immediately north of them. All four units consist of argillaceous limestones that are interbedded with both massive pure limestone lenses and thin shaly zones. All weather to the light, yellowish-white color that characterizes the Mississippian exposures along U. S. Highway 58 in the valley of Cove Creek east of Holston Bridge. (See Pl. 13, B) Lace-like fossils of bryozoa are common and fossil shells of other types

are also present. These limestones reach a total thickness of at least 3,000 feet in southeastern Scott County, and 1,000 feet near Horton Summit. Their soil, although derived from limestones, is much less fertile than other limestone and dolomite soils. The topography of their outcrop is hilly and includes many sinks and closed depressions. The Fido sandstone and Cove Creek limestone are absent north of Clinch River, where the Glen Dean limestone, thickness 350 feet, occupies the statigraphic horizon of the Cove Creek formation.

The Pennington shale, of late Mississippian age, is widely distributed in the county. Much of southeastern Scott County, south and east of Holston River, is underlain by the Pennington formation, whose sandy shales form the irregular country between Sharps Branch and Cove Creek. Another belt crops out north of Clinch River to form Stone Mountain and its linear continuation north of Hunter Valley. The red Fido sandstone, valuable as a key-bed to the structure of the gas-bearing rocks in the southern part of the county (pages 96-98), is so thin--scarcely 50 feet in thickness--that it has little or no effect upon local topography or soil. It is not present north of Clinch Mountain.

Plate 14

(near manuscript page 57)



One of the massive conglomeratic sandstones of the Lee formation which is exposed along the country road near the Stock Creek coal mine. (See pages 36, 57, and 87.)

Pennsylvanian Rocks

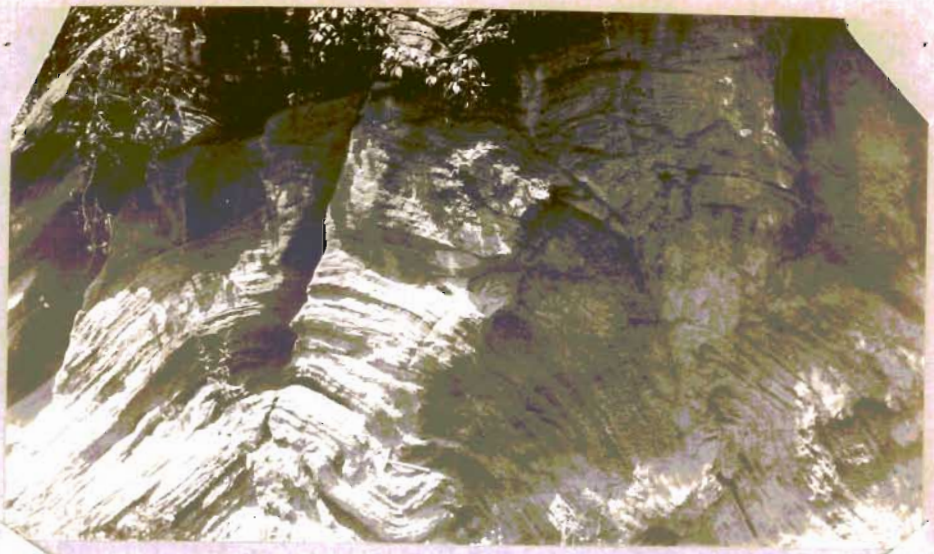
All of Scott County north of Stone Mountain and east of North Fork of Clinch River is underlain by coal-bearing sandstones and shales of Pennsylvanian age. (See Plate 1.) Included in this series are the Norton and Lee formations which attain a total thickness of about 2,1000 feet. (See also pages 86-90)

The coal-bearing rocks form a monotonous repetition of brown sandstones, soft yellowish shales, and thin seams of coal. There are no limestones nor any calcareous beds associated with the fragmental sediments, most common of which is a dirty-brown sandstone composed of quartz grains with smaller amounts of mica and weathered feldspar. It disintegrates readily to form a thin sandy soil that is loose and poorly drained. The drab shales which alternate with the sandstones are also easily eroded and weathered. (See Pl, 13,A.) The coal beds (pages 87-90) vary in thickness from paper-thin films of carbonaceous material to workable seams that are more than 4 feet in thickness. Few of the latter, however, occur in Scott County.

Some of the sandstones are coarse, and a few are actually conglomeratic. The Lee formation, lowest or earliest, of the coal-bearing rocks, contains at least 3 strong conglomerates (Pl. 14) one of which, known as the Bald Rock conglomerate (Pl. 15,B), forms picturesque walls of bare rock on Little Stony Creek, 3 miles north of Dungannon.(See Pl. 17,A) The "Bee Rock", a conglomerate near the top of the Lee formation, is well exposed along Clinch River at the extreme northeastern corner of the county. All of the conglomerates contain rounded quartz peb-

Plate 15

(near manuscript page 58)



A. Folds in contorted Rome shales near the head of Sinking Creek above Adelphia. (See pages 43 and 59.)

B. Ledges of Bald Rock conglomerate along Stony Creek, 1½ miles north of Dungannon. (See pages 57 and 87.)

bles and are dirty gray in color.

Many plant fossils occur in the coal rocks of Scott County. Broken or shredded leaves, stems, and trunks of coal plants are common in the sandstone beds, and occasionally the flattened trunk of an ancient tree is found in the shale beds above the coal seams. Fossil shells are entirely absent in the series, and the plant fossils indicate a fresh-water origin for the rocks.

The coal-bearing portion of Scott County (See Fig. 7) is restricted to the Alleghany Plateau where, except for a disturbed belt along the southern edge, the rocks are essentially horizontal. (See Pl. 13,A.) A dendritic, or tree-like, drainage pattern characterizes the streams. Hillslopes are steep, and the land is largely wooded and uncleared. Much of it is still inaccessible, even to automobile traffic.

GEOLOGIC STRUCTURE

General Statement

The geologist is keenly interested in the structures assumed by the bedrock, for they indicate the direction which a rock stratum will extend below ground, as well as revealing phases of geologic history that are not otherwise recorded. To the layman, however, the structures of the bedrock are much less obvious than topographic features, and even the terms by which these structures are described are relatively unfamiliar.

As originally deposited, all sedimentary rocks were once horizontal. (See Pls.12,A and 13,A.) Possibly they had a slight original inclination, or dip, but it must have been very gentle. In the long eras that have elapsed since their formation, however, many of the beds have been subjected to various disturbing processes that have obliterated their former horizontality, and have developed more complicated structures, chief of which are folds and faults.

A fold is a flexure in which the bedrock has buckled into an arch or crest, known as an anticline, or has been depressed into a basin or trough, known as a syncline. (See Pl.15,A) Some of these folds are sufficiently small to be visible in a hand specimen of rock; others, which involve areas several miles in width, can only be detected by examining the inclination of many beds over a wide region. Both anticlines and synclines are produced by compression and indicate a local shortening of the earth's crust. As they are structures possessed by the bedrock, whereas hills and valleys are the work of erosional processes, it does not necessarily follow that an anticline is a mountain and a syncline, a valley. Indeed, the reverse is not an uncommon feat-

ure, for the topmost beds of an anticline are often subjected to more rapid erosion than are the beds in the trough of nearby syncline. Throughout most of the Appalachian region, anticlines and synclines follow one another in a series of wave-like folds which extends northeastward in the Valley and Ridge province.

Faults are fractures of the bedrock along which movement has displaced one rock mass with respect to another. They may be produced directly by gravity, which causes one block to slip downward in reference to another, or they may result from compression which causes one rock mass to be thrust upward upon an adjacent block. All of the known faults in Scott County are thrust faults, having resulted from the same compression which produced the local folds. No normal, or gravity, faults are present. The outcrop of the edge of the faulted or overthrust mass is known as the trace of the fault, and marks the geographic line of dislocation. From this outcrop, the fault plane ,or fracture surface, dips underground, sloping beneath the overthrust mass and above the over-ridden block. The planes of all Scott County faults dip at moderate angles toward the south or southeast,for the pressure by which they were formed was directed from the southeast.

Many of the local rocks exhibit joints. (See Pl. 13,A.) The latter are cracks or fissures which do not involve any differential movement of the rocks on either side. Commonly the joints are tight or sealed; in some calcareous rocks, they may become enlarged by underground solution. There is little or no cleavage in any of the local rocks.

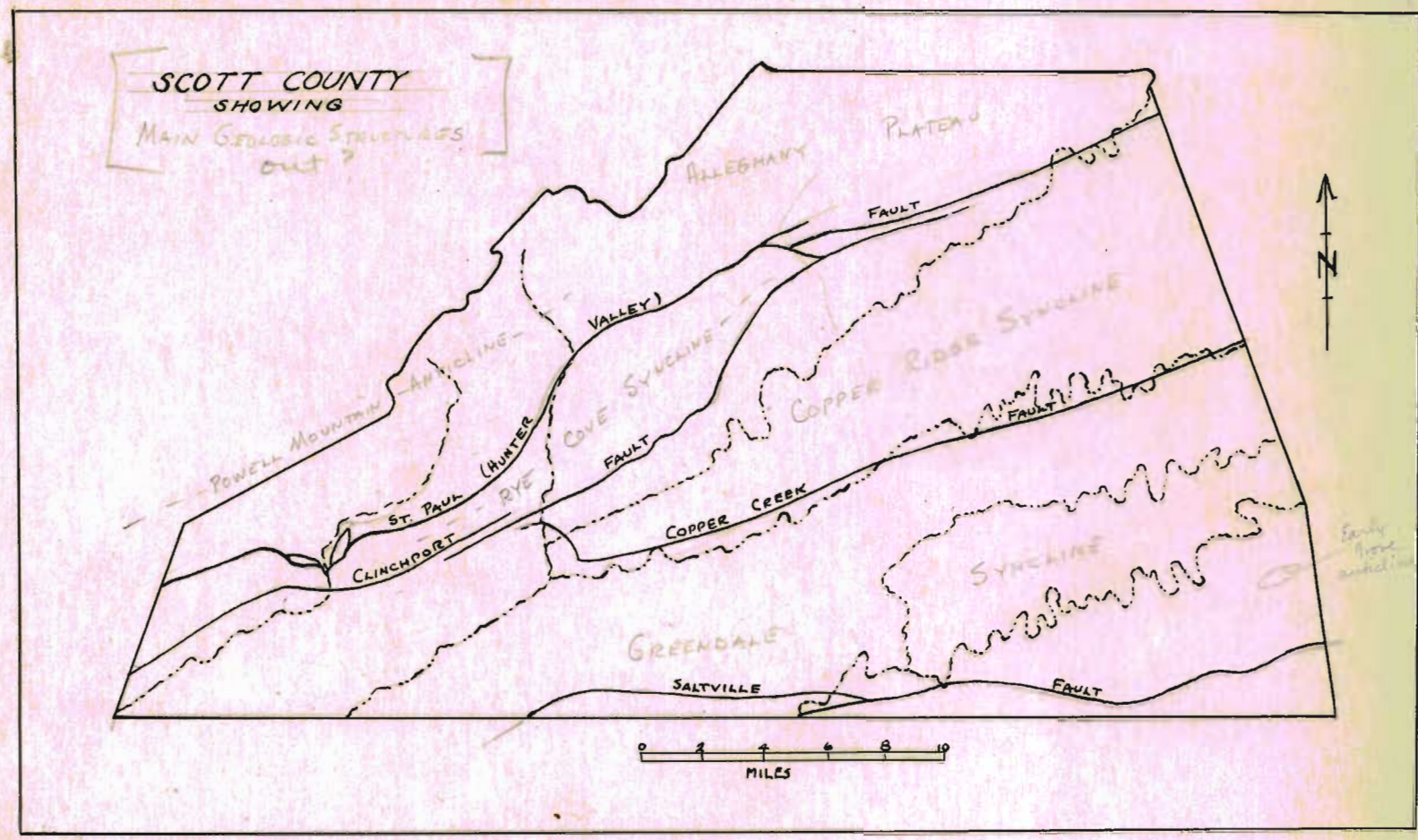


Figure 5, Sketch map of Scott County showing the main elements of the geologic structure (near page 61

Folds

The main structure of Scott County is dominated by several large synclines; there are few, if any, important anticlines. As a result of the faulting, or slicing, which followed the production of the folds, many of the synclines were partially obliterated, and do not exhibit simple fold structures. Masses of overthrust rocks still conceal the southeastern limbs of most of the synclines. (See Fig. 6.)

The most important syncline occupies the area southeast of Copper Creek. As its main axis passes through Greendale in Washington County, it is known as the Greendale syncline. (See Fig. 5.) Throughout this fold, the rocks dip toward the southeast at angles which are steep north of Clinch Mountain, but which become more nearly horizontal near Holston River, and are relatively flat along the axis of the fold. The oldest exposed rocks in the structure are those of the Rome formation, above which occurs a complete sequence of strata up to, and including, the Pennington shale which crops out near Lucille and along Timbertree Creek. The fold encloses the mass of Clinch Mountain (Pl. 6,A.), and its southeastern margin has been fractured and over-ridden by the Saltville faultblock. (See pages 63-64.)

Several smaller folds complicate the southeastern portion of the Greendale syncline, where a small anticline domes the otherwise flat rocks near Early Grove.[1] This anticline is the

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1. Butts, Charles, Oil and gas possibilities at Early Grove, Scott County, Virginia: Virginia Geol. Survey Bull. 27, 1927.

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most favorable structure for the occurrence of oil in the coun-

try, although two test wells have not yet located an oil reservoir. (See also pages 96-99.)

The Copper Ridge syncline, which underlies Copper Ridge is similar to, but smaller than, the Greendale syncline, from which it is separated by an overthrust fault that has obliterated its southeastern limb. A third structure, called the Rye Cove syncline, dominates the area of Chestnut and Purchase ridges; its axis passes through Rye Cove. It is broken at the north by the trace of the St. Paul (or Hunter Valley) fault.

Southwest of North Fork of Clinch River, Powell Mountain is developed upon the southeastern limb of a structure that is known as Powell Mountain anticline. (See pages 89-90.) Although the main axis of this fold lies in Lee County, a small portion of its southern limb extends into Scott County to form the area occupied by Powell Mountain and Stony Ridge.

In Stone Mountain, the bedrock has been tilted on edge, but to the north where it is nearly horizontal, it has not been disturbed from its original position. (See Pl. 13,A.) This level structure is responsible for the Allegheny Plateau which corresponds in extent with the area of flat-lying rocks.

The prevailing dip of the bedrock in Scott County is toward the southeast at angles which vary from 90° to 0°. The strike, or linear extension, of the rock belts is northeasterly, except in the area between Gate City and Speer Ferry, where the strike is nearly due east.

Faults

Four prominent faults cross Scott County. (See Fig. 5.) Each is a great displacement, in which an overthrust block above the fracture has been forced northwestward upon bedrock below the fracture. Some of these displacements indicate movement along earth blocks of considerable length, for their trace may be followed for several hundred miles through Tennessee and Virginia. They were formed by the same process that produced the various synclines and, indeed, may have developed from intervening anticlines that were crushed beyond the breaking point.

The southernmost fracture, known as the Saltville fault 1/ (Fig. 6.), enters the county southwest of Cassard

1. Stevenson, J.J., Notes on the geological structure of Tazewell, Russell, Wise, Smythe, and Washington counties in Virginia: Amer. Phil. Soc. Proc., vol. 22, pp. 114-161, 1885.

and follows an eastward course to pass into Washington county south of Early Grove. Along this displacement, Ozarkian and Canadian limestones and dolomites have been thrust upon the Mississippian rocks that occupy the axis of the Greendale syncline.

The Copper Creek fault 1/, whose outcrop follows the valley of Copper Creek, has obliterated the southern limb of the Copper Creek syncline. Along its trace, the Rome and Honaker formation of the Greendale synclinal belt have been thrust upon the Moccasin and Ottosee formations of the Copper Creek structure.

The trace of the Clinchport fault 2/ roughly follows

2. Butts, Charles, Geologic map of the Appalachian Valley of Virginia with explanatory text: Virginia Geol. Survey Bull. 42, map, 1933.

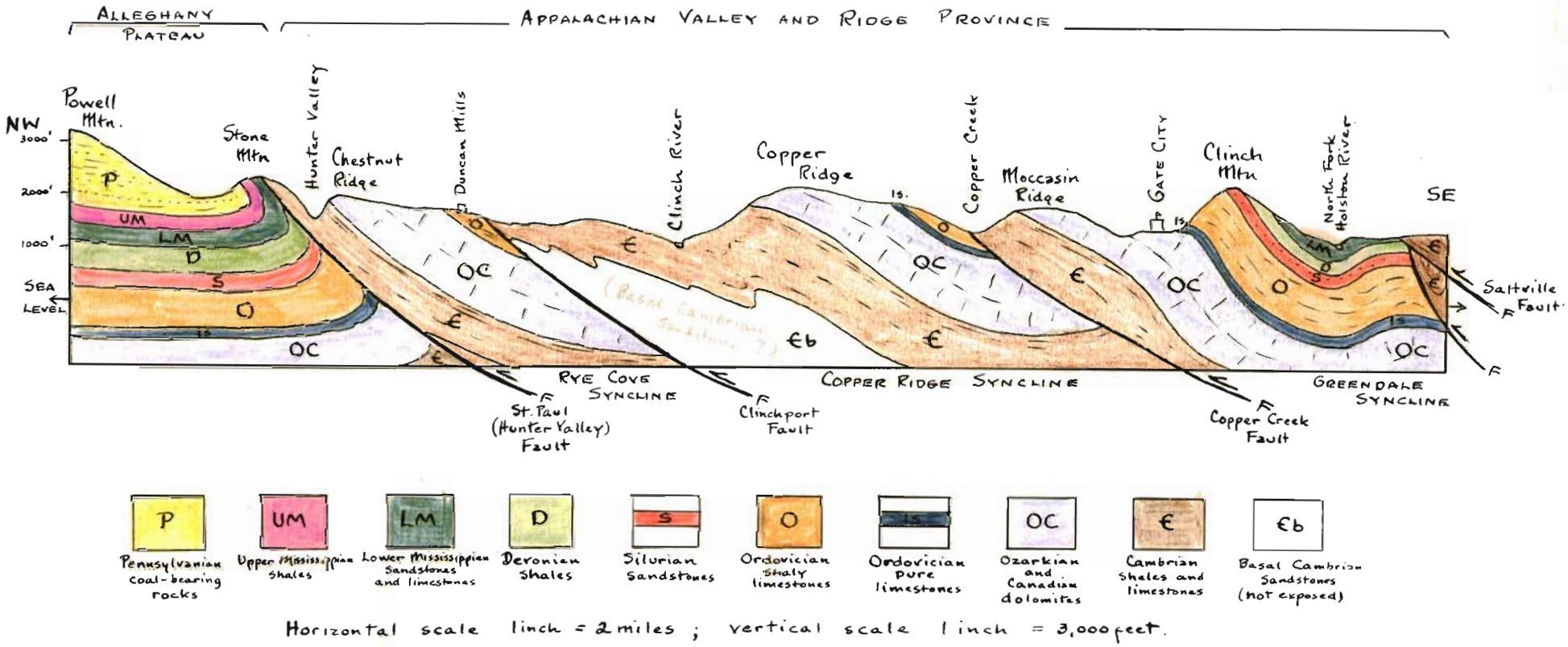

Figure 6. Generalized structural section across Scott County.

