GEOLOGY AND MINERAL RESOURCES OF THE SCOTTSVILLE TRIASSIC BASIN, VIRGINI.

By

Harvey C. Sunderman

Spheroidally weathered boulder conglomerate in hydrothermally altered phase of the Ballinger Conglomerate, County Route 626, one mile south of Howardsville, Nelson County. Photograph by Allen Sinnott.

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DEPARTMENT OF GEOLOGY AND GEOGRAPHY
OLD TECH BUILDING

Oct. 2, '58

Dear Dr. Calver:

Concerning our 'phone call the other day, I forgot to tell you that my Triassic stratigraphic nomenclature: Tatier, Ballinger, Howardsville, and Hardware have not been pre-empted, and have been approved and reserved for my use by the Geologic Names Committee.

Sincerely,
Harvey Sundeen

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GEOLOGY AND MINERAL RESOURCES OF THE SCOTTSVILLE TRIASSIC BASIN, VIRGINIA[1]

By

Harvey C. Sunderman[2]

ABSTRACT

Scottsville Basin is a downfaulted erosional remnant of a Triassic alluvial apron. It is bounded on west, north, and east by normal fault zones with greatest displacement in the west. Faulting occurred before, during, and after formation of Triassic rocks.

The rocks in this alluvial apron constitute the Totier formation, a unit which is divided into three members: Ballinger fanglomerate, Howardsville member, and Hardware fanglomerate. The fanglomerates are heterogeneous, ill-sorted, immaturely-weathered, and lenticular and are typical of the post-orogenic piedmont facies. Volcanic rocks of the Howardsville member were extruded through the west fault zone and are: tholeiitic metadiabase feeder intrusives, and tholeiitic metabasalt flows, interbedded with metatuffs, and derived metasediments.

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[1] This report is based in large part on a paper presented by the author before the Southeastern Section, Geological Society of America, Morgantown, West Virginia, May 1957.

[2] Associate Professor of Geology, Graduate School of Arts and Sciences, University of Cincinnati.

The Totier sediments, derived predominantly from a western source area, were deposited as coalescing alluvial fans which reflect penecontemporaneous tectonism, sedimentation, and vulcanism. During sedimentation and vulcanism the apron was displaced relatively downward along the west fault zone. This faulting hinged along the east fault zone where subordinate movement occurred. As faulting continued in the west zone, successively younger rocks were deposited. The original dip of the older sediments and flows, and eventually of the younger, was gradually reversed to a west dip. Post-sedimentation post-vulcanism faulting has steepened the westward dip.

An irregular aureole of hydrothermal alteration follows the west fault zone and has altered the Hardware fanglomerate, Howardsville member, and westernmost portion of the Ballinger fanglomerate to the green-schist facies.

Post-hydrothermal tholeiitic diabase dikes which formerly cut across all fault zones have been severed by late movement along the west fault zone.

Brick clay, marble, trap, and various other rocks are of potential economic value. The ground water supply is adequate for domestic use.

INTRODUCTION

Location and Area

Seven isolated erosional remnants, all Triassic alluvial aprons, are present in Virginia. These lie in the Piedmont physiographic province, and extend in an irregular discontinuous belt across the State, entering it in Loudoun County at the Maryland border and leaving it in Pittsylvania County at the North Carolina line. These remnants are named: (1) Potomac, (2) Southern Potomac or Barboursville, (3) Scottsville, (4) Richmond, (5) Farmville, (6) Danville, and (7) Taylorsville (Pl. 2).

Scottsville Basin, the Triassic area considered in this report, is situated in central Virginia along the western side of the Piedmont physiographic province, approximately 10 miles east of the granitic rocks of the Blue Ridge Mountains. It has an area of 53.1 square miles, a length of 21.3 miles, in a northeast direction, and a maximum width of 3.8 miles. Included are parts of three counties: 36.9 square miles of southern Albemarle, 9.8 square miles of northwestern Buckingham, and 6.4 square miles of southeastern Nelson (Pl. 3). It lies in the southeastern corner of the Covesville quadrangle, the northcentral portion of the Howardsville quadrangle, and overlaps the southwestern edge of the Scottsville quadrangle.

Previous Work

Among the many 19th century papers concerned with the Triassic of Virginia, those of most importance were written by Rogers (1837, 1840, 1841, 1842, 1854, 1856), Heinrich (1878), Fontaine (1879), and Russell (1892). Though these contributed importantly to the knowledge of the Triassic of Virginia, insofar as this paper is concerned they are of historic background

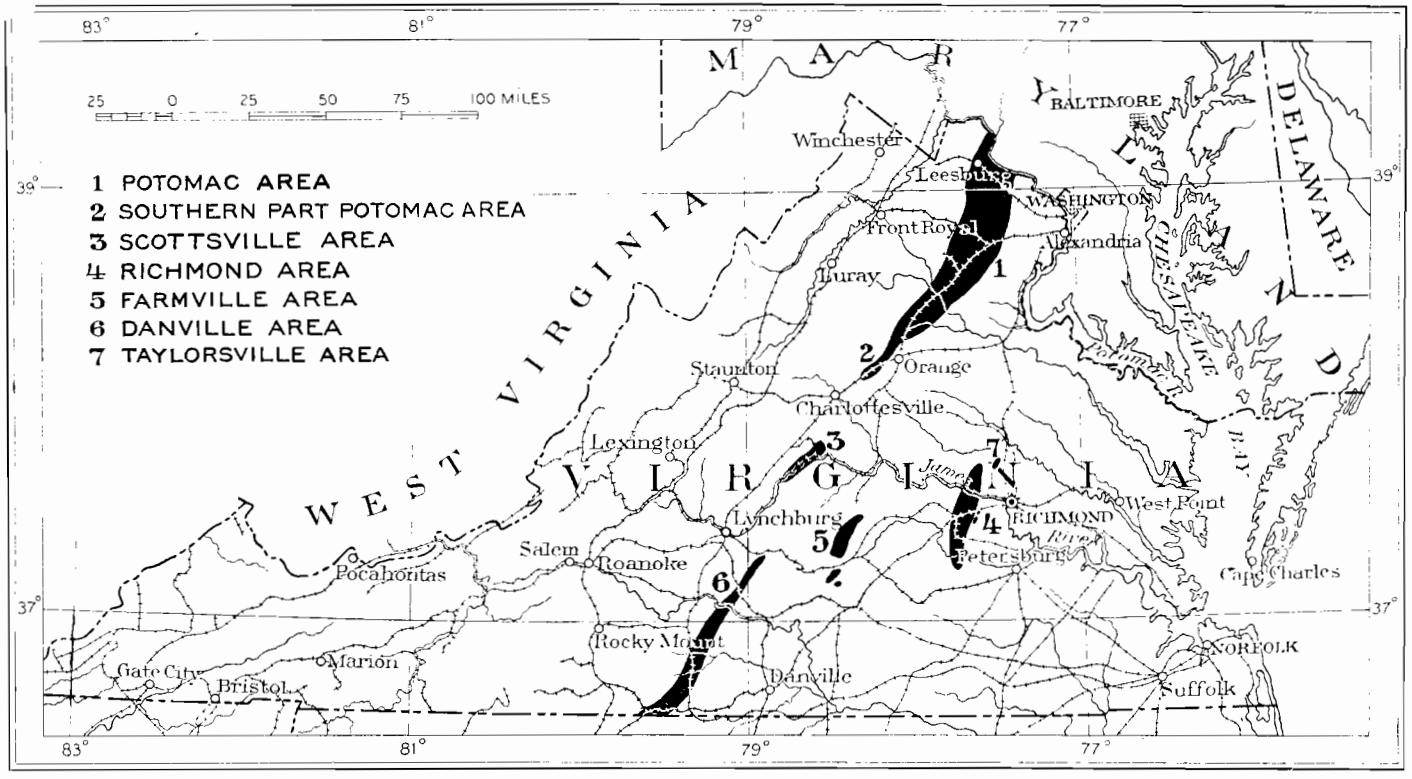

Plate 2. Sketch map of Triassic areas in Virginia (from Roberts, 1928, Pl. 6).

interest only.

A more recent work dealing with the Virginia Triassic is that of Roberts (1928) who described the stratigraphy, sedimentation, structure, paleontology, and economic geology.

Parts of Roberts' work directly concerned with Scottsville Basin are considered elsewhere in the text. Although the writer does not agree with some of Roberts' interpretations, the value of his work is distinctly recognized.

Drainage and Topography

James River, the major stream of the region, flows in a meandering course northeasterly through Scottsville Basin from its entry at Midway Mills to its exit point about half a mile beyond Warren (Pl. 3). A secondary stream, Hardware River, flows southeast across the northern end of the basin and enters James River 12 miles east of the map area. Rockfish River, also a secondary stream, crosses the western boundary of the basin and flows northeast one and three-quarter miles to Howardsville where it also enters James River. Another secondary stream, Totier Creek, enters Scottsville Basin in the vicinity of Glendower, flows diagonally across the basin and joins James River 2 miles east-northeast of Hatton. The numerous smaller tributary streams in general show a dendritic drainage pattern.

Scottsville Basin is a gently rolling lowland surrounded by a higher rolling upland of pre-Triassic rocks.

Within the basin three levels are rather vaguely apparent. The lowest and most distinct of the three, comprising the flood plains of James, Rockfish, and Hardware rivers, averages about 300 feet in elevation.

The highest level, about 500 feet in elevation, forms a discontinuous linear ridge along the western side of the basin. Locally, this ridge is littered with gravels that were deposited in the James River flood plain when it stood at the older higher elevation. These high-level gravels are underlain by hydrothermally altered conglomerates, volcanic rocks, graywackes, and mudstones. The intermediate and least distinct level has an elevation of approximately 400 feet and is underlain predominantly by poorly-resistant unmetamorphosed conglomerates, graywackes, and mudstones. In the southern part of the basin a horst of pre-Triassic crystalline rocks stands at the highest level as an elongate "island" above the two lower levels.

Field Work and Laboratory Investigation

Approximately 150 days were spent in the field during June, July, and August, 1953 and 1954 while the writer was working as a seasonal field geologist for the Virginia Division of Mineral Resources. Further study and laboratory work followed in 1954 and 1956 at the University of Cincinnati. The entire basin was mapped in detail on aerial photographs using stereographic pairs on the scale of approximately 1666 feet to 1 inch.

Acknowledgements

The writer is grateful to the Virginia Division of Mineral Resources and to the Graduate School of Arts and Sciences of the University of Cincinnati for the financial support of the field and laboratory work upon which this paper is based. He is indebted to his colleagues in the Department of Geology of the University of Cincinnati and to the technical and clerical staffs of the Virginia Division of Mineral Resources. In this respect, he is especially indebted to Nellie Rich, William Jenks, and

Raymond Edmundson for help with the manuscript; William McGill, former Virginia State Geologist, for directional guidance during the period of field work; and James L. Calver, Commissioner of the Division of Mineral Resources, for authorization to publish this manuscript and for expediting certain clay and rock analyses.

The writer was ably assisted in the field by Thomas Kingery in 1953 and Daniel Keller in 1954.

Special thanks are due the many residents of the map area who rendered assistance and supplied valuable information during the periods of field work.

STRATIGRAPHY

Pre-Triassic Rocks

From west to east, and from oldest to youngest, the pre-Triassic rocks outside Scottsville Basin comprise the pre-Cambrian granitic gneisses of the Blue Ridge Mountains; pre-Cambrian Lynchburg gneiss; pre-Cambrian Catoctin volcanic schists; and the Cambrian or Ordovician Evington group which from oldest to youngest includes the Candler phyllite, Archer Creek marble, Mount Athos quartzite, and Slippery Creek volcanic schists. A full discussion of these pre-Triassic rocks is outside the scope of this paper, but mention of them is made here for two reasons: first, the Triassic rocks unconformably overlie the Evington group, and/or are in fault contact with that group; and secondly, the Triassic sedimentary rocks were in part derived from all the aforementioned pre-Triassic rocks, particularly from the Evington group.

Triassic Rocks

General Statement

Scottsville Basin is a downfaulted erosional remnant of a Triassic alluvial apron which reflects penecontemporaneous tectonism, sedimentation, and vulcanism. The Triassic rocks within the basin are typical of the postorogenic piedmont facies. They comprise a wide variety of lithologic types that can be divided into four mappable units, three of them members of the Totier formation, -- the Ballinger fanglomerate*,

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*As understood in this report, a fanglomerate is composed of heterogenous materials which were originally deposited in an alluvial fan and which have later become cemented (Bryan, 1922, p. 88, and Lawson, 1913, pp. 328-344.).