(near manuscript page 64)

the valleys of North Fork of Clinch River and Clinch River proper. Along this fault, the Rome formation of the Copper Creek block has been displaced so as to overlap the main axis of the Cove Creek synclinal block. The latter, in turn, is overthrust along the St. Paul [1]/(or Hunter Valley)[2]/ fault upon folded Devonian and Missis-

1. Butts, Charles, op. cit.,loc. cit. (page 63.)

2. Stevenson,J. J., op. cit.,loc. cit. (page 63.)

sippian rocks of the Powell Mountain anticline and the flat-lying coal series of the Alleghany Plateau area. (See Fig. 8.)

As a result of these four displacements, the structural elements of the bedrock of Scott County resemble those of a series of overlapping shingles in which each shingle corresponds to one of the overthrust blocks. The shingles, or fault blocks, are all inclined toward the southeast, and each block partially, but not wholly, covers the underlying block which rises toward the north to overlap part of the next adjacent block. Each individual block, however, unlike the shingles, is internally folded and disturbed, and the entire series has been more or less irregularly eroded. (See Fig. 6.)

An excellent indication of the magnitude of rock faulting occurs along the country road which crosses Timbertree Creek 4 miles east of Lucille, and 2 miles north of Tennessee. The road leads southward from U. S. Highway 58 through a rugged area of Pennington shale which extends to the trace of the Saltville fault. About half a mile north of Timbertree Creek, there is a small island of dolomite which caps a hill summit entirely surrounded by

shale. The dolomite rests unconformably upon the shale, and is completely isolated from other dolomite outcrops. It is impossible to explain this structure except to assume that the island of dolomite was originally part of the forward edge of the Saltville overthrust block, the rest of which was removed by the erosion since the thrusting. With the removal of the thinner portions of the overthrust block, the fault trace has been worn back (i. e. southward) to its present position, leaving an uneroded remnant of dolomite wholly isolated from its parent block. The island of dolomite covers only a few acres of hilltop, and is completely surrounded by the limy blue-gray shales of the Mississippian system. Unless the observer is familiar with the normal sequence of these rocks, he will fail to recognize that the dolomite, which normally occurs 10,000 feet below the shale, has been faulted to its present peculiar position. 1/

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1. Campbell, M.R., U.S. Geol. Survey Geol. Atlas, Bristol folio (No. 59), map, 1899.

Inasmuch as all folds and faults are bedrock structures, they are best observed by irregularities of dip and by variations in the normal succession of strata. Although all major faults have been indicated in Figure 5, they are difficult to detect in the field, and are more conspicuous on a geologic map which indicates the outcrop of each geologic formation. Except for their significance in revealing the geologic history of the region, and for their effect in governing the outcrops of the bedrock formations, folds and faults have mainly scientific importance.

GEOLOGIC HISTORY

General Statement

Political history is a matter of written or spoken record. Geologic history, which is far more ancient, is the story of earth development during the periods before human history began. Its records lie in the rocks of the earth's surface, and in the features of the topography. The methods of deciphering human and geologic history are somewhat similar, for both call for the study of ancient records that may not be wholly complete. Geologic history, however, differs from human history in the magnitude of time involved. Whereas human records are but a few thousand years old, geologic records are tens and even hundreds of millions of years old. It is necessary to appreciate the immensity of the past before one can visualize the sequence of geologic events. Indeed, it is necessary to learn a new chronology, for the familiar divisional units of modern time are inadequate to express even a simple statement of geologic history.

The scientist has devised a time scale for use in describing the vastness of geologic time. For its major divisions, he uses the term era to designate a time-duration of several hundred million years in which a single cycle or sequence of events is the dominant feature. Each era is separated into periods that represent units of time in which similar processes are in operation, and in which distinct stages of inorganic or biologic evolution can be identified. In similar manner, each period is subdivided into still smaller units, known as epochs.

The known history of Scott County may be traced through 3 great eras of geologic time,--the Paleozoic era of ancient time,

the Mesozoic era of medieval time, and the Cenozoic era of modern time. The first of these eras, the Paleozoic, saw the production of the bedrock; it was a long time of sedimentation and rock formation brought to a close by the uplift and crumpling of the ancestral Appalachian mountains. The Mesozoic era was a time when the agencies of erosion were actively engaged in reducing the elevation of the newly-formed mountains, and when the major elements of the drainage and landscape were in the process of their initial formation. The Cenozoic, most recent of all geologic eras, was the time when the details of the present scenery were produced; it has not yet come to an end, for modern time is a phase of the Cenozoic era.

It is convenient to divide the geologic history of Scott County into 3 sections which do not precisely correspond to the major eras of earth history. The first portion of local geologic history extends from the Cambrian through the Mississippian periods of the Paleozoic era; it may be described as the Era of Rock Formation. The second division includes the Pennsylvanian and Permian periods of the Paleozoic era, and may be described as the Era of Mountain Formation. The third and final division includes both the Mesozoic and Cenozoic eras of geologic history and may be called the Era of Land Sculpture. This three-fold treatment has the advantage of emphasizing the stages of the geologic evolution of the region without introducing many of the technical problems involved in a strict adherence to the true geologic chronology.

It should be noted that the 3 divisions of local geologic history deal with widely differing durations of time. The era of rock formation lasted for approximately 300 million years; the formation of the ancestral Appalachians involved approximately 80 million years; the era of sculpture which followed the elevation of the mountains has lasted for more than 200 million years.

The Era of Rock Formation

(Pre- Pennsylvanian History)

At the beginning of the Cambrian period, the general geography of eastern North America was vastly different from that of today. The area of Scott County, now well inland, was then covered with sea water, for it was located in the south-central portion of a long strait, or sea-way, that occupied the present site of the Appalachian Mountains. This sea-way, known as the Appalachian geosyncline, stretched southward from the St. Lawrence region toward the Gulf of Mexico and separated the main portion of the continent from a long narrow borderland which lay between the open Atlantic Ocean and the geosyncline. The latter was narrow at the north, but widened toward the south. Ocean water entered from the north, but as the basin was comparatively shallow, the water ~~water~~ was probably never more than 600 feet in depth.

The eastern borderland has been called Appalachia. It was a long narrow rugged land with a mountainous axis from which rivers descended abruptly to the geosyncline on the west and to the Atlantic on the east. The products of its active erosion were carried into both basins.

The mainland of the continent, which lay west of the geosyncline, was a broad flat land with a few mountains and with wide mature rivers that meandered upon its level surface. Its eastern margin and central portions were occasionally submerged beneath sea water that spread westward from the geosyncline or advanced eastward from some more westerly source. From time to time a shallow interior sea occupied the central and southern portions of the mainland, flooding the areas of present Tennessee and Kentucky and connecting

the Appalachian geosyncline with a similar western strait that occupied the Rocky Mountain region. Marine life of many kinds flourished in the quiet waters of the central sea; and an absence of coarse clastic debris permitted the accumulation of limy mud that was widely distributed as the temporary sea spread from place to place. Scott County then lay near the central portion of the southern part of the geosyncline. When the latter was connected with the interior sea, a broad expanse of marine water extended westward to the Mississippi basin. When the rivers of western Appalachia spread their sands and muds into the geosyncline, the local area lay in the path of the accumulating debris.

There began to develop, then, in Cambrian time, a blanket of sediment upon the floor of the basin in what is now southwestern Virginia. Some of the material came from the erosion of Appalachia, which contributed coarse sand, gravel, silt, and mud; some of the material was lime mud that was spread eastward as the interior sea widened and invaded the present region. Thus, the growing succession of sediments contained sand, mud, lime, and their gradational varieties.

The earliest deposits, which were coarse sands and silts, although probably present in Scott County, are now wholly concealed from view. From their exposure in nearby areas along the Blue Ridge however, it is possible to infer their local presence. As the highlands of Appalachia grew lower under the vigorous attack of erosion, the character of sediments changed from coarse clastic debris to muds and silts. The latter, now consolidated into shales and thin sandstones, comprise the Rome formation which is the oldest member

of the exposed bedrock in Scott County. Gradually the supply of muds and silts diminished, while limy deposits spread eastward from the interior sea to form the interbedded shales and limestones that overlie the Rome formation (Rutledge limestone, Rogersville shale, Maryville dolomite, and Nolichucky shale). The production of these beds occupied the final stage of Cambrian history.

A long period of limestone deposition ensued, and the thick Ozarkian and Canadian calcareous beds (Pl. 12,A and 8,B.) which are products of this deposition, testify to an almost complete absence of gravel, sand or mud in the waters of the geosyncline. This absence is best explained by the temporary reduction of Appalachia to a low land from which little or no coarse rock debris was being transported by the streams. Although most of the Ozarkian and Canadian rocks are now dolomites, it is possible that they were deposited as limestones, and have suffered their alteration into dolomites during subsequent time. The marine life of the time, if adequately represented by Ozarkian and Canadian fossils, consisted mainly of thick-shelled animals, many of which were sea-snails.

The Ordovician period opened with continued limestone deposition, and in its early epochs several beds of extremely pure limestone (Mosheim,Holston, Ottosee) accumulated. Gradually the waters became more muddy, probably as a result of the re-elevation of Appalachia, and the deposits of mid-Ordovician time include dark shales which alternate with thin impure limestones.(See Pl 12,B.) In late Ordovician, the volume of land-derived sediment was greatly increased, as is indicated by the prevalence of sandy shales and sandstones in the uppermost Ordovician rocks (Martinsburg and Juniata shales). The life of Ordovician seas had greatly

expanded with the result that fossil shells and other organic remains are common to most Ordovician sediments.

The rejuvenation of streams on Appalachia was responsible for the production of coarse clastic sediments in the early portion of the Silurian period when the sands, gravels, and silts of the Clinch, Clinton, and "ills creek formations were deposited. During at least one epoch of the Silurian the erosion of Appalachia laid bare rocks that were rich in iron minerals, for the Clinton formation contains several zones of sediments in which the iron content approaches that of true iron ore. The close of the Silurian and the beginning of the Devonian period were accomplished without essential break in the deposition of thin lime muds which followed the clastic sedimentation of mid- Silurian times. These limestones (Tonoloway-Helderberg) testify to a temporary absence of land-derived materials in the sediments of the geosynclinal tract.

Middle and late Devonian epochs saw a shoaling of the area of Paleozoic Scott County. A succession of shales and shaly sandstones ("Romney", Brallier, Chemung, Big Stone Gap) accumulated as components of broad alluvial floodplains that spread westward from the newly rising Appalachia. Ripple marks, rain prints, and rill markings, now preserved in some of these beds, give evidence of the shallowness of the water in which they were deposited. Partially carbonized fragments of leaves and other plant fragments indicate the spread of vegetation on the land.

The period of alluvial sedimentation gave way in early Mississippian time to the deposition of coarser products of more vig-

orous erosion (Price-Pocono formations), possibly indicating a third major uplift of the borderland Appalachia. As in the previous epochs of its uplift, the borderland was quickly lowered by erosion, for a succession of impure limestones (Warsaw, St. Louis, Ste. Genevieve, Gasper, Glen Dean-Cove Creek) was laid down in either an expanded or a deepened geosyncline which was then receiving little terrigenous material. The deposition of these limestones occurred at a time when the seas abounded in life of many types, and nearly all Mississippian limestones contain fossil remains of a varied fauna. At the close of the Mississippian, a thick sequence of sands and muds (Pennington shale) covered the limestones and brought an end to the marine deposits laid down in the Appalachian geosyncline.

Abundant fossils, in the form of shells, fragments of corals, and bits of plants, testify to the progressive development of life throughout the entire era of rock formation. Indeed, the fossils are the best identifying characters of the many rock layers, for certain of the Cambrian shales closely resemble Mississippian shales, while other similarities tend to give a unity to the entire sequence of early and middle Paleozoic sediments.

At first glance, the picture which has been drawn seems to be comparatively simple, if unfamiliar. Upon more careful study, however, several curious features appear. In the first place, the erosion of Appalachia and the deposition of the eroded material in the geosyncline contiued without interruption for nearly one-third of a billion years, which is a long time, even in geologic chronology. Indeed, it is much longer than should have been

necessary completely to plane down the borderland and fill the geosyncline. Yet near the end of the Mississippian, the mountains of Appalachia were scarcely lower than they had been during the Cambrian period, and the geosyncline was still occupied by several hundred feet of ocean water.

Adequately to explain these anomalies, it is necessary to invoke sympathetic movements of blocks of the earth's surface. If the borderland of Appalachia was periodically re-elevated while it was being eroded, the relative height of the mountains would be unchanged. Similarly, if the floor of the geosyncline gradually sank under an increasing load of sediment, the basin would persist as a settling ground for more sediment. Both of these hypotheses seem necessary to account for the known facts, and it is concluded by the geologist that the long-continued surface transfer of material from Appalachia to the geosyncline was counterbalanced by the gradual uplift of the lightened area, and by the persistent subsidence of the overloaded basin.

Under any hypothesis, however, it is difficult to see how the processes of erosion, sedimentation, and counterbalancing could continue indefinitely, and it is logical to expect the long era of rock formation to be replaced by a time of more violent or dynamic events, an expectation which is realized in a survey of the events of late Paleozoic time.

The Era of Mountain Formation

(Late Paleozoic History)

With the beginning of the Pennsylvanian period, a new era in the geologic history of Scott County began. As there are no local limestones of later age than Mississippian, the interior sea must have been completely withdrawn from this region at the close of the Mississippian period. The Pennsylvanian system is composed almost wholly of sandstones and sandy shales that were spread westward in the form of broad alluvial fans across the shallowing geosyncline. The eastern margin of the continental interior was submerged to form vast swamps in which coal plants grew in abundance, while their partially decayed remains supplied the material that ultimately developed into beds of coal. It is probable that the strand-line was more unstable than ever before, and that its oscillation alternately flooded the swamps and drained them of water. The increasing volume of alluvial material drove the sea from the geosyncline, and with its final withdrawal, the area of Scott County assumed the inland position that it has henceforth retained.

A growing instability of the land, the final withdrawal of the sea, and the filling of the geosyncline attended the close of the earlier cycle of earth history. Possibly the elasticity of the earth's crust has been overtaxed; possibly the material beneath the geosyncline had been too greatly compressed. At any rate, events of an entirely different nature began to occur, the first of which involved a tremendous lateral compression of the sediments recently laid down in the geosyncline. Gran-

ually the rocks began to yield to this pressure, at first by arching into wave-like folds,and later by great shearing or sliding movements. The formerly horizontal strata became folded into anticlines and synclines,some of which were compressed far beyond the breaking point. The sealevel position slowly gave way as the area gradually became elevated, and the folds began to arch into lofty ridges--the first or ancestral Appalachian Mountains. The geosyncline was utterly destroyed, giving place to the newly formed mountains which rose above the continental mainland. The borderland of Appalachia disappeared as an isolated land mass and formed a rugged piedmont stretching eastward from the new mountain range to the Atlantic. As a result of these changes, the geography of eastern Paleozoic North America was almost completely changed during the "Appalachian Revolution".

It must not be supposed thst the changes were accomplished suddenly. The Pennsylvanian and Permian periods represent a lapse of nearly 80,000,000 years, and the Appalachian revolution was in progress throughout both periods. Although the changes were revolutionary, they had none of the suddenness of a violent catastrophe but rather progressed quietly and slowly, the folds inching upward and the fault blocks imperceptibly moving forward during a long period of time. Had man been in existence at the time, it is probable that he would have failed to detect the tiny movements that were ultimately responsible for the prodigious changes.

Whatever the cause of the revolution, its results seem to have relieved the previous instability, for when the Paleozoic era came to its close, the era of mountain uplift was at an end and the earth's surface was again stable.

Era of Land Sculpture

(Post-Paleozoic History)

One of the effects of the Appalachian Revolution was to elevate the entire Appalachian belt high above sealevel and to expose it to the processes of erosion and weathering. Indeed, the erosional attack may have begun as soon as the first folds were started, and proceeded apace with the subsequent stages of the mountain-making.

A time of vigorous erosion was inaugurated which continued throughout the entire Mesozoic age. Gradually the height of the mountains was reduced until the belt of the ancestral Appalachians was brought down to a nearly smooth surface, not far above the level of the streams. (See pages 15-17.) Such a period of erosion could only proceed under quiescent earth conditions and the uplift that had previously characterized, or accompanied, the erosion of Appalachia, was entirely absent. Broad mature rivers carried away the products of erosion toward the Atlantic Ocean where they spread the debris along the shore to build a fringing coastal plain. Probably the great distance which the material was carried prevented such dynamic changes as had resulted from the earlier overburdening of the nearby Appalachian geosyncline. Nevertheless, there was a mild uplift that followed the production of the erosion surface; but this time, the uplift was accomplished without lateral disturbance, and merely involved a gradual increase in elevation with only minor tilting and warping.

One complete cycle of erosion was terminated by the uplift and a new cycle was begun. Rivers that had developed meand-

ering courses on the level ground of the peneplane now found themselves high above sealevel, where, with increased currents, they were forced again into activity.

A new drainage pattern was developed and a second series of ridges and valleys began to emerge in the area of the former mountains. The previously developed erosion surface had bevelled both hard and soft rock belts alike, but the new erosion was directed primarily at the belts of weaker rocks where streams could sink their valleys more readily. Long parallel ridges began to mark the outcrop of hard rock belts, and the hills grew relatively higher as the intervening belts of weaker rocks were deepened by erosion. A second range, the present Appalachian mountains, was in the process of development.