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the Howardsville member, and the Hardware fanglomerate, ---- and the fourth, the late tholeiitic diabase dikes. The Totier formation and its three members are newly defined in this paper.

Redefinition of Stratigraphy

According to Roberts (1928, pp. 24-25), the Triassic rocks in Scottsville Basin are, from oldest to youngest and in order of outcrop from the east and west margins to the center of the basin, as follows: Border conglomerate, Manassas sandstone, and Bull Run shale. During the early phases of the present study this interpretation was followed by the writer;

however, it became apparent in the course of very detailed field work that this sequence needed modification. Study of the measured section across the Ballinger fanglomerate member ("Border conglomerate", "Manassas sandstone", and Bull Run shale" of Roberts) will serve to make this point (Table 1, pp. 11).

The outstanding characteristic of this section is its extreme heterogeneity. The lithologic alternations and variations shown are incompatible with the separation of three lithologically distinct formations as Roberts' "Border conglomerate", "Manassas sandstone", and "Bull Run shale". Throughout the section the individual beds are invariably lenticular and grade laterally and vertically as would be expected in a piedmont environment of sedimentation where alluvial fans have converged and interfered with each other at their confluent margins -- thus reflecting a single distinct environment of sedimentation wherein lenses of coarse clastic sediments monotonously alternate with contiguous lenses of much finer grained material.

The name "Border conglomerate" has been rejected for use in the classification of the United States Geological Survey, probably because it lacks a geographic name and a specific type locality (Wilmarth, 1938, p. 238). The "Manassas sandstone" and "Bull Run shale" have geographic names and type localities in the Potomac Triassic Basin (Roberts, 1928, pp. 25 and 39), but it seems highly improbably that nonfossiliferous, continental, clastic rocks such as those of Scottsville Basin could be correlated with the rocks of the Potomac Basin with any degree of confidence. Therefore, the writer proposes a redefinition of the stratigraphy of Scottsville Basin. "Border conglomerate", "Manassas sandstone", and "Bull Run shale" have been abandoned and their place taken by a simple, more justifiable unit, here named the Ballinger fanglomerate member of the Totier formation.

The fact that the rocks of the Scottsville area are deeply weathered, and the area has relatively flat topography and a paucity of outcrops, makes it impossible to find for measurement a stratigraphic section across the Ballinger fanglomerate which does not include large covered intervals. The most nearly complete section is the one presented in table 1, pp. 11 , measured in large part along the Nelson and Albemarle Railroad where it follows the valley of Ballinger Creek. This is considered the type locality and the member derives its name, Ballinger, therefrom.

The Howardsville member of the Totier formation, a Triassic unit composed of metamorphosed volcanic and sedimentary rocks within Scottsville Basin, was previously unrecognized as such. Roberts (1928, Pl. 4) mapped this member as undifferentiated Cambrian schists, and Furcron (1935, Pl. 1) mapped a small part of it as thin greenstone flows within the pre-Cambrian Wissahickon formation. However, all the pre-Triassic greenstones within a 20-mile radius of Scottsville Basin (Slippery Creek volcanic schists and Catoctin volcanic schists) have been completely reconstituted by regional metamorphism and possess fabrics characteristic of regionally metamorphosed rocks (Pl. 4). Conversely, the metamorphosed Triassic volcanic rocks within Scottsville Basin have been subjected to a local Triassic hydrothermal metamorphism and are characterized by relic trachytic, ophitic, and amygdaloidal textures (Pl. 4). Also, clastic boulders derived from early phases of these metamorphosed Triassic volcanic rocks occur throughout the conglomerates of the Ballinger fanglomerate, while late feeders of these same volcanic rocks intrude the youngest exposed parts of the Ballinger fanglomerate. Furthermore, these interbedded Triassic volcanic and sedimentary rock fit structurally into Scottsville Basin. They are here named the Howardsville member of the Totier formation.

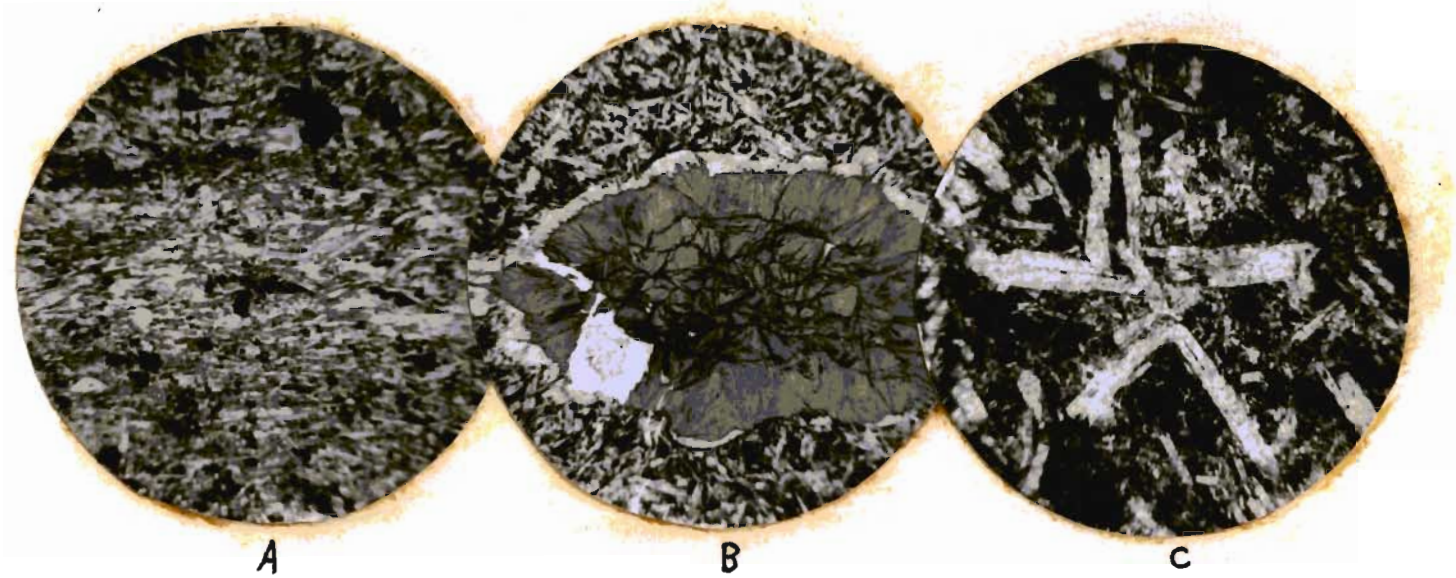

Plate 4 . Photomicrographs illustrating fabric differences between Triassic and pre-Triassic metavolcanic rocks in the Scottsville area.

A. Regional metamorphic fabric of a completely reconstituted basalt flow-rock of the pre-Triassic Catoctin greenstone schist, four miles west northwest of Howardsville, Albemarle County. Plain light. The irregular elongate string of opaque minerals in the center of the field measures .35 mm. Mineral constituents are albite, chlorite, calcite, epidote, quartz, sphene, leucoxene, and pyrite.

B. Relic amygdaloidal texture in metabasalt flow of the Howardsville ~~formation~~ member, one mile northwest of Howardsville, Albemarle County. Plain light. The amygdule measures 3.8 mm.in length. Mineral constituents are ~~[illegible]~~ altered plagioclase, albite, chlorite, epidote, quartz, magnetite, and leucoxene.

C. Relic ophitic texture in metadiabase feeder dike of the Howardsville ~~formation~~ member from Glendower, Albemarle County. Plain light. Large chloritized feldspar laths radiating from the center of the field average 1.27 mm. in length. Mineral constituents are ~~[illegible]~~ altered plagioclase, albite, chlorite, epidote, magnetite, leucoxene, and carbonate.

The Hardware fanglomerate member of the Totier in part overlies the Howardsville member and is the youngest Triassic sedimentary unit in Scottsville Basin. This fanglomerate has been shown on previous maps as undifferentiated Cambrian (Roberts, 1928, Pl. 4), and as pre-Cambrian Wissahickon schist (Furcron, 1935, Pl. 1). It fits structurally and stratigraphically with the other Triassic rocks of Scottsville Basin as can be told from the fact that it includes clastic chips of the pre-Triassic rocks from which it was derived. This Triassic fanglomerate has been slightly altered by hydrothermal metamorphism, and consequently has a fabric much different from the regional metamorphic fabric of the pre-Triassic rocks. The name Hardware fanglomerate is proposed for this member of the Totier formation.

The Totier formation includes all the Triassic rocks in Scottsville Basin except the late tholeiitic diabse dikes. The name Totier is taken from Totier Creek, a tributary of James River which flows in a meandering course diagonally across the basin (Pl. 3). The type locality is situated along Totier Creek from the stream's entry into the west side of Scottsville Basin near Glendower to the stream's emergence on the east side of the basin, 1.6 miles southwest of Scottsville.

The Totier formation is a genetic unit formed under uniform environmental conditions which were local and temporary. The members within this formation, the Ballinger, Howardsville, and Hardware are transgressive and coeval, but all three are mappable units, split from the Scottsville alluvial apron, the Totier formation, to make mapping practcable.

Detailed reasons for the redefinition of the stratigraphy and descriptions of the members of the Totier formation will be demonstrated in appropriate places in the remainder of the text.

Totier Formation

Ballinger Fanglomerate Member

The outcrops of the Ballinger fanglomerate lie between the east margin of the basin and the easternmost outcrops of the Howardsville member (Pl. 3). The type section is presented below.

Table 1

Geologic section of the Ballinger fanglomerate member of the Totier formation

(Measured in Ballinger Creek valley, Albemarle County, and in the bluffs of James River, Buckingham County, southeastward from the outcrop of the Howardsville member to the pre-Triassic boundary near Warren)

Volcanic rocks	Howardsville member	
Covered	A fault zone and zone of hydrothermal alteration; much boulder-conglomerate float	1030.1'
Red mudstone	Clay, silt, and fine sand	26.3'
Red conglomerate	Cobble-sized clastic particles of vein quartz, Evington quartzite, and metamorphosed Triassic volcanic rocks; sand and mud matrix	2.1'

Red mudstone	Clay, silt, and fine sand ----------	26.3'
Covered	----------	6.7'
Red graywacke	Sand-sized clastic particles of Evington phyllite and quartz; sorting and rounding poor; 35% mud matrix ----------	4.8'
Covered	----------	808.5'
Red conglomerate	Pebble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; 80% sand and mud matrix ----------	9.2'
Red mudstone	Clay, silt, and fine sand ----------	8.9'
Red conglomerate	Pebble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; 60% sand and mud matrix ----------	13.5'
Red graywacke	Coarse sand-sized particles of quartz, phyllite, and metamorphosed Triassic volcanic rocks; sorting and rounding poor; 20% mud matrix ----------	8.8'
Red conglomerate	Cobble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; 65% sand and mud matrix; thermally metamorphosed to a slight degree ----------	15.8'
Covered	----------	38.2'
Red conglomerate	Cobble-sized clastic particles of metamorphosed Triassic volcanic rocks and vein quartz; mud and sand matrix; thermally metamorphosed ------	20.0'

Diabase	Tholeiitic diabase dike ----------	109.8'
Covered	----------	115.9'
Red conglomerate	Cobble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix; slightly thermally metamorphosed ----------	12.5'
Red graywacke	Coarse sand-sized clastic particles of phyllite and quartz; 25% mud matrix; slightly thermally metamorphosed ----------	13.5'
Red conglomerate	Cobble-sized clastic particles of vein quartz, Evington quartzite, Evington phyllite, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix; slightly thermally metamorphosed ----------	23.5'
Red mudstone	Clay, silt, and fine sand ----------	18.6'
Red conglomerate	Pebble-sized clastic particles of vein quartz, and metamorphosed Triassic volcanic rocks; sand and mud matrix ----------	4.1'
Covered	----------	21.1'
Red conglomerate	Pebble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix ----------	27.0'
Covered	----------	1262.9'