The Mesozoic era closed while the erosion was still in progress, and the scenery grew more and more bold throughout the Tertiary period of the Cenozoic era. For a time, the elevation of the land seems to have been halted, while the streams took opportunity to broaden, rather than deepen, their valleys. This temporary diversion was terminated by further uplift, and the rivers again renewed their incision and sculpture of the land. Indeed, it is unlikely that erosion has ever been completely halted from the late Cretaceous period to the present time.

The uplift and accompanying erosion have so completely destroyed the old peneplane that it is now difficult to identify its remnants; yet the crests of the higher ridges show flat tops that are probably relics of the Upland level. (See pages 15-17.) Even the benches or terraces now known as the Valley-floor lev-

Plate 16

(near manuscript page 78)

A. Fertile "bottom" land occurs along some portions of Clinch River, as in this view near Dungannon. (See page 30.)

B. Steep valleys tributary to Clinch River, as in the above view near Hill Station, indicate considerable active erosion since the "Valley-floor level" (represented on the tops of the hills) was produced. (See pages 17, 78, and 90 .)

els which were formed during the temporary halt in uplift have been largely destroyed by the very stream that produced them (See Pl. 10,A.), for the present rivers have sunk their valleys from 200 to 400 feet below the Valley-floor level. (See Pl. 16,B.)

The land is still in an era of sculpture, and one may actually observe the processes of erosion attacking the mountains of Scott County. (See Pls. 4,B and 5,A.) The present stage of scenic development can scarcely be described as the ultimate end of the erosion cycle already initiated; rather, it must be interpreted as a phase of the ever-changing evolution of the earth.

MINERAL RESOURCES

GENERAL STATEMENT

In order to qualify as a mineral reserve, a rock or mineral deposit must meet certain standards of quality, quantity and accessibility. In order to qualify as a material of actual value, it must further meet the requirements of the present market, selling price, competition, and many other economic factors before it can be profitably extracted. For the first group of requisites, the geologist is able to make useful examination; it is the economist who must consider the other factors.

The following pages deal with the geologic relations of potential mineral resources in Scott County. These deposits are described, so far as possible, in terms of their actual quality and quantity, and some suggestions are given as to their accessibility. It should be clearly understood, however, that attractive geologic conditions do not necessarily insure successful mineral development, and a careful survey of many economic factors should precede any attempt to develop mineral resources, anywhere, and at any time.

The only mineral operations now active in the county are the mining of coal and the quarrying of limestone. (See Figs. 7 and 9.) Both are successful, but both can be more fully developed. As transportation facilities increase, more and more of the county's coal can be utilized, and it is to be hoped that the large reserves of coal may ultimately be made more useful than at present. (See Table 3.) Additional quarrying of stone for lime and cement purposes need not await more adequate means of dis-

tribution, for the present transportation facilities are excellent. Indeed, at no other point in southwest Virginia can one find purer limestone in as favorable quantity and under more accessible conditions. It would seem as if the variable elements of cost of development, demand, selling price, and financial support are the only uncertain factors in its successful operation. Glass or "silica" sand is in the same category, for ample supplies in ready access to rail transportation await profitable exploitation. Stone for building or construction use, water power, and supplies of water for domestic use are all available when, as, and if they are needed.

It is probable that the county can supply satisfactory raw material to a brick or tile manufacturer, and that its supply of material for this purpose merits development. It is not impossible that the Early Grove anticline will furnish commercial quantities of natural gas, but it is definitely undesirable to support the financing of further drilling operations without some attempt to utilize the gas obtained, and without adequate geologic advice as to location, number, and depth of wells drilled.

Eventually, as the known supplies of iron, manganese, lead, and zinc of other regions become exhausted, it may be profitable to work the meager supplies of these metals in Scott County, but such a day seems far in the future. The land-owner can buy or sell property containing ores of these metals with complete assurance that they should not add to the present buying or selling prices. Ultimately they may give a premium to the land; now, they do not.

The geologist can confidently predict failure to attend any search for gold, silver, or copper in Scott County, and he is

near manuscript page 80

Table 3

MINERAL PRODUCTION OF SCOTT COUNTY 1./

Mineral	Period of Years	Quantity Short tons	Value
Coal	1918-1933	776,234	$1,952,917
Sand and gravel	1921-1933	419,872	871,990
Limestone	1924-1933	157,869	187,306
Lime	1919-1935 (to August)	2,987,634 *	
Quartz, or "silica", sand	1925-1933	4,750	24,715
Manganese) Zinc) Iron)	Small production, no available statistics		

* volume of raw stone quarried for cement
(see page 120-122)

1. Data from files of the Virginia Geological Survey

very reluctant to admit much chance of obtaining oil. Unless the Early Grove anticline--already tested by two deep wells--holds a supply of oil at greater depths than those now reached by the drill, his reluctance turns to utter unwillingness to predict possible success for any local oil venture.

It is highly probable that the materials listed above constitute the county's most valuable mineral resources, and that few other materials have any potential value. One can only hope that the normal development of the county will permit the successful operation of the materials known to be present, and that if the geologist has made errors of judgment, they are in the direction of understatement rather than overestimation of the possible resources.

Table 3, which follows, shows the mineral production of Scott County in recent years. (Insert Table 3 here).

FUELS

General Statement

Coal, oil, and gas constitute the 3 natural fuels obtainable from the rocks of the earth. All are of original organic origin. Coal is an accumulation of the woody fibers of plants pressed flat, hardened, and chemically changed through long ages of interment in the rocks of the earth. The coal plants were of terrestrial origin and grew in swamps where their partially decomposed remains accumulated beneath a layer of quiet or stagnant water. Oil and gas are of somewhat uncertain origin, although it is clear that they have resulted from organic material of some kind, possibly from the decomposition of marine plants. Commonly it is thought that black shales furnish the source of oil and gas in most of the known fields.

Although the 3 fuels are closely associated in origin, there are certain inherent differences in the rocks in which they occur. Coal always occurs in terrestrial, or land-derived, rocks and it is not present in any strata older than the Mississippian system. Oil is always found in marine sediments but not in those of geologic systems earlier than Ordovician. Gas may occur in either continental or marine rocks; it is not known to occur in pre- Cambrian rocks but is found in many types of younger sediments. Oil is rarely found without gas, but gas may occur without economically important quantities of oil. Although oil, gas, and coal may occur in the same field, they are never found in the same individual stratum. A persistent relationship has been found

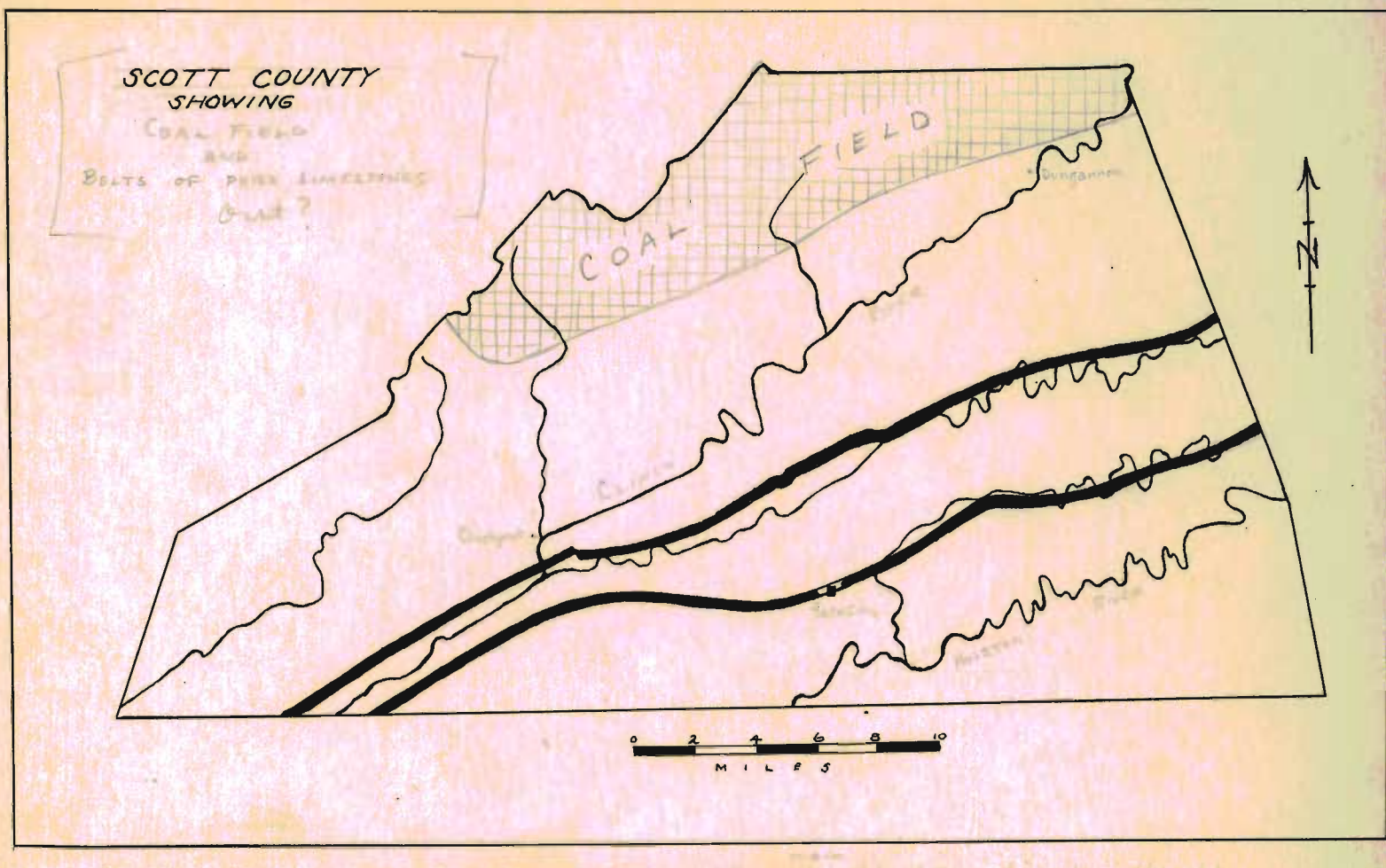


Figure 7, Sketch map showing Scott County and coal field — belts of prime limestone (black)

(near page 83)

between the occurrence of oil and the character of coal in adjacent areas of the Appalachian region. Whereas oil is occasionally present in fields where coal has a fixed-carbon content that is less than 60 percent, it is amost never found in any field where the fixed-carbon content is more than 63 percent. This relationship may be confidently used to determine the possibilities of oil production in regions where coal can be tested.

Scott County contains a small area of coal-bearing rocks and is a minor producer of coal. Gas has been reported from the Davis Elkins Well No. 1, near Early Grove, and may occur in quantity sufficient for commercial exploitation. The search for oil has been unsuccessful, and it is unlikely that it will be found anywhere in the county, despite the fact that Scott County contains the most favorable location for its accumulation that is known in southwest Virginia.

Coal

General Statement

All of the coal-bearing rocks of Scott County lie north of Clinch River. (See Fig. 7.) The local field is bounded at the south by Stone Mountain and at the west by Powell Mountain. It merges with the coal field of Wise County at the north and extends into Russell County at the east. It contains approximately 75 square miles, or 14 percent of the area of the county. The drainage of the entire field is carried by Clinch River.

The field may be separated into three main districts; (1) the western district, including the basins of Stock and Cove Creeks; (2) a central district, including the basin of Stony Creek; and (3) an eastern district, in the basins of McGhee, Dry,

and Little Stony creeks. Elevations in the coal districts range from 1,250 to 4,000 feet above sealevel.

A recent bulletin (No. 24) of the Virginia Geological Survey entitled "The geology and mineral resources of Wise County and the coal-bearing portion of Scott County, Virginia," by J. Brian Eby and others, gives a thorough description of the local coal-bearing rocks and the characteristics of the field in general. The present writer has made free use of the data from this earlier bulletin to which the reader is referred for additional information relating to the local field.

Development

Although coal has long been known to occur in northern Scott County, the more abundant and more accessible supplies in Wise and Russell counties attracted the attention of early operators who made little attempt to develop the local field. From 1890 to 1910, a few ambitious operators prospected some of the more accessible seams in this county, with the result that a number of wagon, or truck, mines were opened. Most of these mines were small private enterprises, but several larger mines were started, including the Hagan mine on McGhee Creek, and the J.S.T. mine on Little Stony Creek, 1 mile north of Clinch River. (See Pl. 17,A.) The latter has been the chief shipping mine, for it has rail connections with the Clinchfield Railway at Stony, 2 miles above Dungannon. Several large-scale truck mines are now active, including the operations of the Cove Creek Coal Company, Inc., 1 mile north of Mabe.

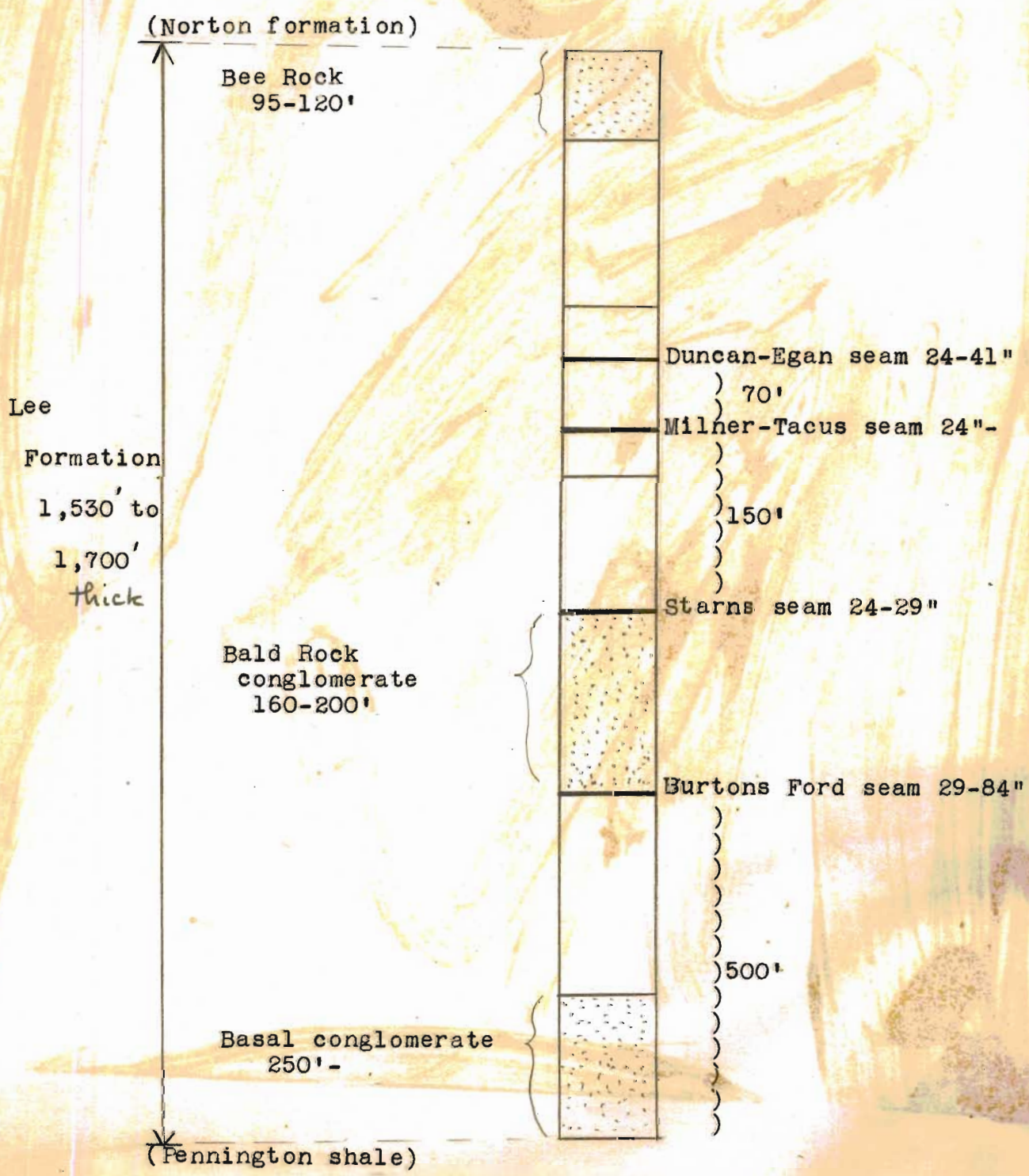
The Scott County coal field is relatively inaccessible. Clinch River, which is followed by the Clinchfield Railway, bounds the field at the extreme east but swings southward away from the field in the central and western part of the county. The river forms a natural barrier to intercourse from central Scott County northward, and the linear ridge of Stone Mountain forms a further obstruction to travel; Powell Mountain bounds the field on the north. There are two roads that cross the field --State Highway 72 which extends northward from Dungannon, and State Highway 73 which leads northward from Fort Blackmore. Except along these roads, neither of which is macadamized within the county, automobile travel is still difficult, and many of the deeper hollows can be reached only on foot or on horseback. Only the mines in the lower valley of Little Stony Creek have rail access to their markets; hence, the products of all other mines must be distributed by truck. Many truck mines distribute coal to such adjacent communities as Gate City, Bristol, and Kingsport.

Most of the mines are drift mines, in which there is a horizontal main entry from which other openings, or "rooms", are driven laterally. Pillars of coal, which are left to support the roof, may be ultimately removed when the seam is"robbed out", or the mine is abandoned. Because of steep dips at the J. S. T. mine, the rooms are driven one above another up the rise of the seam from a main horizontal entry. (See Pl.17,A.) There are no mines in which the entry is vertical, and there are few slope mines with an inclined entry.

Figure 8.

SECTION OF COAL-BEARING ROCKS

SCOTT COUNTY



Mine water is not a serious problem in the field, for most entries can be so located as to permit accumulating water to escape naturally by gravity flow. In the larger workings forced air currents insure a steady supply of clean air and there is little gas in any of the local mines. Mules or ponies haul the coal cars in most operations, although where electricity is available, there are locomotives. Much of the local coal is mined by hand, and among the smaller workings it is not uncommon to find operations where the entire mining, transporting, and loading of coal into a truck are the work of a single miner. The coal is commonly distributed as "run-of-the-mine" lump coal without previous sorting or sizing.