Red graywacke	Coarse sand-sized clastic particles of phyllite, metamorphosed volcanic rocks, and quartz; sorting and rounding poor; 40% mud matrix ----------	8.7'
Red mudstone	Clay, silt, and fine sand ----------	16.6'
Red conglomerate	Granule-sized clastic particles of Evington phyllite, metamorphosed Triassic volcanic rocks, vein quartz, and Triassic graywacke; sand and mud matrix ---------	25.0'
Red mudstone	Clay, silt, and fine sand ----------	4.7'
Red conglomerate	Granule-sized clastic particles of vein quartz, Evington phyllite, and metamorphosed Triassic volcanic rocks; sand and mud matrix ----------	9.1'
Red mudstone	Clay, silt, and fine sand ----------	4.7'
Covered	----------	61.6'
Red conglomerate	Pebble-sized clastic particles of quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix ----------	10.5'
Covered	----------	190.7'
Red conglomerate	Pebble-sized clastic particles of vein quartz, Evington quartzite, metamorphosed Triassic volcanic rocks, Triassic graywacke, and Evington marble; sand and mud matrix---	20.9'
Covered	----------	59.2

Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 40% mud matrix ----------	10.7'
Red mudstone	Clay, silt, and fine sand ----------	22.4'
Red conglomerate	Pebble-sized clastic particles of metamorphosed Triassic volcanic rocks, vein quartz, and Triassic graywacke; sand and mud matrix ----------	27.5'
Red mudstone	Clay, silt, and fine sand ----------	25.0'
Red conglomerate	Pebble-sized clastic particles of vein quartz, phyllite, and metamorphosed Triassic volcanic rocks; sand and mud matrix ----------	13.3'
Red mudstone	Clay, silt, and fine sand ----------	5.1'
Red conglomerate	Pebble-sized clastic particles of metamorphosed Triassic volcanic rocks, Triassic graywacke, and vein quartz; sand and mud matrix ----------	5.1'
Red mudstone	Clay, silt, and fine sand ----------	1.1'
Red graywacke	Coarse sand sized clastic particles of phyllite, quartz, and metamorphosed volcanic rocks; sorting and rounding poor; 35% mud matrix ----------	6.3'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; rounding and sorting poor; 40% mud matrix ----------	22.6'

Covered	----------	66.2'
Red mudstone	Clay, silt, and fine sand ----------	10.0'
Red conglomerate	Pebble-sized clastic particles of quartz and phyllite; sand mud matrix ----------	6.0'
Red graywacke	Sand-sized clastic particles of quartz and phyllite; sorting and round poor; 20% mud matrix ----------	5.1'
Red mudstone	Clay, silt, and fine sand ----------	17.4'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 35% mud matrix ----------	4.8'
Red mudstone	Clay, silt, and fine sand ----------	6.7'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 45% mud matrix ----------	2.2'
Red mudstone	Clay, silt, and fine sand ----------	3.5'
Covered	----------	187.2'
Red mudstone	Clay, silt, and fine sand ----------	26.1'
Red conglomerate	Granule-sized clastic particles of Evington phyllite, metamorphosed Triassic volcanic rocks, and vein quartz; sand and mud ---------	4.0'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 25% mud matrix ----------	10.0'

Covered	----------	24.6'
Red conglomerate	Pebble-sized clastic particles of Evington phyllite, vein quartz, and metamorphosed Triassic volcanic rocks; sand and mud matrix ----------	40.2'
Covered	----------	30.8'
Red mudstone	Clay, silt, and fine sand ----------	15.2'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 45% mud matrix ----------	14.8'
Red mudstone	Clay, silt, and fine sand ----------	11.3'
Red graywacke	Coarse sand-sized clastic particles of quartz and phyllite; sorting and rounding poor; 50% mud matrix ----------	3.1'
Red mudstone	Clay, silt, and fine sand ----------	9.4'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 45% mud matrix ----------	3.5'
Red mudstone	Clay, silt, and fine sand ----------	34.3'
Red conglomerate	Granule-sized clastic particles of vein quartz, Evington phyllite, and metamorphosed Triassic volcanic rocks; sand and mud matrix ----------	19.9'
Red mudstone	Clay, silt, and fine sand ----------	32.0'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 35% mud matrix ----------	2.7'

Red mudstone	Clay, silt, and fine sand ----------	12.1'
Red conglomerate	Granule-sized clastic particles of vein quartz and metamorphosed Triassic volcanic rocks; sand and mud matrix ----------	5.1'
Red graywacke	Sand-sized clastic particles of quartz and phyllite; sorting and rounding poor; 70% mud matrix ----------	12.7'
Red conglomerate	Cobble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix ----------	6.1'
Red graywacke	Sand-sized clastic particles of quartz and phyllite; sorting and rounding poor; 75% mud matrix ----------	16.0'
Red graywacke	Sand-sized clastic particles of phyllite, quartz, and metamorphosed volcanic rocks; sorting and rounding poor; 20% mud matrix --	5.5'
Red graywacke	Silt-sized clastic particles; 70% mud matrix ----------	18.7'
Red graywacke	Coarse sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 25% mud matrix ----------	3.9'
Red graywacke	Silt-sized clastic particles; 60% mud matrix ----------	37.0'
Red conglomerate	Pebble-sized clastic particles of vein quartz and metamorphosed Triassic volcanic rocks; sand and mud matrix ----------	6.6'

Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 40% mud matrix ----------	37.4'
Red graywacke	Silt and fine sand-sized clastic particles; 20% mud matrix ----------	10.0'
Red conglomerate	Pebble-sized clastic particles of vein quartz and metamorphosed volcanic rocks; sand and mud matrix ----------	17.1'
Red graywacke	Sand-sized clastic particles of quartz, metamorphosed volcanic rocks, and phyllite; sorting and round poor; 50% mud matrix -----	9.7'
Covered	----------	436.2'
Red graywacke	Fine sand-sized clastic particles of phyllite and quartz; 70% mud matrix ----------	16.3'
Red graywacke	Sand-sized clastic particles of metamorphosed volcanic rocks, phyllite, and quartz; sorting and rounding poor; 40% mud matrix----------	12.5'
Red conglomerate	Pebble-sized clastic particles of metamorphosed Triassic volcanic rocks and vein quartz; sand and mud matrix ----------	4.8'
Red graywacke	Fine sand-sized clastic particles of phyllite and quartz; 35% mud matrix ----------	7.2'
Red conglomerate	Granule-to cobble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix ----	30.2'