Character

Most of Scott County's coal are hard, clean, and evenly jointed. They are known as "block coals" and, when properly mined, reach the car in fairly large lumps. The coal is chiefly of good bituminous rank, although some cannel coal is also present. (See Table 4.) It is reported that tests of cannel coal from McGhee Creek indicate a possible yield of 56.5 gallons of distillate per ton, an amount which exceeds the normal yield of the best cannel coals of the Appalachian area. Unfortunately, the local bed is too thin to warrant the establishment of a reduction plant. Coal mined from the Egan seam on Stock Creek becomes slightly greenish after 14 hours' exposure to the air, a property that serves to identify the product of the Stock Creek Coal Company.

The average of several proximate analyses of coal (see

Table 4

Proximate Analyses of Coals of Scott County.[1] [redacted]

(Analyses are of coals as received at testing laboratory)

	Bed		Location	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	British Thermal Units
1	Burtons Ford	Cannel Coal	McGhee Creek.	2.4	33.8	34.9	28.88	.99	10,490
2	Burtons Ford	Bituminous Coal	3 Miles North of Dungannon.	2.9	30.8	59.4	6.92	.95	13,690
3	Milner	Bituminous Coal	Stony Creek, 5 Miles North of Ka.	3.2	33.0	58.1	5.70	1.64	13,750
4	Duncan	Bituminous Coal	Stony Creek, 1½ Miles North of Ka.	3.1	33.3	57.2	6.44	.85	13,640
	Average	Bituminous Coal	Analyses 2 - 4	3.1	32.4	58.2	6.35	1.15	13,693

1. Eby, J. Brian and others, Geology and mineral resources of Wise County and the coal-bearing portion of Scott County, Virginia: Virginia Geol. Survey Bull. 24, p. 525, 1923.

Near Neumeyer page 86

also Table 4.) from Scott County [1] is as follows:

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1. Eby, J. Brian and others, Geology and mineral resources of Wise County and the coal-bearing portion of Scott County, Virginia: Virginia Geol. Survey Bull. 24, p. 503, 1923.

Moisture..... 2.9
Volatile matter.....32.7
Fixed carbon.....52.4
Ash.....11.99
Sulphur.....1.11
B. T. U.....12,890 units

(Insert Table 4 here)

Coal-bearing Rocks

Although the Norton formation has a small outcrop in Scott County, all of the workable coal beds occur in the Lee formation at the base of the Pennsylvanian system. (See Fig. 8.) This formation, which is about 1,600 feet thick, is a series of sandstones and shales containing several thin coal seams. The Lee formation contains 3 thick, massive sandstone or conglomerate members (Pl.14), which occur at top, bottom, and near the middle of the unit. The uppermost bed, which is known as the "Bee Rock", is a massive conglomerate ranging from 95 to 120 feet thick that forms overhanging crags along the north slope of Powell, Stone, and Little Stony mountains. The middle conglomerate, known as the "Bald Rock" is about 200 feet thick (Pl. 15, B.) and the basal unnamed conglomerate is more than 250 feet thick. All 3 beds contain hard, clean quartz grains, with pure vein-quartz pebbles that are well rounded. The intervening beds consist of shale, sandy shale, and thin coal seams. Along the southern edge of the field, the Lee formation has been folded and is steeply inclined, (Fig. 6); elsewhere it is essentially horizontal. (See Pl. 13,A.)

A few outliers of Norton formation occur in the coal field, but are too thin or carry too little coal to be of economic importance. A few scattered and unimportant beds of bony coal occur locally in the Pennington shale below the Lee.

Several coal seams occur in the Lee formation between the Bald and Bee Rock conglomerates. The Starns seam, immediately above the Bald Rock, and the Burtons Ford seam immediately below the Bald Rock are the most important beds. The Milner and Duncan seams of the Stony Creek basin, and the Tacus and Egan seams of the Stock Creek basin lie above the Bald Rock conglomerate.

Burtons Ford Seam-- The Burtons Ford coal seam is the most important and persistent coal bed in Scott County. It underlies the massive Bald Rock conglomerate (Pl. 17,A.), and is about 500 feet above the base of the Lee formation. It crops out at many localities in the upturned rocks along the edge of the field with a thickness which ranges from 30 inches on Stock Creek to more than 90 inches on Little Stony Creek. For the most part it contains excellent bituminous coal. On McGhee Creek, however, where it is about 48 inches thick, it contains 2 benches of cannel coal, 2 benches of impure coal, and a bench of mixed bituminous and cannel coal. It is named from Burtons Ford on Clinch River, 2 miles below St. Paul, Wise County, and is well exposed along Clinch River and in the basins of McGhee, Dry, and Little Stony creeks. In earlier reports this seam was erroneously thought to occur in the Pennington shale.

Starns Seam-- The Starns seam which occurs immediately above the Bald Rock conglomerate ranges from 24 to 30 inches in thickness and is well exposed on Stock Creek, north of Mabe. Other exposures occur on Stony Creek and on Donald Branch, a tributary of Mountain Fork.

Milner-Tacus Seam-- The Milner coal, which occurs on Stony Creek about 150 feet above the Starns bed, has an average thickness of less than 2 feet. It crops out on Mountain Fork, where it was opened about 30 years ago to supply fuel for engines on a lumber tramway. Although it is nearly 65 inches thick in the original Milner mine, it is clear that this abnormal thickness can not be expected elsewhere.

It is thought that the Tacus seam, which is 4 feet thick on Stock Creek, is the equivalent of the Milner, as both occupy the same stratigraphic position in the Lee formation - from 150 to 200 feet above the Starns seam. The Tacus coal is well exposed 2 miles north of Mabe, where its thickness ranges from 24 to 42 inches.

Egan-Duncan Seam-- The Duncan coal crops out along on Stony Creek near the mouth of Coalpit Branch, where its thickness is about 24 inches. It occurs about 70 feet above the Milner coal, or about 220 feet above the Bald Rock conglomerate. Probably it is equivalent to the Egan seam of the Stock Creek basin. The latter is one of the best beds of the Stock Creek area, and has been opened at several points. It is 58 inches thick at mines 2 miles north of Mabe.

Other Seams-- Several thin coal beds have been reported above the Duncan-Egan seam in the upper portion of the Lee formation. One of these coals, with a reported thickness of 24 inches, has been prospected north of Mabe, where it occurs 90 feet above the Egan seam. Several other coals are reported from the area of the headwaters of the Little Stony Creek, but none is known to be persistent, nor of thickness comparable to the described horizons.

Structure

Except for an outcrop of Burtons Ford coal, which stands at high angles in the J.S.T. mine on Little Stony Creek (Pl. 17,A), all of the coal beds of Scott County are gently inclined. Although the main axis of the Powell Mountain anticline lies in Lee and Wise counties, the local field is dominated by this structure toward which all coal rocks gradually rise. The southeastern edge of the field is marked by a sharp upturn in the coal-bearing rocks produced by movement along the St. Paul or Hunter Valley fault. (See pages 63-64.) Stone Mountain, which terminates the field on the southeast is formed by resistant beds of the Lee and Pennington formations which are overturned throughout a belt that averages half a mile in width. All of the field is a rugged district with steep, narrow valleys and precipitous slopes. (See Pl. 16,B.) It has been thoroughly dissected, and forms the "Alleghany front" of the plateau province. (See page 14.)

Chief Coal-producing Districts

Western District-- The western coal field of Scott County occupies the basin of Stock Creek and lies along the eastern flank of Powell mountain; it also includes the drainage basin of Cove Creek. 1/ The

1. Eby, J. Brian and others, op.cit., pp. 471-489.

exposed lower portion of the Lee formation dips southeastward at an average inclination of about 4°. Six or eight coals have been prospected by drilling which has revealed the general thickness of the available beds. The Burtons Ford bed, thickness 30 inches, the Starns coal, thickness 30 inches, the Tacus seam, thickness 30 to 48 inches, and the Egan coal, thickness 40 to 58 inches are all

present. These coals are usually clean, hard, and well jointed. There has been considerable surface prospecting but little commercial mining.

Two operations were active in 1935. The Stock Creek Coal Company is operating a mine on the right-hand tributary of Stock Creek, 1 mile north of Mabe. The mine has a hard sandstone floor and follows the Egan seam which is about 42 inches thick. Twenty men were engaged in actual mining, and the total production for August 1935 was reported to be 300 tons. Although the coal is of good quality, it is high in ash and sulphur. Coal from this mine can be readily recognized, for a distinct greenish color develops on its surface after it has been exposed to the atmosphere for 10 to 14 hours. The seam dips gently to the southeast toward Stone Mountain.

The Cove Creek Coal Company, with a force of about 20 men, is operating a mine on the east side of Cove Creek, 2 miles north of Stanleytown. A new tipple was erected in 1935 at the mine entry which is about 400 feet above creek level. The coal lies below the Egan bed and is probably the Tacus seam; its thickness is reported to hold an average of 50 inches.

Both mines furnish coal which is distributed by truck to local communities; but as the roads to the mines are in poor repair, the difficulties of transportation are considerable. Rail facilities would be improved by construction of a short spur-line to connect Stock Creek with the Southern Railway at Sunbright (Horton Summit). The addition of this line, although desirable, is not at present warranted by the known resources of the basin,

Plate 17
(Near manuscript page 92)

A. Coal mine in the Burtons Ford seam stratigraphically below the vertical ledges of Bald Rock conglomerate on Little Stony Creek, 1 mile north of Dungannon. (See pages 20, 36, 57, 85-9, 92, 133.)

missing. 3-22-63

B. "Limestone" quarry for crushed stone in the Copper Ridge dolomite at Glenita. (Compare Pl. 12, A.) (See page 127.)

for there are only 2 coals of thickness sufficient to deserve operation, and both are of less importance than the seams on Stony Creek in the central district.

Central District-- The central portion of the Scott County coalfield lies along the basin of Stony Creek where the bedrock dips gently toward the southeast. [1] Many of the headwaters of Stony

1. Eby, J. Brian and others, op. cit., pp. 471-489.

Creek rise in deep isolated ravines to which access is difficult at present because of the many waterfalls produced by the sandstones of the upper Lee formation. The Starns seam, thickness 30 to 48 inches, and the Milner coal, thickness 18 to 20 inches, are the chief available horizons. A mine, opened by the Stony Creek Lumber Company near the mouth of Mountain Fork, was formerly operated in the Starns coals; the Milner mine, once operated on Mountain Fork, utilized the Milner seam. Various prospect trenches show other thin coal beds, and both major seams are exposed along the hillslopes and in road cuts.

Some attempt has been made to utilize the coals of this district, which is traversed by State Highway 73 from Fort Blackmore to Norton. The prospecting, however, has revealed little workable coal, and the difficulties of transportation have so far prevented any extensive development. A few truck mines operate occasionally from this district, but there has been little commercial development. The coals of the central region are too thin for present profitable mining and until more satisfactory transportation facilities are available, they will probably fail to receive further development.

Eastern District--The eastern district includes the basins of McGhee, Dry, and Little Stony creeks where most of the bedrock dips gently toward the south and east.[1] A zone of overthrusting along the southeastern edge of the field contains dips which range from 40° to 60° N. Sharp overturning of Lee sandstones has brought to the surface valuable coals that would be otherwise inaccessible in this district. One of these coals is the Burtons Ford seam which crops out near the high ledges of Bald Rock conglomerate that jut across Little Stony Creek, 2½ miles northeast of Dungannon. (See Pl. 17, A.)

1. Eby, J. Brian and others, op.cit., pp.471-489.

The Burtons Ford seam is the principal coal horizon of the district. It has an average thickness of 4 to 6 feet and contains a parting which varies from several inches to 1 foot in thickness. The bed is a layer of excellent bituminous coal on Little Stony Creek, but changes in character to a mixed cannel and bituminous coal on McGhee Creek. There are a few seams in the upper part of the Lee, but none can be considered to have potential value at present.

The J.S.T. mine is located on the east side of Stony Creek about 1 mile above Clinch River. The main entry of the mine is driven into the Burtons Ford seam, which dips N.20°E. at angles that range from 36° to 40°. Numerous rooms have been opened along the rise of the seam which varies in thickness from 58 to 90 inches but holds an average thickness of about 60 to 65 inches. The coal crops out on both sides of the creek immediately beneath (south of) a towering wall of Bald Rock conglomerate that is more than 60 feet thick. (See Pl. 17, A) Operations have been undertaken on both sides of the creek at various levels. This seam is also exposed along Clinch River at Miller Yard, near Bangor, and on both sides of the basin of Little Stony Creek. A narrow-gauge tram connects the workings near the J.S.T. mine with the Clinchfield Railway at Stony, and State Highway 72 follows the lower part of the creek valley from Dungannon to Coeburn, in Wise County. The Hagan mine on McGhee Creek follows the Burtons Ford seam, which has a total thickness of

about 48 inches and is chiefly composed of cannel coal. Several abandoned pits 1 mile north of the mouth of Dry Creek also exhibit the Burtons Ford seam with a thickness of about 5 feet.

The eastern district is more accessible by rail and road than the central and western portions of the local field, and its chief bed, the Burtons Ford seam, has a proven thickness that cannot be duplicated elsewhere in the county. For these reasons this district is likely to prove the most valuable, despite its present small development.

Future Development

It has been estimated that a total of 1,600,000,000 tons of coal are contained in 90,000 acres of Scott County.[1] It is unlikely, however, that as much as one-third of this amount can ever be recovered even with intensive operation. It is also probable that the number of accessible seams more than 30 inches thick are so few as to bring the total volume of available coal to a still smaller figure. It is finally probable that the present inaccessibility of the coal districts will not be immediately relieved.

1. Eby, J. Brian and others, op. cit., pp 503.

When all of these items are considered, and additional factors of (1) competition from adjacent fields, (2) distance from available markets, and (3) general overproduction of bituminous coal are also reviewed, it is at once apparent that the immediate prospects for additional coal operations are not promising. Coal is undoubtedly present in minable quantity, but it is difficult to foresee its practical exploitation on a larger scale for some time to come. Local operation of small mines will probably continue to be profitable, but large-scale development can scarcely be anticipated under present--or even moderately favorable future--circumstances. It is likely that other natural materials will continue to outrank coal among the county's most valuable mineral reserves.

Oil and Gas

Ever since oil and gas were discovered in the adjacent states of West Virginia and Kentucky, they have been eagerly sought in Virginia, where much prospecting has been attempted, and many wells have been drilled. Thus far, however, these attempts have met with failure, although Scott County contains the only producing natural-gas well in the State.

The natural occurrence of either oil or gas depends upon (1) the presence of favorable bedrock structures, and (2) the degree of metamorphism, or alteration, which the rocks have undergone. It has long been known that both oil and gas tend to escape from whatever porous rocks they occur in. If the rocks are fractured, both will reach the surface and disappear; if the rocks are tight or nonporous, they may become trapped below ground and thereby prevented from immediate escape. The crest of an anticline of impervious rocks forms an ideal structure to trap either gas or oil; hence a prospective operator searches for an anticline in the bedrock of a possible oil-producing area, and drills his well as near to the crest of the arch as possible.

Although a favorable structure may be present, it is no guarantee of the presence of either oil or gas. It has been found for example, that accumulations of oil rarely, if ever, occur in commercial quantity where the fixed-carbon content of nearby coal beds (computed on an ash-free and moisture-free basis) is above 60 percent, It is further known that crushed or fractured rocks have probably permitted the escape of any previously existing accumula-

tions of either oil or gas. To expect oil, therefore, one must discover a locality (1) where there is a favorable anticlinal structure, (2) where the fixed-carbon content of nearby coal beds is less than 60 percent, and (3) where neither faulting nor close folding have disturbed the rocks. There must also be a source for the oil or gas, a porous reservoir in which it can accumulate, and an impervious layer capping the anticline.

There are only two portions of Scott County in which there are even remote possibilities of finding oil. One is the coal field north of Stone Mountain and east of Powell Mountain; the other is the area of Mississippian limestones southeast of Holston River adjoining Washington County. Although the coal field is located on the flank of Powell Mountain anticline, the axis of the arch lies in Wise County, and the structural relations indicate that if oil or gas are present, they will be found north, rather than south, of the county line. A well known as the "Nettle Patch" was recently drilled near Clear Creek School, 3 miles northwest of High Knob. The slight flow of gas which was encountered at a depth of 2,153 feet was of insufficient volume to encourage further exploitation. The failure to find oil could have been predicted, for the coal of the Wise and Scott county field has a fixed-carbon content of more than 63 percent, which is an amount incompatible with the nearby presence of oil.

However, the fixed-carbon ratio does not limit the occurrence of gas, and it is possible that further drilling along the axis of the Powell Mountain anticline might be rewarded. Properly to follow the crest of the structure, however, the wells should be lo-

cated in Wise County, and it can not be recommended to drill for gas in the Scott County portion of the field.

Somewhat different conditions occur in the southeastern corner of the county where nearly horizontal beds of Mississippian age underlie the region between Fido and Early Grove. A small oval anticline is outlined by the outcrop of the red Fido sandstone.(See Plate 1.) The axis of this fold extends northeastward, and the rocks dip at angles of about 10° in all directions away from the crest of the structure. Several porous sandstones with intervening impervious rocks occur between the surface of the ground and a depth of 3,500 feet, and the nearby black Devonian shales ("Romney") might indicate a possible source for either gas or oil.

Dr. Charles Butts [1] indicated the presence of this anti-

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1. Butts,Charles,Oil and gas possibilities at Early Grove, Scott County, Virginia: Virginia Geol. Survey Bull. 27, pp. 1-18, 1927.

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cline in 1927, and described the features which were favorable and unfavorable for the occurrence of oil. Acting upon this information the Davis Elkins operations drilled a well near Early Grove in 1931. The well was sunk on the farm of Earl Ridgeway and reached a depth of 3,613 feet. Gas was encountered at depth of 3,210 feet and again at a depth of 3,253 feet, but no more gas, nor any oil, was encountered. Very little accurate information has been released about this well. It is reported that the open flow from the 2 gas horizons amounted to more than 1 million cubic feet every 24 hours, and that there was a rock pressure of 1,500 pounds to the square inch. Although the well was immediately capped, a small volume of gas was piped for domestic use in the home of Mr. Ridgeway, who has the distinction of being the only person to use Virginian natural

gas in his home. The well was reopened in 1934 but after some mechanical difficulties was recapped and is still (1935) sealed.

In August 1935, a second well was started by the same company on the farm of J.A. and C.B. Hunsucker, a third of a mile southwest of the first well. The surface elevation of the new well is approximately 100 feet higher than that of the earlier well. A 90-foot steel derrick was erected for the second well; a small wooden rig was used in the first well. It was expected to use gas from the 1931 well for fuel at the new location.