Red graywacke	Sand-sized clastic particles of quartz and phyllite; sorting and rounding poor; 70% mud matrix ----------	9.6'
Red graywacke	Coarse sand-sized clastic particles of phyllite, quartz, and metamorphosed volcanic rocks; sorting and rounding poor; 35% mud matrix ----------	5.8'
Covered	----------	134.0'
Covered	James River alluvium ----------	208.0'
Covered	James River ----------	360.0'
Covered	James River alluvium ----------	306.0'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 35% mud matrix ----------	12.2'
Red graywacke	Sand-sized clastic particles of phyllite, quartz, feldspar, and epidote; sorting and rounding poor; 25% mud matrix ----------	64.8'
Red conglomerate	Granule-sized clastic particles of quartz, Triassic graywacke, and metamorphosed Triassic volcanic rocks; sand and mud matrix--	31.9'
Red graywacke	Sand-sized clastic particles of phyllite, metamorphosed volcanic rocks, and quartz; sorting and rounding poor; 45% mud matrix---	18.6'
Red conglomerate	Cobble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix ----------	4.6'

Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 40% mud matrix ----------	30.1'
Red conglomerate	Cobble-sized clastic particles of metamorphosed Triassic volcanic rocks, Triassic graywacke, and vein quartz; sand and mud matrix ----------	2.0'
Red mudstone	Clay, silt, and fine sand ----------	41.3'
Red conglomerate	Granule-sized clastic particles of metamorphosed Triassic volcanic rocks and vein quartz; sand and mud matrix ---------	11.0'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 70% mud matrix ----------	16.2'
Red conglomerate	Cobble-sized clastic particles of metamorphosed Triassic volcanic rocks, Triassic graywacke, and vein quartz; sand and mud matrix ----------	4.2'
Red graywacke	Sand-sized clastic particles of phyllite, metamorphosed volcanic rocks, and quartz; sorting and rounding poor; 55% mud matrix-----	5.8'
Red conglomerate	Cobble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, granite, and Triassic graywacke; sand and mud matrix ----------	11.0'

Red graywacke	Sand-sized clastic particles of phyllite, metamorphosed volcanic rock, and quartz; sorting and rounding poor; 60% mud matrix ----	2.1'
Red conglomerate	Cobble-sized clastic particles of vein quartz, metamorphosed Triassic volcanic rocks, and Triassic graywacke; sand and mud matrix ----------	2.9
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 65% mud matrix ----------	0.8'
Covered	----------	10.3'
Red graywacke	Sand-sized clastic particles of phyllite and quartz; sorting and rounding poor; 60% mud matrix ----------	5.4'
Covered	Fault zone contact Triassic and pre-Triassic	26.0'
pre-Triassic		

Scottsville Basin is characterized by very sparse outcrop and, as a consequence, at no place within the basin can all of the Ballinger be seen and measured. The above type section is by far the most nearly complete and best exposed section of the Ballinger in the mapped area. Much of its lower part is covered by James River and James River alluvium, and its uppermost part is a covered inter-fan area littered with boulder-conglomerate float. Several covered intervals within the section may include faults. The top, bottom, and other covered intervals cannot be filled by interjecting appropriate partial sections from other sectors of the basin because each measured section of Ballinger was found to be unique and could not be matched or integrated with any other. Thus, the type section of the Ballinger lacks

the classical stratigraphic significance customarily expected of such sections. This condition is inherent in a piedmont environment of sedimentation.

It is impossible to give a true thickness for the Ballinger fanglomerate because it is an erosional remnant of only a small part of a fossil alluvial apron. The top and bottom of the member are involved in a very complex fault zones on the east and west sides of the basin. It is poorly exposed and may be faulted in the covered areas. Thus, little can be said about the thickness of the Ballinger except that its maximum outcrop width is about 3.4 miles, and its average dip is approximately 30 degrees.

The Ballinger fanglomerate extends the entire length of the basin and reaches its maximum areal development in the east-central and north-eastern parts of the mapped area. It decreases in outcrop width southwestward from this sector and eventually is present only as isolated "islands" surrounded by pre-Triassic crystalline rocks.

The Ballinger fanglomerate unconformably overlies, or is in fault contact with, the pre-Triassic crystalline rocks of the Evington group. This contact is sedimentary for several miles along the extreme southern part of the east boundary of the basin; however, most of the contact between the Ballinger and the Evington is faulted and lies within border fault zones that surround the basin (Pl. 3). The faulting, which will be considered later, took place before, during, and after Ballinger time.

The time of genesis of the Howardsville member transgresses all of Ballinger fanglomerate time. This age relationship is verified by the fact that an appreciable percentage of the conglomerate lenses throughout the thickness of the Ballinger fanglomerate contain clastic fragments of metamorphosed Howardsville volcanic rocks, and that late flow-feeders within the Howardsville member are intrusive into the youngest part of the Ballinger.

An irregular zone of hydrothermal alteration follows the fault zone that borders the basin on the west and has altered the westernmost part of the Ballinger to the greenschist facies. Post-hydrothermal tholeiitic diabase dikes are intruded into the Ballinger and have thermally metamorphosed it locally. These metamorphisms and the dikes will be discussed more fully later in the text.

Apex areas of individual fans in the fossil Scottsville alluvial apron are clearly indicated by resistant thick boulder conglomerate lenses in the Ballinger. These apex areas lie along the Ballinger-Howardsville contact in the zone of hydrothermal alteration, and stand as topographic highs. Fan apex areas show a striking correlation with present subordinate drainage in Scottsville Basin; however, available field evidence indicates that the streams which deposited the Ballinger were short, steep, and probably consequent on the scarp of the west border fault zone, and thus bear no genetic relationship to the modern drainage pattern. Furthermore, it is well known that a Cretaceous overlap extended over the region and that present streams were consequent on its surface.

The clastic rocks that constitute the Ballinger fanglomerate are a heterogeneous, ill-sorted association of pebble- to boulder-conglomerate, arkose, sandstone, sand- to silt-sized graywacke, and mudstone. They show

extremely poor sizing and contain a large percentage of unstable, immaturely weathered clastic minerals and rock chips. In overall aspect, the Ballinger in fan areas within the alluvial apron is predominantly a monotonous succession of irregular, alternating graywacke and conglomerate lenses (Pl. 5A). From botton to top, the lenses of this fanglomerate member increase erratically in grain size from silt-sized graywackes and pebble conglomerates to sand-sized graywackes and boulder conglomerates. Also from oldest to youngest and east to west, the graywacke lenses thin progressively and the conglomerate lenses thicken, culminating in several hundred feet of boulder conglomerate. In continental clastic rocks like those of the Ballinger, no single section can typify the entire member. Since the type section was of necessity measured between fans in the Scottsville alluvial apron, it necessarily differs from the just-described characteristics of a fan area within the alluvial apron.