Unless oil is struck in the well now drilling, it is improbable that the Early Grove anticline will prove productive elsewhere, despite the fact that the anticline is the most favorable structure in southwest Virginia. The gas possibilities of the anticline have not yet been made known. If information released by the drilling company is accurate, the original well was capable, when first brought in, of furnishing 1 million cubic feet per day. Although this volume would not rival the output of producing fields elsewhere in the Appalachian region, nevertheless it would be sufficient to warrant some commercial exploitation.

In view of the small size of the Early Grove anticline, it is a probable assumption that only a limited volume of natural gas is present, and that few wells should be drilled, for there is a practical limit to the number of wells needed on a small structure. Unless there are other advantages in continued drilling, it will probably be better to capitalize on the known gas present, whatever its volume, than to overdrill the field.

There is no likelihood of either oil or gas being found in the central portion of the country or in Poor Valley. A deep

well was being drilled by a Gate City operator on the floodplain of Clinch River, near the mouth of Cove Creek about 3½ miles below Fort Blackmore. (See Pl. 11,A.) The bedrock consists of the folded shales, sandstones, and thin limestones of the Rome formation of Cambrian age. When visited in August 1935, the well had reached a depth of 800 feet and operations were temporarily halted to allow the casing to settle. The operator was hopeful of encountering oil, yet it would be difficult to choose a location where the prospects were less favorable.

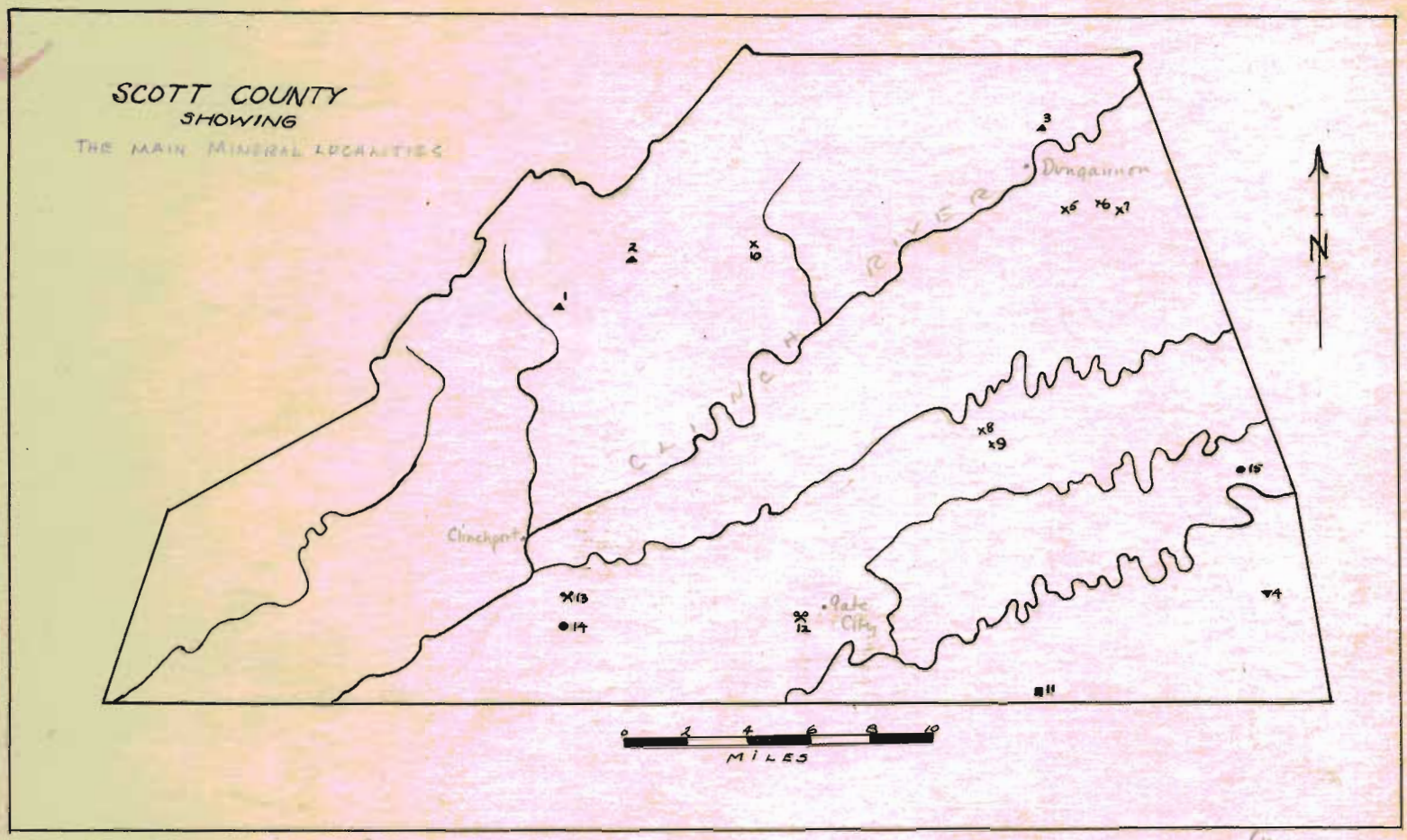

Figure 9, Sketch map showing important mineral localities of Scott County. (See manuscript page 100)
(For legend, see on reverse side)

METALS

General Statement

Although metallic minerals are not uncommon in Scott County, valuable or minable deposits are far rarer than those localities where ores make conspicuous showings at the surface of the ground. Whereas almost any landowner in central Scott County can find masses of iron ore on his land, there are extremely few localities where economically valuable iron deposits occur. Such items as the cost of operation, difficulties of transportation, nature of the ore minerals, and distance from the refiner, are invisible but inescapable factors that conspire to prevent all but the most promising deposits from reaching the stage of successful operation. Hence the geologist is constantly faced with the discouraging task of attempting to persuade the landowner that the masses of iron ore which occur in his fields have no practical value; that the "silver mine" of his investment contains no silver; and that the show of "gold" is actually a flake of mica.

Minerals of 4 metals occur in Scott County in sufficient quantity to attract attention. These are the ore minerals of iron, manganese, lead, and zinc. There is no gold, silver, nor any copper in the local rocks. Only 1 metal mine, the Graves-Bowman zinc prospect near Lucille, has ever been active; a few deposits have been prospected, and many others have been examined.

The following paragraphs describe the most important mineral localities and the opportunities for their future development. (See Fig. 9.)

Iron and Manganese

Red Clinton Iron Ore

Beds of red hematite are common members of the Silurian system of eastern United States. As the ore occurs in the Clinton formation, it is familiarly known as "Clinton ore."

Deposits of Clinton ore have been profitably worked in Lee and Wise counties along the eastern slope of Wallen Ridge, a few miles west of Scott County. [1] The mines, which were operated

1. Eby, J. Brian and others, Geology and mineral resources of Wise County and the coal-bearing portion of Scott County, Virginia: Virginia Geol. Survey. Bull. 24, pp. 544-564, 1923.

mainly by the Intermont Coal and Iron Company of Big Stone Gap, cluster along the foot of the ridge near Oreton and Irondale. They were exploited with great hopes in the period from 1890 to 1910, when the ore was sent to blast furnaces at East Stone Gap. After 1910, the increasing costs of operation, and the strong competition from Lake Superior ores gradually weakened the local iron industry, and both furnaces and mines were closed in 1920.

The ore consists of brick-red hematite in thin beds or layers that are interstratified with the sandstones and shales of the Clinton formation. As many as 4 different beds of hematite are known in Lee county, where their maximum total thickness reaches 4 feet. Two types of ore occur:(1) Fossil ore, in which a mass of shell fragments has been replaced by iron oxide, and (2) oolitic ore, consisting of an aggregate of tiny pellets, or grains, cemented together by iron oxide. The average ore which contains about 38 to 36 percent of metallic iron, is an excellent source of iron. It is

1. Eby, J. Brian and others, Geology and mineral resources of Wise County and the coal-bearing portion of Scott County, Virginia: Virginia Geol. Survey Bull. 24, pp. 544-564, 1923.

out

out.

thought that the orebodies were deposited as original sediments, for they possess the same structure as the beds which contain them.

Although the Clinton formation is well exposed (1) on the slopes of Powell Mountain and Stone Ridge, and (2) along the southern summit of Clinch Mountain (Pl. 16,A), no workable beds of hematite occur in either belt. The valuable seams of Wise County follow Wallen Ridge through Lovelady Gap into Lee County, and have no continuation on Powell Mountain. A careful search along Powell Mountain and Stone Ridge showed red ferruginous sandstone at the ore horizons, but the beds do not carry sufficient iron to warrant use. The red sandstones crop out along U.S. Highway 58 on the slope of Powell Mountain and along the road leading from Pattonsville to Flag Pond. They have the brick-red color of hematite, but lack the weight of actual iron ore, and carry a much smaller percentage of metallic iron. True Clinton hematite, if scratched with a knife-blade, will show an orange-red streak; the knife will readily scratch the ore, and the mineral will stain the hands, even after the ore has been thoroughly washed. The red sandstones cannot be scratched by steel, and, if washed clean, will not continue to produce a stain.

The ore horizons are also occupied by red sandstones on Clinch Mountain where the most accessible exposures occur along the road from Fugates Hill to Mendota, immediately east of Scott County. A small area of red Clinton sandstones occurs along North Fork of Clinch River 4 miles southwest of Pattonsville, but no iron ore occurs in its outcrop.

Brown Iron and Manganese Ore

Accumulations of brown iron and manganese ore have been worked profitably on both small and large scale throughout the Ap-

palachian region, where they are commonly found in residual soil derived from the decay of the underlying rocks; in other localities they occur directly in the bedrock in the form of veins, cavity fillings and replacements. It is thought that the ores were deposited by circulating underground waters and were later enriched during the development of the Valley-floor peneplane. (See page 17.)

The ore consists of earthy, brown to black, porous minerals that generally occur in irregular masses admixed with chert, soil, or bedrock. Limonite, the chief iron mineral, is brown iron oxide. It is never crystalline, and its earthy appearance, medium weight, and brown or yellow color, distinguish it from other minerals. The chief manganese minerals are the oxides psilomelane, manganite, and pyrolusite. All are deep brownish-black in color, and possess an earthy to glistening luster; they occur in masses of irregular shape.

Powers Prospect-- This prospect (Fig. 9) is located 2½ miles southeast of Dungannon on a terraced spur of Copper Ridge, 700 feet above Clinch River and about 2,200 feet above sealevel.[1] The prospect pits are located on the property of Mr. Lathrop Powers of Dungannon, 100 yards east of the road which leads southwestward from Dungannon toward Valley Creek.

The site was first prospected for iron ore in 1888 when a trench, more than 100 feet long, was made; prior to 1888, the area had been prospected for silver. It was worked over by Powers who dug a score of trenches, shallow pits, and other excavations in a

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1. Stose, G.W. and Miser, H.D., Manganese deposits of western Virginia: Virginia Geol. Survey Bull. 23, pp.197-199, 1923.

north-south belt about 1,600 feet long, and 500 feet wide. About 15 tons of "high-grade" manganese ore were hand-picked from shallow pits and sledded to Dungannon. No ore was shipped, no prospecting has been done since 1922, and no actual mining has ever been attempted.

The prospect occurs in residual clay derived from the lower beds of the Copper Ridge dolomite, not far above the top of the Nolichucky shale. White chert and masses of white sandstone occur in the residual soil with nodules of ore minerals that range from pellets the size of a marble to masses weighing 1 or more tons. A soil that is highly stained with iron oxide covers the bedrock which dips to the southwest at angles ranging from 40° to 45°; the uppermost stratum is an interlaminated limestone and dolomite.

Several types of ore materials occur. On the surface of the knoll are abundant masses of a brown porous material which contains small quantities of psilomelane, pyrolusite and manganite admixed with larger quantities of limonite. This ore is invariably associated with broken sandstone or rounded chert fragments. The ore that occurs on the east side of the hill is richer in manganese than the one near the top of the knoll, and consists chiefly of dense pyrolusite and rounded, or mammilary, masses of manganite. A quantity of good gravel ore was found in one of the pits on the side of the hill. As indicated by the surface float, the ore zone is from 200 to 500 feet wide and more than 1,000 feet long.

The occurrences of surface ore at this locality have been locally considered to indicate a large body of ore below ground. This is neither a necessary nor a logical conclusion, for the visib-

ble ore has accumulated during long epochs of surface weathering and erosion in which the original dolomite or limestone has been decomposed or dissolved, and the ore minerals which it contained have become concentrated as the bedrock gradually changed to soil. In most deposits of this type, the best ore is at the surface of the ground.

Nevertheless, the prospect of developing the locality is not wholly discouraging. Under favorable shipping condition and with a fair price for a small quantity of ore, it is probable (1) that cautious small-scale mining of the visible ore would meet with no loss; (2) that some of the high-grade manganese ore could be separated as a by-product; and (3) that the operations would give valuable information as to the quantity of ore below ground. A prudent attempt to develop a small mine for iron with accessory manganese might be sufficiently successful to pay for the thorough testing of the underground possibilities. No such attempt, however, should be made until conditions of transportation and disposal of the available ore are more satisfactory than at present.

Cox Prospect-- This prospect, which is located on the Jack Cox farm near the head of Falls Creek, 1½ miles east of the Powers property, shows a similar but less encouraging quantity of surface ore. (See Fig.9.) Masses and nodules of limonite and manganese minerals are common in the surface soil under topographic conditions analogous to those at the Powers locality. There has been little or no development; no ore has been taken out, and the prospecting has been haphazard. Until the more promising Powers pros-

pect is proven, it is unwise to attempt development of the Cox prospect.

Grear Prospect-- The property of Jasper Grear which adjoins the Cox prospect also contains surface indications of brown ore. It is also reported that a water well encountered a mass of ore between 3 and 4 feet thick at a depth of 60 feet below the surface of the ground. Little additional information is available, and the prospect is unpromising.

Long Hollow Prospect-- A tract of 100 acres is reported to contain a large body of manganiferous iron ore at the head of Long Hollow, about 2½ miles east of the Powers Prospect. This property was leased about 1898 by the Virginia Iron, Coal, and Coke Company, but no mining and little prospecting was undertaken. The surface indications are those of residual masses of brown limonite admixed with manganese materials. There is no known indication of richer ore below ground.

Dougherty Prospect-- This prospect is located on property belonging to Mitchell Dougherty, a short distance south of Valley Creek branch, and a quarter of a mile from the creek. It is on the southeast slope of Copper Ridge, about 5 miles southeast of Dungannon, and 2 miles from Nickelsville. Small fragments and nodules of limonite occur in the soil with soft lumps of psilomelane in clay associated with gray-white chert. A short distance away, across a low hill, a 40-foot water well on the Castle farm is reported to have encountered a mass of manganese ore that was 18 inches thick.

Robinson Prospect-- The locality is in a small hollow north of a spur of Moccasin Ridge, 1 mile due north of Snowflake, and about 8

miles northeast of Gate City. It was originally prospected as an iron mine and a number of shallow trenches were dug on the slope of the ridge about 50 feet above the creek. There is a large waste dump of porous limonite which contains small pockets of bright yellow ocher. Some of the limonite nodules have cores of pyrite, but no manganese minerals were visible although it is reported that manganese ore containing from 33 to 36 percent of metallic manganese was found at this locality.[1]

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1. Stose, G. W. and Miser, H.D., op. cit., p.199, 1923

Perry Prospect-- The Perry prospect is located immediately south of the Robinson prospect on the south side of a spur of Moccasin Ridge, north of Big Branch. Several shallow trenches have been dug into the ridge which is covered with chert fragments derived from the Copper Ridge formation. One trench has been cut in the bedrock which is badly broken and stained by iron. The dump shows limonite and yellow ocher but no manganese ore.

Carter Prospect-- This prospect is located half a mile west of Ka (sic.) in the eastern end of Hunter Valley between Stone Mountain and Chestnut Ridge (See Fig. 9) It is situated on the northern slope of Chestnut Ridge a short distance south of the road. Nearby is a fault whereby the Honaker dolomite has been thrust upon the "Romney" black shale, which is overthrust upon the Glen Dean limestone. The ore occurs in residual clays 50 feet downhill from ledges of dolomite and immediately above an outcrop of black Devonian shale. The shaly Glen Dean limestone crops out along the road 100 feet to the north. Several shallow pits and trenches have been dug, and a small dump pile of low-grade cavernous limonite was examined. Al-

though the limonite contains yellow ocher which is reported to have been in local use for paint on doors, mailboxes, and fences, the showing of ore is too meager for practical development.

Lead and Zinc

General Statement

Valuable occurrences of lead and zinc minerals in eastern Tennessee have stimulated the local search for analogous deposits in Scott County. The two most common minerals of these metals are galena (lead sulphide), which is a very heavy, lead-gray, metallic mineral, and sphalerite (zinc sulphide), which is a heavy, yellow-brown to black, mineral. Both are primary in origin and are thought to have been formed below the zone of underground water. Secondary oxidized minerals, mostly light buff or brown in color, occur in irregular masses in the residual soils of the bedrock. These minerals include calamine (zinc silicate), smithsonite (zinc carbonate), and cerussite (lead carbonate). Limonite, or brown iron oxide, is a common accessory mineral.

The search for local deposits of lead and zinc ore has been almost entirely unsuccessful in Scott County. Only two localities are known to contain such ores, and none of these is now being worked.

Developments

Graves-Bowman Prospect--A small lead and zinc prospect is located 1 mile south of Lucille Post Office; it is 1½ miles northwest of Arcadia,Tennessee and about 150 yards north of the Tennessee boundary.[1]

1. Secrist,Mark H., Zinc deposits of east Tennessee: Tennessee Geol. Survey Bull. 31, pp. 33-37, 1924.

(See Fig.9.) The presence of galena and sphalerite was discovered about 1900, when a shaft and a few open cuts were made by a Mr. Graves of Bristol. In 1906,Mr. Frank Bowman made two more openings near the eastern end of the property and worked the deposit at intervals until 1918, when operations ceased. A small crusher, and two sorting tables were erected at a mill where about 25 tons of zinc concentrates were produced. No ore was shipped from the property, and the workings and shafts are now abandoned; the washer is in ruins, and the road which passes the mine is in a bad state of repair.

The original Graves prospect consisted of an 80-foot shaft and a surface cut which followed the trace of the ore body for about 40 feet. Near the center of this cut, there was a second shaft which was about 45 feet deep. Both shafts are now filled with water,and only the surface wall-rock can be examined. An additional 90-foot open cut was made by Bowman along the strike of the ore-bearing rocks 1,200 feet southeast of the Graves workings. This cut, about 15 feet wide and now filled with water, is said to have been 20 feet deep. Bowman also sank a shaft to a depth of 125 feet at a point 500 feet further to the southeast. This opening,however, is now inaccessible. The washer was located between the two Bowman openings and the concentrates taken out by Bowman were mined from the deep southeastern shaft.

The bedrock is a narrow strip of Copper Ridge dolomite overthrust against the Honaker dolomite, and similarly overfaulted by

younger beds. The strata are nearly vertical, and strike N.80° W. The ore-bearing rock is a dark-gray fine-grained crystalline dolomite that contains numerous beds of light-gray chert. The chief ore mineral, which is dark sphalerite ("black jack"), is associated with pyrite (iron silphide), chalcopyrite (iron-copper sulphide), galena, dolomite, and calcite. The minerals occur along the southern boundary of the Copper Ridge dolomite in small veins that are roughly parallel to the strike and dip of the bedrock. Veinlets, stringers, and irregular blebs of metallic minerals streak the dolomite walls of the openings, and the country rock is somewhat recrystallized and partially replaced by the sphalerite. The hanging wall is formed by the compact Honaker dolomite; the footwall is a member of the Copper Ridge formation. The ore minerals occur along a sheeted zone about 15 feet wide in which mineralization has taken place. It is reported that the pyrite and chalcopyrite increase in abundance in depth, and that a vein of sphalerite was encountered in the deep Bowman shaft.

The mineralized zone is about a third of a mile long, and grades longitudinally into unmineralized dolomite. The workings lie from 30 to 300 feet southeast of an abandoned road that formerly extended from Scott County southeastward into Tennessee. The ore in sight has largely been extracted, and the few small dumps have been well picked over. Specimens of the black sphalerite that encrusts the walls of the Graves prospect may be obtained from a precarious position above the open mouth of the water-filled shaft.

Several of the larger operating zinc companies in Tennessee have prospected this locality, but none has attempted any serious development of the prospects. Despite the previous attempts to recov-

er workable ore in this ground, it is unlikely that the property will be found to have economic importance because of its mineral value. Unless more information than is available to the writer comes to view, and until there is likelihood of a greater return for the investment than is now apparent, it will probably be discreet to discount the property as a possible mining venture. However, it is the most favorable locality in the county for the collection of intersecting minerals.

Price Prospect-- The Price prospect is located in the valley of Sinking Creek near the top of the spur that separates Sinking Creek from Cowan Branch, a fourth of a mile east of Russell County. It is about 5 miles due east of Dungannon. As it was erroneously thought to contain silver, the prospect has come to be known as the "silver mine".

A small open cut was made in 1931 by Logan Gray in a thinly bedded series of limestones and dolomites near the top of the Nolichucky shale. Abundant trilobite fragments occur in the thin gray limestones near the top of the 15-foot cut. No ore veins are present, but a careful search revealed a few scattered grains of pyrite and small blebs of resinous sphalerite. Both occur in such minute quantities as to be without practical value.

A few miles to the east in Russell County, small amounts of sphalerite and galena are disseminated through the Copper Ridge dolomite on the property of Pat Keith.

Other Metals

Gold and Silver

As neither gold nor silver occurs in the rocks of Scott County, the search for such materials is futile, and reports of their local occurrence are wholly ungrounded. Unfortunately, the Price lead and zinc prospect was reported to contain silver, and is now locally known as the "silver mine", but no silver is present either at this prospect nor elsewhere in Scott County.

Copper

There is no copper ore in Scott County. There is a mistaken but locally prevalent belief that the small greenish nodules or pellets that occur in some of the limestones are indications - if not minerals- of copper. These nodules are common to the blue-gray limestones of the Cambrian shales along the northern slopes of Copper Ridge.(See Pl. 10,B.) Possibly their presence may have suggested the name of the ridge. The nodules consist of the mineral glauconite, which is a hydrous iron silicate and contains no copper. Glauconite is a common mineral in many types of marine sediments and, in the small quantities present in the local rocks, is wholly without value.

Aluminum

Most of the counties of southwestern Virginia have considerable areas overlain by thick residual soil. Much of this soil is rich in aluminum, but, unfortunarely, no practical method has been developed profitably to extract the metal from clay, even where it is present in abundance.

NON-METALLIC MATERIALS

General Statement

The non-metallic elements of the bedrock, although less spectacular in their occurrence and methods of mining than the metals or fuels, are by no means of less value, and for many regions, they constitute the main reserves of natural mineral wealth. Quarries in Scott County limestones, shales, and sandstones may ultimately bring a revenue to the county that will command the respect of adjacent portions of the State.

Lime and Cement Materials

General Statement

Among the materials used for lime and cement are pure limestone, argillaceous limestone, dolomite, and limy shale, all of which are abundantly present in Scott County.

In theory, pure limestone consists of calcium carbonate, represented by the chemical formula $CaCO_3$. Such a rock, however, is extremely rare, and two types of impurities normally reduce the lime content; (1) Magnesia, which replaces some of the calcium, and (2) physical impurities of silica, iron, or clay. Thus relatively pure limestones grade in one direction through magnesian limestones into true dolomites, and in another direction from argillaceous limestones to limy shales.

In the production of lime, a stone free from all impurities is of most value; for the manufacture of cement, a certain amount of argillaceous material is necessary. An ideal limestone for lime production should contain about 95 percent of calcium carbonate and less than 1 percent of silica, or insoluble material. An ideal stone for cement manufacture should carry about 75 percent of calcium carbonate and 20 percent of clayey materials. Fortunately, however, it has been found practical in the lime industry to use rock with a calcium-carbonate content as low as 86 or 87 percent; and the required composition of cement material can be met artificially by combining pure limestones with argillaceous rock in the required proportions.

Both the Holston and Mosheim limestones meet the strict requirements of commercial lime-production. As the Mosheim is thin and poorly exposed, the Holston limestone forms the most important

local source of lime. Several formations, including the Ottosee, Moccasin, and Martinsburg shales, contain argillaceous rock in abundance. Under ordinary conditions and for ordinary uses, neither dolomites nor any rocks high in magnesia are usable for commercial lime or Portland cement. However there are uses for a high-magnesia lime, as well as for dolomite that can be utilized with furnace flux or as a refractory furnace lining. A finish lime with high plasticity should find a ready market in Virginia, and dolomite with a low amount of insoluble material might prove to be useful in its production. Probably the purest local dolomite is the Bellefonte dolomite which crops out near the belts of Ordovician limestone. (See Pl. 1.)

Table 5

ANALYSES OF HOLSTON LIMESTONE,

SCOTT COUNTY, ~~VIRGINIA~~

	1	2	3	4	5	6	7	8	9	10	11	12 Average
Silica, or Insoluble	8.26	8.42	0.86	27.34	0.18	11.50	16.96	20.54	4.88	0.88	0.56	9.13
Al_2O_3	1.82	3.66	1.10	0.90	0.04	0.89	1.03	0.46	1.14	0.32	0.15	.71
Fe_2O_3				1.70	0.12	0.77	1.05	0.90	0.90	0.50	0.25	.89
CaO	50.40	47.12	55.00	38.31	55.26	47.19	43.77	42.72	49.57	53.69	54.85	48.90
$CaCO_3$	90.89	84.14	98.21	68.40	98.60	84.41	77.17	76.32	85.07	96.0	98.0	87.30 ← x
MgO	0.12	0.67	0.08	0.85	0.65	1.99	1.15	1.24	2.24	1.34	0.87	1.02
$MgCO_3$	0.26	1.41	0.17	1.77	1.37	4.16	2.42	2.60	4.76	2.81	1.83	2.13 ← x
Loss	40.63	37.76	43.30	31.13	43.89	38.31	35.97	34.66	40.96	43.32	43.61	39.40
Total	101.23	97.63	100.34	100.23	100.14	100.65	99.93	100.52	99.69	100.05	100.29	100.05

1. Dark argillaceous limestone, Gate City.
2. Blue argillaceous limestone, Gate City.
3. Light-colored, coarsely crystalline limestone, Speer Ferry.
4. Dark-gray, cherty, argillaceous limestone, Marcem Quarry, Gate City.
5. Medium-gray, coarsely crystalline limestone, Gate City.
6. Dark, argillaceous limestone, Gate City.
7. Finely crystalline, dark limestone, Gate City.
8. Dark-gray, finely crystalline limestone, Gate City.
9. Dark, knotty, argillaceous limestone, Gate City.
10. Gray and pink, coarsely crystalline limestone, Gate City.
11. Medium-gray, coarsely crystalline limestone, Gate City.
12. Average of analyses 1-11.

Analyses 1-3, J. H. Gibboney, analyst.[1]

west of the Blue Ridge:

1. Bassler, R. S., Cement resources of Virginia, Virginia Geol. Survey Bull. 2-A, ~~[illegible]~~ pp. 231-233, 1909.

Analyses 4-11 furnished the author by the Pennsylvania-Dixie Cement Corporation, through their Kingsport office.

(x These data were not furnished by the Penn-Dixie, but were recalculated by H.P.W. as follows: $CaO \times 1.78 = CaCO_3$; $MgO \times 2.09 = MgCO_3$. The calculations were made by slide rule)

Near manuscript page 117

Local Supplies of Lime and Cement Materials

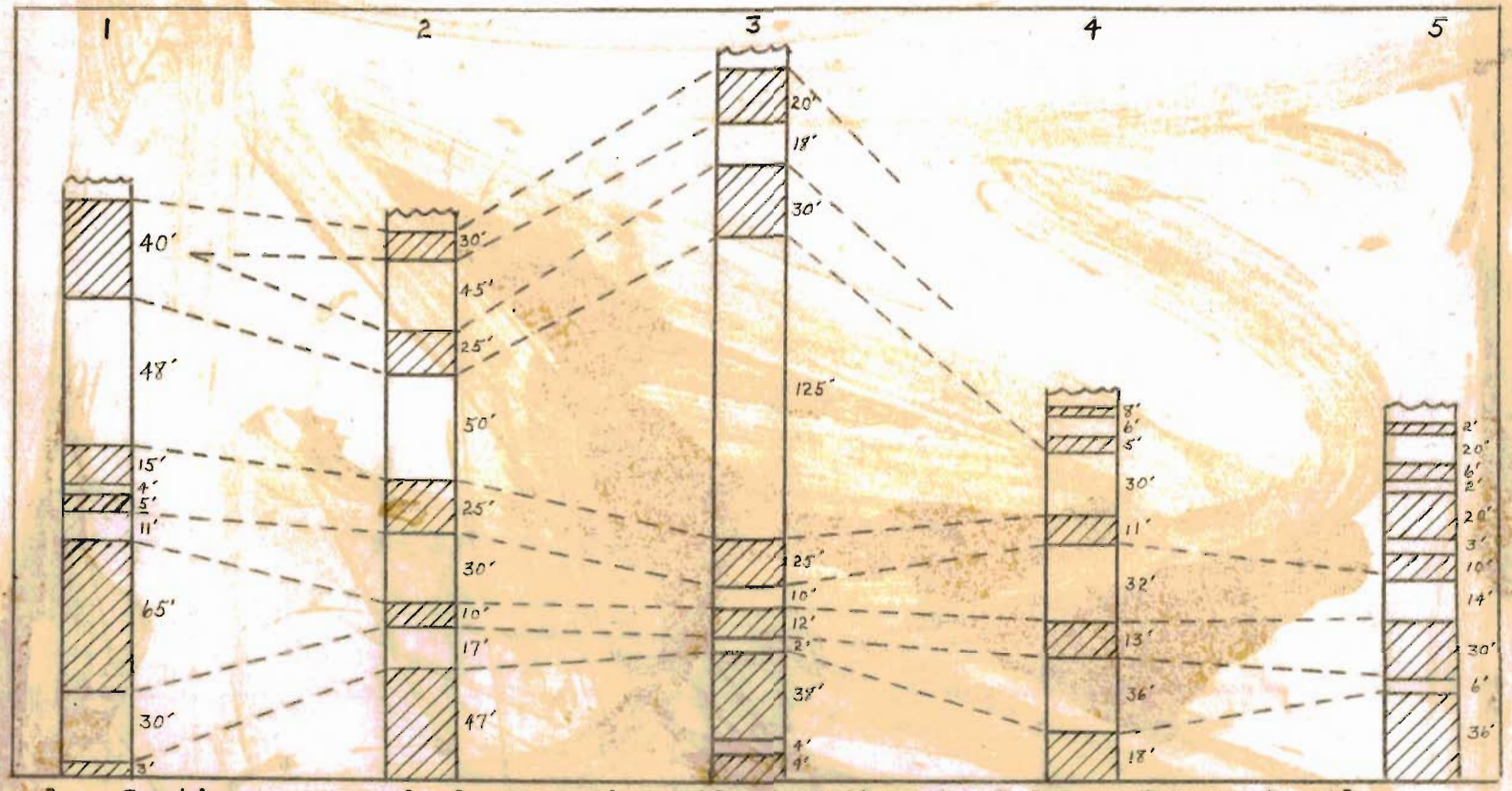
Lime.-- The Holston limestone which is an aggregate of calcareous beds, varies from 250 to 350 feet in total thickness. It rests upon cherty, knobby, argillaceous Lenoir limestones, and is overlain by the thin-bedded fossiliferous Ottosee formation. Within the Holstom may be found a wide variety of limy rocks, 3 types of which have commercial importance. The most common type is a fine-grained to grainy, dark to medium-gray, thin-bedded, argillaceous limestone. It forms about one-fourth of the volume of the Holston limestone, and it is not essentially different from the beds of the underlying Lenoir or overlying Ottosee formations. In chemical composition it maintains an average of about 70 to 85 percent of calcium carbonate, and from 8 to 20 percent of insoluble silica. (See Table 5.) When mixed with purer beds, the stone is wholly satisfactory for lime production. However, unless alumina is present in addition to the silica, it is unsuitable for cement purposes. Table 5, which follows, shows the average chemical character of the Holston limestone.
(Insert Table 5 here)

The second type of Holston limestone is a medium to light-gray, evenly crystalline massive limestone that is relatively free from cherty or siliceous impurities, It carries a small percentage of clayey minerals, and contains from 80 to 90 percent of pure calcium carbonate; it may be used for lime.

The third variety is a coarsely crystalline, massive, light-gray to reddish rock that contains from 90 to 98 percent of calcium carbonate. It is the purest of all local limestones, and constitutes one-fifth to one-fourth of the bulk of the Holston formation. It is as easily recognized by its coarse texture as by its pink or cho-

Sections of Holston Limestone in Scott County, Virginia

Measured from the top of the Lenoir formation; coarsely crystalline beds of pure limestone shaded.



1. Section measured along road 4 miles southwest of Speer Ferry, 1 mile southeast of Clinch River.
2. Section along railway near Speer Ferry.
3. Section at Marcem Quarry, 1 mile west of Gate City.
4. Section along Moccasin Creek, 1 mile east of Whiteforge.
5. Section along Moccasin Creek, between Snowflake and Flat Rock.

Figure 10

(near manuscript page 18)

colate color. The individual beds of this limestone range through the entire formation and occur in lenses some of which are more than 50 feet thick.

The writer measured more than 20 detailed sections of the Holston limestone in Russell and Scott counties in the hope of determining if the valuable limestones occurred at any persistent horizons within the formation. Study of these measurements indicates that the pinkish or light-gray, coarsely crystalline beds are lenticular in extent. Although one or more zones may be expected in all outcrops of the formation, they vary in thickness and position from place to place in such fashion as to render almost impossible any exact correlation of individual strata. (See Fig. 10)

The Holston limestone crops out in two local belts[1].

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1. Bassler, R.S., Cement resources of Virginia west of the Blue Ridge: Virginia Geol. Survey Bull 2A, pp. 202-237, 1909.

(See Fig. 7.) The southernmost is followed by Moccasin Creek from Russell County to Gate City, and by Little Moccasin and Troublesome creeks from Gate City to Speer Ferry, whence it continues southwestward into Tennessee. The northern belt which is followed by Copper Creek from Russell County to Clinch River, continues between Big Ridge and the River Knobs to pass near War Gap in Tennessee. Except for the point where it crosses Clinch River, the northern belt is somewhat inaccessible to rail transportation, although it may be easily reached by road in many places, especially near Nickelsville and Wayland. The southern belt is accessible by road along its entire length east of Speer Ferry, and is followed by the Southern

Railway for 9 miles between Speer Ferry and Gate City.

Argillaceous limestone-- As previously indicated, pure limestone is not the sole requisite for the manufacture of cement, and a body of clayey, or argillaceous material is also necessary. In a few rocks, known as natural cements, the original composition of the stone supplies both lime and clay in the proper proportions, but no rock of this kind is known in the county. Normally it is necessary to mix relatively pure limestones with less pure, argillaceous, stone to provide the desired composition, and either limy shales or shaly limestones may be used for this mixture.