A traverse normal to the strike shows a monotonous repetition of graywacke and conglomerate, and creates an illustion of cyclic sedimentation (Pl. 5A). A traverse parallel to the strike or an attempt to integrate contiguous measured stratigraphic sections brings to light the lenticular nature of the Ballinger.

Many types of rock, too numerous in number and too small in outcrop area to be considered separately, constitute the Ballinger fanglomerate. This is a condition to be expected in an alluvial apron; consequently, only the most common, graywacke and conglomerate, will be described.

The brick-red graywacke is composed of sharply angular, poorly sorted, immaturely weathered fragments choked with a hematite-stained, argillaceous

Plate 5

B

A. Alternation of graywacke and conglomerate lenses typical of the Ballinger fanglomerate, Ballinger Creek, Albemarle County.

B. Metamorphosed conglomerate lens in Ballinger fanglomerate, a quarter of a mile northeast of Howardsville, Albermarle County. Conglomerate is so firmly united because of the Triassic hydrothermal alteration that fracture takes place across clastic boulders of diabase, basalt, and quartzite instead of around them. Photograph by Allen Sinnott.

matrix. The matrix commonly constitutes about 35 percent by volume of the rock, but extremes of 15 to 80 percent are not uncommon. The clastic sand-sized to silt-sized fragments are dominantly quartz and phyllite chips. Clastic grains of epidote, feldspar, and metamorphosed Triassic volcanic rock chips are present in relatively small amounts.

Fresh, unmetamorphosed conglomerate is composed of an unsorted aggregate of sharply angular to poorly rounded fresh rock fragments within a hematite-stained sand and mud matrix. Generally this brick-red matrix constitutes about 40 percent by volume of the rock but extremes up to 80 percent are common. The coarse clastic fragments vary in size from granules to six-foot boulders and consist for the most part of metamorphosed Howardsville volcanic rocks, Evington phyllite, vein quartz, and reworked Ballinger fanglomerate graywacke. Less commonly pieces of Lynchburg gneiss, Blue Ridge granitic rocks, Catoctin greenstone, and Evington marble and quartzite are present.

Sporadically developed in the top of the Ballinger fanglomerate are zones of unknown thickness where boulder conglomerate lenses have been cemented by tholeiitic metadiabase of the Howardsville member. Superimposed upon these zones of metadiabase cement and extending as much as 3000 feet beyond them is a part of the irregular aureole of hydrothermal alteration in which both the metadiabase-cemented zones and mud-cemented boulder conglomerate lenses have been hydrothermally metamorphosed to the greenschist facies. The metamorphosed conglomerate lenses are chlorite green in color and so firmly united that fracture takes place across the boulders instead of around them (Pl. 5B). The lenses often weather spheroidally (Frontispiece), and at a distance are indistinguishable from the highly weathered, post-hydrothermal, tholeiitic diabase dikes that cut the Ballinger. This unusual phase of the Ballinger fanglomerate is well exposed and easily accessible

at the following localities; (1) Langhorne Quarry, farm of Harry Langhorne, four and one-quarter miles west of Scottsville on State Route No. 6, Albemarle County; (2) Glendower, in a road cut along State Route No. 20, Albemarle County; or (3) road cuts along County Route No. 626, a quarter of a mile northeast of Howardsville, Albemarle County.

In the Connecticut Triassic, Krynine (1950, pp. 31-70) made successful correlations on the basis of type and frequency of heavy minerals. This technique probably can not be used in the Ballinger because the source areas of the different fans that constitute this member were lithologically too closely similar.

Howardsville Member

Howardsville member is the name given to the metamorphosed Triassic volcanic and sedimentary rocks of the Totier formation which occur in the west border fault zone and are bounded on the west by pre-Triassic and Hardware fanglomerate, and on the east by Ballinger fanglomerate (Pl. 3). This member extends the entire length of the basin and at the type locality reaches a maximum areal development, approximately 6000 feet in outcrop width, immediately west and northwest of Howardsville, Albemarle County (Pl. 3).

The Howardsville member consists predominantly of metamorphosed sedimentary rocks interbedded with rarer meta-igneous flow, pyroclastic, and intrusive rocks. The flows were extruded periodically through faults in the west border fault zone; consequently, the meta-igneous rocks are intrusive dikes (flow feeders) at some localities, and extrusive sheets at others --- depending on their proximity to a fault. The flow feeders are long, narrow, tabular dikes within and parallel to the west border fault zone.

Though individual sedimentary, pyroclastic, intrusive, and extrusive elements within the Howardsville are recognized in specific exposures, tracing and mapping of these individual units within the member is an impossibility for several reasons: (1) the member lies entirely within the west border fault zone where faulting took place before, during, and after Howardsville time; (2) parts of the Hardware and Ballinger fanglomerates are involved in the west border fault zone, and some of the sedimentary rocks which appear to be Howardsville may be fault slices of Hardware or Ballinger; (3) Triassic hydrothermal alteration and thermal metamorphism from individual flow feeders have obliterated many primary features; (4) outcrop in this area of faulting and metamorphosed basic rock is exceedingly poor.

Numerous types of rocks make up the flow, feeder, pyroclastic, and sedimentary units that constitute the Howardsville member, but only the two most important, flow and feeder, will be considered.

The flows are dark-green, blue-green, or gray-green, according to the proportions of various primary and secondary mineral constituents. The rocks are usually meso-microcrystalline and commonly porphyroblastic, lepidoblastic, or schistose. Palimpsest textures can be observed by use of the petrographic microscope. Trachytic and amygdaloidal relics are locally preserved near flow tops. Such relics not uncommonly give way to fine ophitic

relics which are succeeded, deeper in the extrusive, by ghosts of coarse ophitic texture.