Several formations contain stone suitable for admixture with pure limestones for cement purposes. (See Tables 6 and 7, and Plate 1.) The more important are the shaly Ordovician formations--including the Ottosee, Moccasin (Pl.12,B), and Matinsburg formations, which immediately overlie the Holston limestone. Primarily to qualify for cement use, the shaly beds must be physically free from sand, chert, and flint and chemically free from magnesia and excess silica. Most of the rock of the Ordovician shales meets this requirement, and beds of almost any desired composition can probably be found. As the composition of the argillaceous material necessary for cement manufacture depends upon the grade of pure limestone used, it is not possible to anticipate which members of the Ordovician shaly limestones will be most usable. Nevertheless, as all grades of stone from pure limestone to shale are present, there should be no difficulty in obtaining the proper ingredients for any necessary mixture. Other formations, including the Nolichucky and Rogersville shales, and possibly some of the Mississippian formations, might

Table 6

ANALYSES OF ROCKS (Part 1)

SCOTT COUNTY, ~~VIRGINIA~~

	1	2	3	4	5	6	7	8
Silica, or Insoluble	89.52	41.72	3.88	2.58	87.48	31.22	35.06	31.7
Al_2O_3 } → Fe_2O_3 }	7.22	5.68	1.36	1.12	1.32	6.20	1.90	1.8
CaCO	0.40	17.32	46.22	30.80	3.60	21.41	29.16	35.7
$CaCO_3$	0.72	30.93	82.53	55.00	6.42	38.23	52.07	63.8
MgO	1.05	9.17	5.62	19.70	1.76	10.90	5.33	0.9
$MgCO_3$	2.21	19.29	11.80	41.37	3.70	22.89	11.20	1.9
Total	99.67	97.62	99.57	100.07	98.92	98.54	100.23	99.4

(J. H. Gibbony,

1. Sandy shales; middle part of Rome formation; Clinchport
2. Brown, clayey shale; upper Rome formation; Clinchport.
3. Gray limestone; basal Rutledge formation; Clinchport.
4. Dark limestone; upper Rutledge formation; Clinchport.
5. Sandy shale; lower Rogersville shale; Clinchport.
6. Calcareous shale; upper Rogersville shale; Clinchport.
7. Black, cherty limestone; Maryville limestone; Clinchpor
8. Black, cherty limestone; Maryville limestone; Clinchpor
9. Blue, crystalline limestone; Maryville limestone; Clinc
10. Grayish, subcrystalline limestone; Maryville limestone;
11. Rather pure, blue limestone in Nolichucky shale; Clinch
12. Bluish-gray limestone; Copper Ridge dolomite; Clinchpor
13. Gray, dolomitic limestone; Nittany dolomite; Clinchport
14. Purer gray limestone; Nittany dolomite; Clinchport.
15. White, argillaceous limestone; Bellefonte dolomite; Spe
16. White, argillaceous limestone; Bellefonte dolomite; Spe
17. Dove limestone; Mosheim limestone; near Mendota, Washin
18. Average of analyses 1-17.

1. Bassler, R.S., Cement resources of Virginia we
Virginia Geol. Survey Bull. 2A, pp. 22

(Combine with table 7.?)

(near manuscript page 119)

Table 7

(Combine with Table 6?)

ANALYSES OF ROCKS (Part 2)

SCOTT COUNTY, ~~VIRGINIA~~

	1	2	3	4	5	6	7	8	9	10	11	12	13	14 Average
Silica or Insoluble	9.48	32.24	34.28	28.86	39.20	23.48	7.08	33.40	55.60	55.55	7.72	10.40	8.56	26.65
Al_2O_3 } →	2.34	4.50	4.96	4.40	5.80	3.86	1.88	4.92	7.60	8.37	0.68	0.72	1.00	4.25
Fe_2O_3 }														
CaO	49.12	33.96	31.88	35.96	29.20	39.44	50.60	32.86	18.20	18.41	50.20	48.64	49.24	37.52
$CaCO_3$	87.71	60.64	56.92	64.26	52.16	70.53	90.36	58.68	32.50	32.88	89.64	86.85	87.92	67.00
MgO	0.35	0.25	0.68	0.55	0.07	0.09	0.41	0.18	0.61	0.72	0.89	0.86	0.88	.50
$MgCO_2$	0.75	0.53	1.44	1.17	0.15	0.18	0.87	0.38	1.29	1.51	1.87	1.71	1.85	1.05
Total	100.28	97.91	97.60	98.69	97.31	99.05	100.19	97.38	96.99	98.31	99.91	99.78	99.33	98.67

(J. H. Gibboney, analyst [1])

1. Heavy, argillaceous limestone; Ottosee formation; near Mendota, Washington County.
2. Impure, red, clayey limestone; Moccasin formation; Gate City.
3. Red, argillaceous limestone; Moccasin formation; Speer Ferry.
4. Red, shaly limestone; middle Moccasin formation; near Mendota.
5. Thin limestone; lower (Trenton) Martinsburg formation; near Mendota.
6. Calcareous shale; lower (Trenton) Martinsburg formation; Gate City.
7. Thin, black limestone; lower (Trenton) Martinsburg formation; Speer Ferry.
8. Calcareous shale; lower (Trenton) Martinsburg formation; Speer Ferry.
9. Sandy shale; middle (Eden) Martinsburg formation; Speer Ferry.
10. Shale; upper (Maysville) Martinsburg formation; Gate City.
11. Massive, blue limestone; of Mississippian age; 2 miles southeast of Mendota.
12. Dove-colored limestone; of Mississippian age; 2 miles southeast of Mendota.
13. Dark-blue limestone; of Mississippian age; near Horton Summit.
14. Average of analyses 1-13.

1. Bassler, R.S., Cement resources of Virginia west of the Blue Ridge: Virginia Geol. Survey Bull. 2A, pp. 220-236, 1909.

Near manuscript page 119

serve as additional sources of cement material, if needed.

Tables 6 and 7, which follow, show the chemical character of the various rock types in Scott County.

(Insert Tables 6 and 7 here)

Present Developments

The commercial operation of local limestones has been undertaken by the Pennsylvania-Dixie Cement Corporation at 2 localities. The first operations were located at Speer Ferry in 1910, a short distance north of U.S. Highway 23-58 near the tracks of the Southern Railway. In 1918, the company moved its workings to Marcem, 1 mile west of Gate City, where they have been in continuous operation from November 1918 to the present time. A total volume of 2,987,634 tons of limestone had been removed at the Marcem quarry prior to August 1, 1935.[1]

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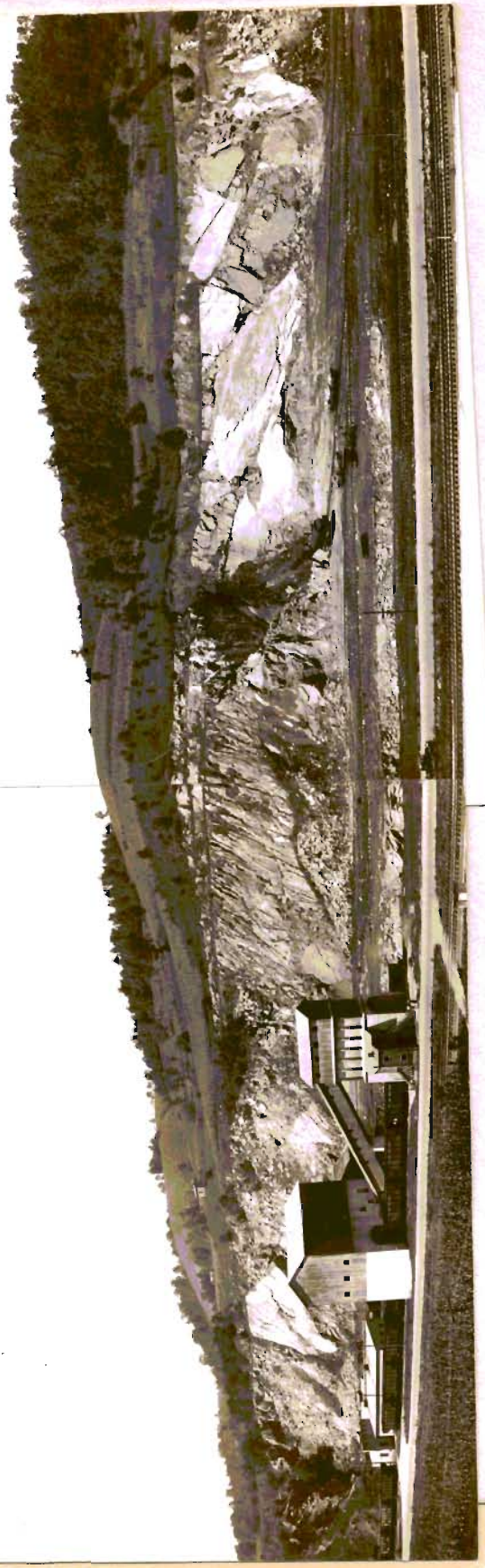
1. These data were furnished the author by Mr. N.V. Geyer, superintendent of the Company's plant at Kingsport, Tennessee.

Plate 18
(Near manuscript page 121)



Panoramic view of the Marcau quarry which is operated by the Penn-Dixie Cement Corporation, 1 mile west of Gate City. U.S. Highway 23 (and 58) is in the middle foreground of the view which faces north.
(See pages 48, 121, and 127.)

The Marcem quarry (Pl.18) consists of an immense open cut, extending for approximately a quarter of a mile north of, and along, the main highway, where it flanks a spur of Moccasin Ridge. (See Fig. 9.) Except for two deep pits, now filled with water, the quarry floor is at road level, and the workings extend northward for more than 400 feet into a hill where the central portion of the quarry exposes a face of rock more than 100 feet high. The workings range through the entire Holston formation from the Ottosee limestone, which is exposed along the main road at the west end of the cut, to the footwall of Lenoir limestone at the inner face of the main cut. The rocks are steeply inclined toward Clinch Mountain and dip toward the south at angles exceeding 50°; in places they are nearly vertical. At least 5 zones of pure coarsely crystalline rock have been utilized, and almost all of the stone exposed has been of sufficient quality for commercial use. The stone, which is crushed in a nearby mill, is transported on the Southern Railway to Kingsport, Tennessee by the company's rolling stock, where it is used at the local plant of the Pennsylvania- Dixie Cement Corporation for cement manufacture. Silica, which is also needed for cement, is obtained from deposits of sand along Holston River at Kingsport.

Limestone from this quarry maintains an average composition of about 87 percent calcium carbonate, 9 percent silica, 0.7 percent alumina, and 2.15 percent magnesium carbonate.(See also Table 5.) The rock which is of excellent grade and maintains a uniform quality, is readily available for quarrying and transportation. Considerable high-grade stone for chemical lime could be obtained by hand-picking the quarry output, or by restricting operations to purer

beds. A measured section at the quarry showed a maximum thickness of more than 330 feet for the entire Holston formation, with a total thickness of 117 feet of pure crystalline limestone. (See Fig.10)

Further Development of Lime and Cement Materials

It is probable that materials for lime and cement manufacture constitute the county's most valuable mineral resources, and that the strip of country along U.S. Highway 23-58 and the Southern Railway from Gate City to Speer Ferry can scarcely be rivalled in southwest Virginia for quality and abundance of cement materials, and for ease of transportation and quarry operation.

The volume of excellent limestone in the two belts of Holston limestone is sufficient to funish a score of operators with stone for a long time in the future. Transportation is readily available, and there are no known geologic conditions that might hamper commercial development.

Practically all of the rock is suitable for agricultural lime; much of it can be used for cement manufacture; lime for mortar is readily obtainable; individual beds are sufficiently pure for high-quality chemical lime; and material for the manufacture of calcium carbide (which requires a low-magnesia, high-calcium limestone) is likewise present. Under favorable economic conditions, the Holston limestone of Scott County could readily be made much more of a commercial asset than at present.

Clays and Shales

General Statement

Deposits of clay or beds of clay shale which are of potential value for brick or tile manufacture, should be considered as mineral reserves. The clay material may be derived (1) from an argillaceous bedrock such as shale, (2) from residual clayey soil, or (3) from stream-transported clay of floodplain origin.

In the manufacture of clay products, the natural material - whether it be clay or ground shale - is mixed with water, molded into the desired form, and then fired in a kiln. The physical factors of plasticity (or the ease with which it can be molded), the amount of water needed to produce the plasticity, and the shrinkage in drying, are items of importance in the ceramic industry. In general, clay should be readily plastic; it should need less than 25 percent water of plasticity, and should have an air shrinkage that is less than 5 percent in order to be satisfactory. Tests for fusibility or hardening must also be met. Normally a clay is tested at three temperatures: 950° Centigrade (known as Cone 010), 1,050° C. (known as Cone 05), and 1,150° C. (known as Cone 1). The behavior of the clay at each of these 3 temperatures, the amount of further shrinkage and the porosity of the brick are other factors which influence the choice of clay to be used. Miscellaneous features such as tensile strength, color of the fired brick, availability, and ease of mining also control the use of natural clays. (See Table 8.)

No commercial development of any clays has yet been undertaken in Scott County, where the most valuable clay formations are the Rome and Nolichucky shales of Cambrian age and the "Romney" and

Brallier formations of Devonian age.

Table 8 indicates the results of a series of physical tests made upon clay shales of Russell and Scott counties.

(Insert Table 8 here)

Table 8

Physical Tests of Clay Shales in Russell and Scott Counties, [redacted] [1]

Shale and Locality	Water Plasticity	Plasticity	Tensile Strength	Air Shrinkage	At Cone 010		At Cone 05		At Cone 1		Color
					Fire Shrinkage	Absorption	Fire Shrinkage	Absorption	Fire Shrinkage	Absorption	
Nolichucky shale at Castlewood	20.0	Fair	25.0	3.7	—	—	—	—	1.5	10.5	Pink
Russell shale at Carbo	21.0	Fair	25.0	3.3	0.0	13.6	1.7	7.4	4.7	3.8	Red
Brallier shale at Richlands	25.0	Good	80.0	4.8	0.0	15.7	1.6	10.7	5.0	0.4	Red
Brallier shale at Big Moccasin Gap	22.0	Fair	40.0	3.8	—	—	1.0	13.4	2.6	9.1	Red
Brallier shale at Oreton	20.0	Good	44.0	4.0	0.0	16.0	2.6	8.5	4.3	1.0	Red
Pennsylvanian shale at Dante	20.0	Good	—	4.4	0.0	18.0	1.6	13.0	—	—	—
Pennsylvanian shale at Dante	—	—	—	5.2	0.7	21.1	3.7	12.6	8.3	2.3	Red

[redacted]

1. Ries, H., and Somers, R.E., Clays and shales of Virginia west of the Blue Ridge: Virginia Geol. Survey Bull. 20, pp. 32-33, 88-92, 105-106, 1920.

Near monument page 125

Local Sources of Clay and Shale

The outcrop of Rome shales which is followed by the Clinchfield Railway from Clinchport to Dungannon (Pl.7,A) contains a number of beds of possible value for ceramic use.[1] Some of the

1. Ries, Heinrich and Somers, R.E.; Clays and shales of Virginia west of the Blue Ridge: Virginia Geol. Survey Bull. 20, pp.32-35, 1920.

beds when ground so as to pass through a 20-mesh sieve, produce a mass having moderate plasticity which can be fired into a good hard brick for building purposes. The shales near the railroad deserve to be tested for commercial development at whatever point the location of a plant would be most convenient. The Nolichucky shale which crops out along the northern crest of Copper Ridge is also a clay shale, although its location and general clay content are somewhat inferior to that of the Rome formation. (See Table 8.) It is possible that clay of fair grade might also be obtained from the Rogersville shale near Clinch River, or from the Ordovician shales near Cove Creek or along Clinch Mountain.

The belt of "Romney" and Brallier shale which is followed by the Southern Railway in Poor and Hilton valleys, contains beds that will furnish a clay suitable for brick manufacture.[2] (See

2. Idem., pp. 90-92.

Table 8.) The shales crop out at many localities, and are well developed near Hilton and Mace Spring. At Moccasin Gap where the shale is widely exposed, there are several beds that are suitable for use in the manufacture of hollow brick as well as for paving brick and sewer pipe. Mississippian shales, such as those near Powell Mountain north of Duffield, or shales of Pennsylvanian age associated with

the coal seams, may possibly prove to be additional sources of clay material, although they are inferior in quality to the shales previously mentioned.

Much of central Scott County is covered with a blanket of residual limestone or dolomite soil which has furnished material for small local kilns. Its thickness is not sufficient for the development of any extensive workings. There are no important deposits of floodplain clays in the county.

Summary

The development of some of the county's clay resources is a possibility worthy of consideration. The Devonian shales of Poor Valley and the Rome shales of Clinch Valley which are both adjacent both to rail transportation contain beds of usable grade. In the absence of large towns, the need for building brick has been supplied by kilns in adjacent counties. It might be a successful venture, however, to attempt the local development of such building material as the clay resources could provide. Other factors than those relating to the geology, however, should determine the advisability of such an undertaking.

Building Stone and Construction Materials

Scott County contains a number of rock formations from which limestone, sandstone, and marble suitable for building or rough construction work may be obtained. Sand for cement or concrete is also present.

Most of the calcareous rocks, including both limestone and dolomite, may be used for rough construction.(SeePl. 1.) They are readily crushed into stone for road metal, and many local quarries,the largest of which is at Glenita (Pls. 12,A and 17,B) have been opened upon their outcrops during the construction of local roads. As most counties in western Virginia also contain wide outcrops of limestone, there is a little opportunity to ship stone of this kind, for each area is largely independent of others for its supply of construction stone.

Certain of the thick-bedded limestones will furnish sized stone for building purposes. The Holston limestone (Pl. 18), for example, has already supplied stone that has been successfully used in several buildings in Gate City. Although the rock is pleasing in color and can be readily trimmed, there has been little commercial development. A short distance south of this county, a popular local building stone has been quarried from the Nittany and Copper Ridge formations, and its quarrying and practical use have been equally successful in Tennessee.As there is considerable variety of color and texture in the limestones within this county, a similar development might well be attempted.

Except for the Clinch formation which is less accessible than the analogous limestones, the sandstones of the county, although usable for rough road work or for walls, are not suitable for building purposes.

The Holston limestone, from which the pink "Tennessee marble" is derived, and the Bellefonte dolomite, which is the source of the "New Tennessee marble", are widely exposed in Scott County. (See Fig. 7.) Neither, however, has been developed for stone, and it is not likely that a profitable branch of the marble industry could be established in the county. The Holston formation contains many zones of stone that can be polished into satisfactory decorative material for interior work, but the local rock is not sufficiently massive, nor persistent in character to attract serious attention as a source of marble. Little is known about the possibility of utilizing the Bellefonte dolomite for marble. The rock has a pleasing, clean, pink color when freshly broken and will take a good polish. It is doubtful, however, if stone that is sufficiently attractive for use can be obtained in any quantity. Probably either formation could be drawn upon for use in Gate City and in the other towns of the county, but it would be a dubious venture to attempt any large-scale exploitation of Scott County marbles. Sand for the manufacture of glass and other purposes is derivable from the Clinch formation (pp. 129-131), but the bedrock is chiefly suitable for rough construction. Sand and gravel for concrete, although locally present, do not occur in large enough volume to attract attention as a source of revenue.

Silica Sand

General Statement

The term silica sand may be conveniently used to designate quartz sand designed for glass manufacture, abrasive use, or foundry and molding purposes, as opposed to sand or gravel for construction, cement, or concrete. In general, silica sand is composed of relatively pure quartz grains, free from clay, iron, or other impurities that can not be screened out to meet standard requirements. The grains should be of uniform size and should range between 30 and 120 mesh. Sand of this character may be derived from either loose quartzose sand, pure sandstone, or a pure quartzite. Although there are several formations which fall into this category, only the Clinch sandstone of Silurian age qualifies as a possible source of silica sand.

The Clinch formation is convenient to transportation facilities in its outcrop along Clinch Mountain (Pl. 6,A.), which is paralleled by the Southern Railway from Speer Ferry to Washington County, while the tunnel of the Clinchfield Railway penetrates the mountain between Speer Ferry and Kermit (Cassard Post Office). The formation contains several beds of cemented quartz grains which occur near the creast of the mountain. The rocks are granular in texture and have a friable or crumbly surface; they are dense and hard within. The slight amount of iron present is not sufficient to destroy the value of the sand for ordinary pane or bottle glass, nor to interfere with its use as foundry sand or for silica brick. The thickness of the workable beds is between 20 and 30 feet or approximately one-fifth of the total thickness of the Clinch formation.

Local Development

The Pennsylvania Glass Sand Corporation formerly operated a quarry on the southern slope of Clinch Mountain at a point about 9 miles southwest of Gate City, and an eighth of a mile west of the southern entrance of the Clinch Mountain tunnel of the Clinchfield Railway. The quarry is located about 500 feet above the level of Poor Valley, 1 mile northwest of Kermit Station (known also as Cassard Post Office).(See Fig.9.)

The original operations, started in 1920, were confined to a quarry not far from the right-of-way of the Clinchfield Railway above its tunnel. It was shortly found that quarrying operations interfered with a telegraph line above the tunnel, and the workings were moved to another point at the same level about 500 yards to the southwest. The second quarry consists of a large open cut 100 yards long with a quarry face more than 90 feet high; the latter extends to the actual crest of the ridge from which the rocks dip steeply southward at an angle of about 60°. The usable zones consist of a pure granular sandstone in which a peculiar fossil worm-boring, known as Arthrophycus, is abundant.

The sand was hauled on a narrow-guage tram to an incline near the original quarry, whence it was lowered to a crusher that was located one-third of the way down the mountain slope; from the crusher, the sand was lowered to the mill at Kermit. The original plant was an up-to-date mill where the sand was screened, cleaned, and sized. Much of the product was used for glass manufacture at Kingsport; some was shipped for abrasive use in the marble quarries of Tennessee; and some was sold for foundry sand. A variety of economic factors, which did not include lack of raw material, brought a halt to the operations in 1932. Not the least of these factors

was a vigorous complaint by residents of Poor and Opossum valleys to the accumulation of lost sand in the local streams. When operations ceased, the quarry was abandoned, the tracks and incline were torn up, and the mill was dismantled.

The Silica Sand Corporation of Hilton, Virginia formerly operated 2 quarries near the crest of Clinch Mountain about 2½ miles due west of Mendota and 1 mile north-northwest of Silica Station of the Southern Railway. (See Fig.9.) The location is about 1½ miles east of Washington County. The upper quarry is immediately below the crest of the mountain and is about 200 feet above the lower quarry. Both were opened near the base of the Clinch formation in white granular sandstones which are slightly stained with iron, but are sufficiently pure for any ordinary use to which silica sand is put. The workings were connected by an inclined tram-way, and both quarries were connected to a mill at the base of the mountain by an overhead cable by means of which the sand was lowered from a crusher located near the lower quarry. A large mill at Silica on the railroad housed equipment for screening, sifting, and sizing. Some of the sand was shipped for glass manufacture; some was made into silica brick in the mill. The silica quarries are not in present operation. The mill has not yet been dismantled, although the overhead cable, tramway, and crusher are in a bad state of repair.

Economic rather than geologic factors have been responsible for cessation of work at the two silica-sand quarries, for there is an ample supply of sand still present along the crest of Clinch Mountain. Transportation seems to be a simple problem, for between in the belt between Moccasin Gap and Cassard, the sand could be lowered to a railroad on either or both sides of the mountain, and from Moccasin gap eastward, it is in easy reach of the Southern Railway tracks on the south side of Clinch Mountain.

Table 9.

Flow of rivers, Russell and Scott counties[1]

Locality	Basin in square miles	Discharge records available	Gage height in feet		Discharge in second-feet		
			Maximum	Minimum	Maximum	Minimum	Mean
Clinch River at Cleveland	536	1920-1933	21.1	No record	15,000	50	724
Clinch River at Clinchport	1,000	1907-1909	18.8	No record	No record	131	No record
Clinch River at Spear Ferry	1,140	1920-1933	24.4	0.32	37,200	63	1660
Clinch River at Tazewell, Tenn	1,500	1927-1933	14.9	1.26	37,800	122	2,400
North Fork of Holston River at Mendota	500	1920-1931	14.4	1.47	19,600	38	683
North Fork of Holston River at Gate City	675	1931-1933	10.6	1.18	11,200	55	906

1. Grover, N.C., Surface water supply of the United States, Ohio River basin: U.S. Geol. Survey Water-Supply Paper 743, 1935

Near manuscript page 132.

WATER RESOURCES

Surface Waters

Scott County is well drained by a network of surface streams all of which are tributary to the Mississippi River system. The principal streams are (1) Clinch River (Pl 7,A.), whose main branches are North Fork, Copper Creek (Pl. 5,B), and Stony Creek, and (2) North Fork of Holston River, with two large tributaries, Moccasin and Opossum creeks. Considerable potential water is available, but there has been little attempt to make use of it.

Clinch River follows a southwesterly course across the county and maintains an average flow at Speer Ferry (below the mouth of Copper Creek) of about 1,600 second cubic feet of water per second. (See Table 9.) North Fork of Holston River below the entrance of Moccasin Creek has an average flow of about 950 second feet per second, (See Table 9.) Clinch River falls about 4 feet per mile, thereby theoretically producing about 760 horsepower per mile. North Fork of Holston River, with a fall of about 7 feet per mile, theoretically generates about 600 horsepower per mile. In neither case, of course, is the total estimated amount of power available. For the Clinch basin as a whole, the run-off is about 44 percent of the total rainfall; the remainder of the rainfall sinking underground or becoming lost by evaporation. In the basin of Holston River, the runoff carries 41 percent of the rainfall. The flow of both rivers fluctuates considerably in volume, although disastrous floods are uncommon. Table 9 shows the flow of the main rivers in Russell and Scott counties.(Insert Table 9 here.)

A number of "roller" mills are located along the smaller

streams where there are many desirable sites for such operations. Except for these mills, none of the surface run off has been used for power.

As there are few towns and many springs in the county, the supply of water for drinking or domestic use presents no problem. In the event that additional water should be needed to supply a large local community, it is possible that the valley of Little Stony Creek might be converted into a reservoir. A dam advantageously placed between the jutting ledges of Lee sandstone 1 mile above Dungannon (Pl 17,A) might be made to impound a considerable volume of water which could be led by gravity flow to the point of distribution. Any attempt to utilize the basin, however, should be preceded by a careful examination of the porosity of the Lee sandstone and a survey of methods to control the purity of the water. Some of the upper tributaries of Stony Creek could also be impounded into small reservoirs for urban use.

Table 10, which follows, shows the results of several analyses of water from Russell and Scott counties.

(Insert Table 10 here)

Table 10

Analyses of Water, Russell and Scott Counties, [redacted] [1]

(F. H. Fish and J. A. Addlestone, analysts)

Composition		Surface Streams				Town Supplies	
		1 Holston River	2 Clinch River	3 Copper Creek	4 Cedar Creek	5 Gate City	6 Lebanon
Parts per Million	Silica	7.0	4.4	16.2	5.0	17.2	7.2
	Iron + Alumina	1.2	2.2	3.4	2.0	2.6	1.0
	Calcium	19.9	28.0	37.3	44.5	42.0	34.2
	Magnesium	9.9	7.8	9.9	7.4	20.3	19.9
	Sodium	1.63	4.85	0.5	11.1	None	14.5
	Bicarbonates	106.3	115.0	147.6	133.3	211.8	155.8
	Sulphates	3.28	11.5	1.6	6.5	1.9	5.0
	Nitrites	.01	.001	.05	.006	—	.001
	Nitrates	0.75	0.48	0.10	0.6	0.092	0.6
Total dissolved solids		91.8	122.0	166.5	174.5	193.5	171.5
Total hardness (calculated)		90.3	102.0	133.8	137.1	188.0	163.7
Suspended matter		—	—	448	—	—	—
Turbidity		20	None	800	None	None	None

1. Holston River.
2. Clinch River at St. Paul.
3. Copper Creek near Nicklesville.
4. Cedar Creek near Lebanon.
5. Tap water in Gate City.
6. Tap water in Lebanon.

[redacted]

1. Industrial surveys of Scott and Russell counties, Virginia: Southwestern Virginia Inc., 1924 and 1930.

Near manuscript page 134

Sub-surface Water

Scott County is favored with an abundance of springs which furnish most of the water for domestic use. Although there are few large springs, the distribution and abundance of small springs in all parts of the county insure a steady supply of excellent drinking water. Such other phenomena as sinks, caves, and Natural Tunnel (Pls. 8,B and 9,A), also testify to a considerable underground circulation, and suggest that water may be reached at almost any point by deep wells.

Gate City is supplied with water from a group of springs located about 6 miles from the city. The water flows by gravity to a number of small reservoirs having a combined capacity of 120,000 gallons, whence it is distributed untreated throughout the town. (See Table 10.) The water supply is municipally owned.

(Insert Table 10 here)

There are a number of small mineral springs located south of Clinch Mountain in Poor Valley, of which Maces Spring, 4 miles east of Hilton, and Mountain Spring, near Yuma, are the best known. Small summer resorts formerly attracted many local visitors to these springs.

REFERENCES

There are few existing publications dealing with the geology of Scott County. Among the following list of titles may be found those which have been of most service in preparing this report, and which may profitably be consulted by the interested reader.

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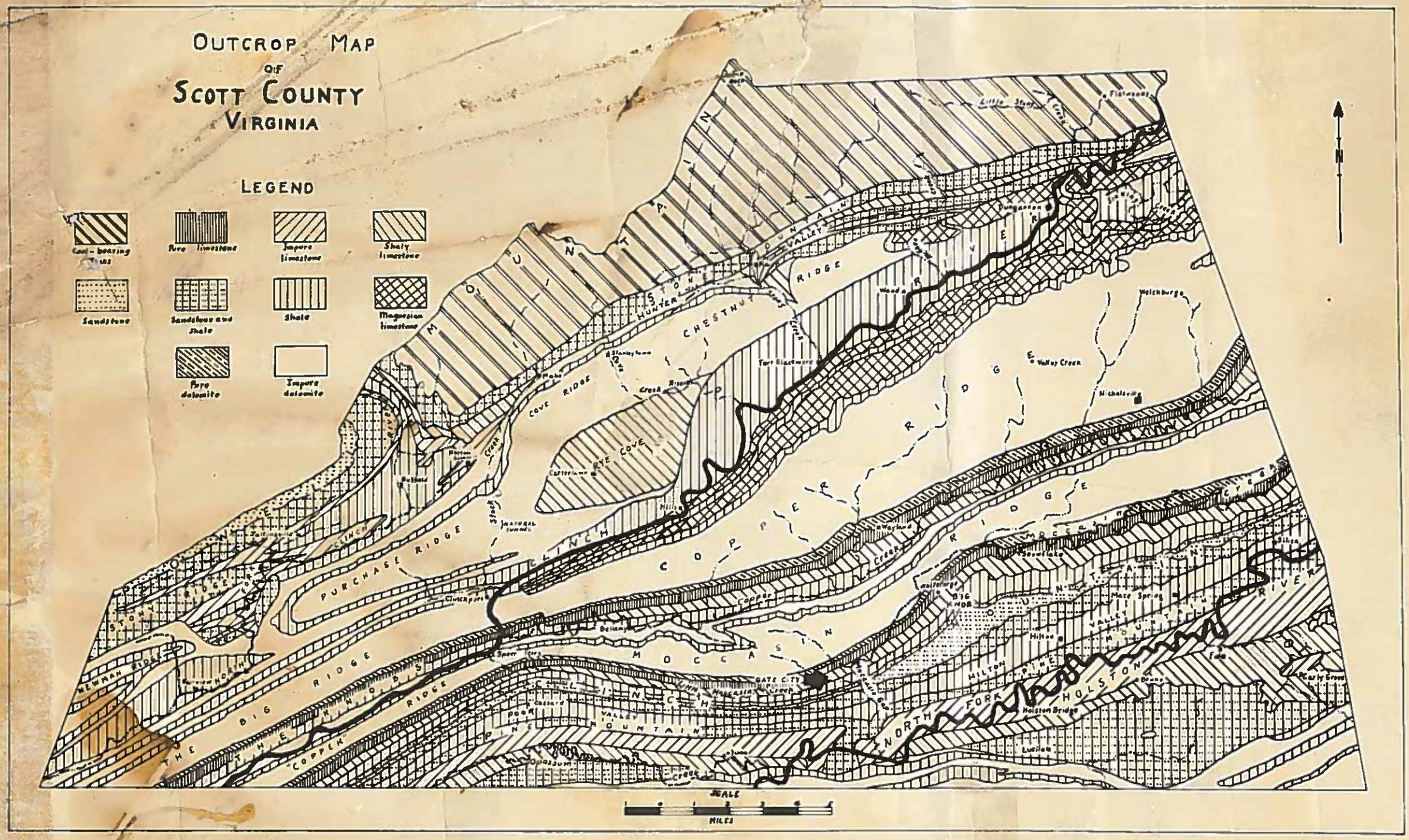
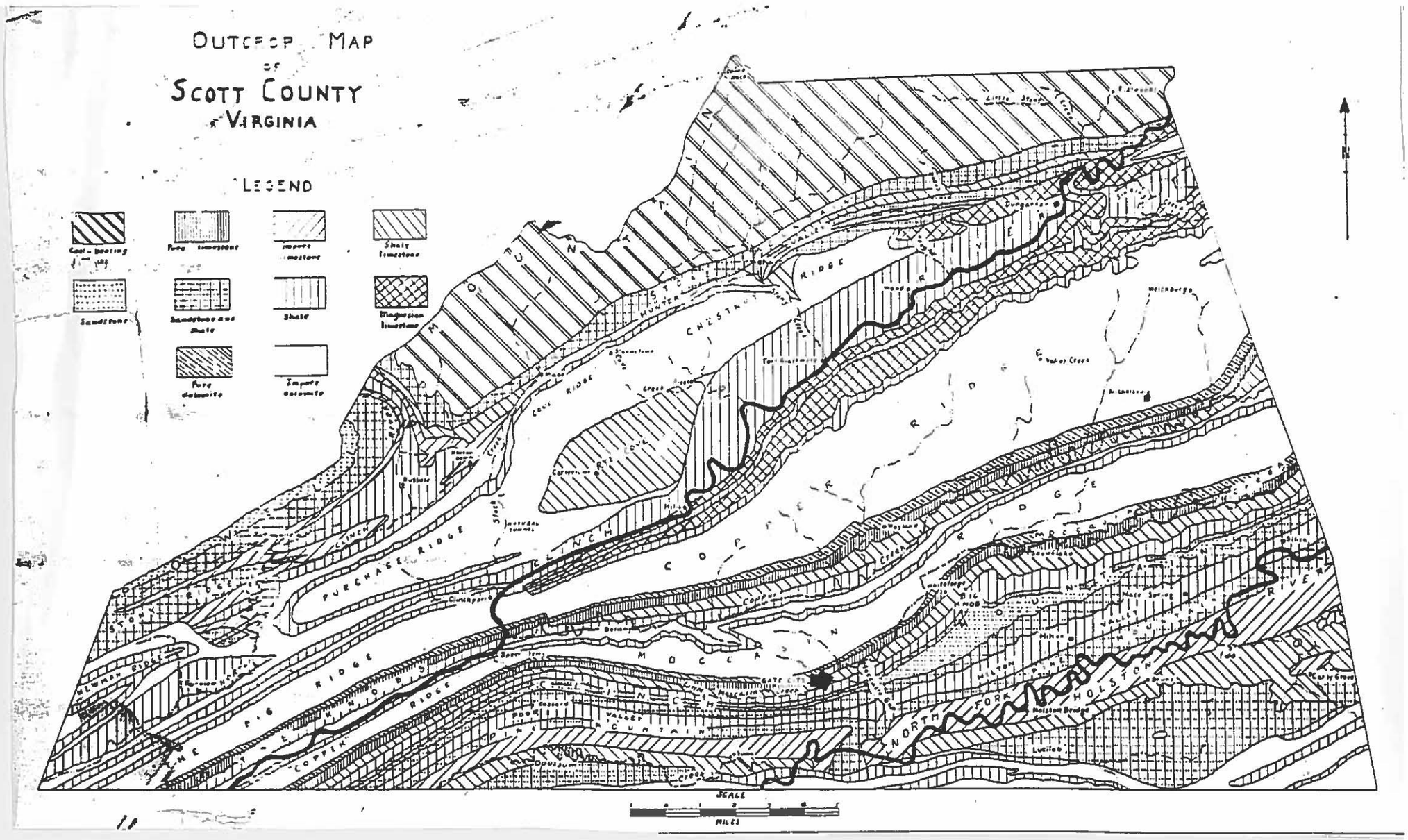

OUTCROP MAP
OF
SCOTT COUNTY
VIRGINIA
LEGEND
Coal-bearing strata
Pure limestone
Impure limestone
Shaly limestone
Sandstone
Sandstone and shale
Shale
Magnesian limestone
Pure dolomite
Impure dolomite
N
SCALE
MILES
MOUNTAIN
CHESTNUT RIDGE
COVE RIDGE
EYE COVE
PURCHASE RIDGE
COPPER RIDGE
MOCCASIN
BIG RIDGE
NEWMAN RIDGE
NORTH FORK HOLSTON RIVER
HOLSTON RIVER
Weedon
Valley Creek
Nickelsville
Weichburg
Gate City
Hilton
Hilton Pine
Holston Bridge
Lucilla
Mace Spring
Big Indian
Fort Blackmore
Dungannon
Fletcherville
Little Stony Creek
Clinchport
Speer Ferry
Dickenson
Cassard
Poor Valley
Pine Mountain
Opossum Creek
Copper Creek
Moccasin Creek
Stony Creek
Rose Creek
Mabe
Hunter
Stonetown
Bullard
Hilton
Silica
Bruce
Fox
Bear by Grove


OUTCROP MAP
OF
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Coal-bearing
Pure limestone
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