Mineralogically, the flows locally contain up to 25 percent primary plagioclase, An 49 to An 60, in various stages of preservation, and anhedral embayed, diopsidic augite and nearly uniaxial pigeonite. The remainder of the rock, commonly 80 percent or more, is composed of the following secondary minerals developed during the Triassic metamorphisms: untwinned xemoblastic albite, zenoblastic penninite with a small 2V and anomolous "berlin blue" interference colors, zenoblastic to idioblastic epidote, and laths of tremolite in some rocks and grunerite in others. Secondary accessory minerals --- carbonate, magnetite, and leucoxene --- are also present.

The mineral assemblages of the feeders resembles those of the flows, as do the textures, except that they are coarser and have a much higher percentage of ophitic relics.

Evidence that vulcanism occurred periodically throughout Howardsville time is supplied by the following field and laboratory data: (1) late flow feeders have metamorphosed earlier ones, thus obscuring most of the megascopic evidence of several generations of feeders, but in thin section the metamorphic effect of one feeder on another is apparent from palimpsest textures and relative degree of reconstitution; (2) thick sedimentary lenses are present between flows; (3) conglomerate lenses throughout the Ballinger fanglomerate contain clastic fragments of meta-igneous rocks derived from the Howardsville member; and (4) late flow feeders (dikes) locally are intrusive into the easternmost exposures of the Hardware fanglomerate.

Hardware Fanglomerate Member

The Hardware fanglomerate member of the Totier formation receives its name from Hardware River, a stream in Albemarle County, in the extreme northern part of the basin. Here it is well exposed in the bluffs and reaches its maximum areal development, approximately a mile in outcrop width (Pl. 3).

Like most fanglomerates, the Hardware is made up of many different types of rock; however, alternating lenses of mudstone and graywacke interspersed to some extent with pebble conglomerate make up the bulk of the member.

It is impossible to measure or even estimate the thickness of this unit, since it is everywhere involved in a border fault zone, is hydrothermally and locally, in addition, thermally altered, and contains no definite horizon markers. It might be argued that the Hardware should not be treated as a member because its age and relation to the Ballinger and Howardsville members cannot be precisely determined; nevertheless, the Hardware is lithologically distinct, easily recognized and mapped, in part overlies volcanic rocks of the Howardsville member with sedimentary contact, and unlike the Ballinger is notably free of clastic fragments of Howardsville except in its basal part. These facts in the writer's opinion justify the member status here proposed.

The Hardware fanglomerate extends northwesterly along the west margin of the basin from a point about a mile and a half north of Boiling Springs to the bluffs of Hardware River (Pl. 3). It is intruded by several late

flow feeders of the Howardsville member and in part rests unconformably on the Howardsville, but in most places can be seen only in fault contact with the volcanic units of this member or with pre-Triassic rocks. A small fault sliver of Hardware is present along Rockfish River where this stream enters the basin (Pl. 3).

The clastic sediments that make up the Hardware fanglomerate are a lenticular, ill-sorted association of pink, gray, and green metamudstones, sand- to silt-sized metagraywackes, and granule and pebble metaconglomerates. These metasedimentary rocks are poorly sized and are characterized by a high content of clastic Evington phyllite chips. Only the two most common types, mudstone and graywacke, will be described.

The mudstone consists of a microcrystalline aggregate of sericite, chlorite, quartz, and carbonate, oriented so that tiny flakes of mica parallel primary fissility. Angular clastic particles of quartz and phyllite chips, the size of silt and fine sand, not uncommonly constitute as much as 30 percent by volume of the rock, and form minute lenticles which roughly parallel initial fissility.

The graywacke is a poorly sorted aggregate of sand- and silt-sized angular quartz grains and phyllite chips, surrounded by a reconstituted argillaceous matrix which is now a microcrystalline aggregate of metamorphic sericite, chlorite, and quartz with some carbonate and epidote. The quartz particles have sutured boundaries and with the phyllite chips constitute 40 to 80 percent by volume of the rock.

It is possible upon superficial examination to confuse Evington phyllite with certain metamudstones of the Hardware fanglomerate. Both rock types are involved in the complex border fault zones and are in fault contact with

each other. Both are of the greenschist facies, lustrous gray in color, and both show cleavages that appear to be similar. However, critical examination permits ready differentiation of these rocks. The Evington phyllite has a typical regional metamorphic fabric and locally exhibits crinkles and slip cleavages. The Hardware metamudstones have an initial fissility that is often crinkled and ruptured, thus forming a pseudo-slip cleavage which megascopically somewhat resembles the true slip cleavage of the phyllite. But thin section the fabrics of the two rocks differ greatly. The phyllite has been completely reconstituted by a pre-Triassic regional metamorphism while the metamudstones have been subjected to the same Triassic metamorphisms that incompletely reconstituted the Howardsville member and part of the Ballinger fanglomerate. Clastic mica and quartz grains along the fissility of the Hardware metamudstones vary greatly in size, whereas the metamorphic mica and quartz of the phyllite have comparatively uniform size. Finally, the Hardware metamudstones are composed in part of megascopic clastic chips of the Evington phyllite from which the metamudstones initially were derived.

Tholeiitic Diabase Dikes

Tholeiitic diabase dikes cut the Triassic and pre-Triassic rocks in the Scottsville area. The dikes are apparently vertical and strike northerly. They vary in width from 5 to more than 300 feet and in length from a few feet to many miles.

Many of the dikes shown on plate 3 were mapped solely on float and soil type; it is not unlikely that others exist still unmapped. Mapping of the dikes on the basis of float was somewhat complicated by the fact that farmers of this rich, agricultural basin periodically bring in or remove diabase boulders from their land.

The ophitic to subophitic diabase dikes of the Scottsville area are black to dark gray in color and medium to fine grained. They are composed of 45 to 60 percent plagioclase that varies from An 50 to An 60. Most of the feldspars are polysynthetically twinned and normal zoning is common. Late patches and streaks of micropegmatite, -- intergrown quartz and orthoclase, -- are present in amounts up to 10 percent. Purplish colored, high-titanium augite and almost uniaxial pigeonite constitute 30 to 40 percent of these tholeiites, and olivine is absent or comparatively rare, 5 percent being the maximum. Other minerals are a spinel which has leucoxenic alteration, rather abundant chlor-apatite needles, and secondary amphibole and chloritic materials.

The thermal metamorphism caused by these dikes will be considered later.

Alluvium

Within the map area alluvium extends from the level of James River up to more than 200 feet above river level. The uppermost deposits consist of quartzite pebbles and cobbles which are remants of gravels that were deposited in the James River flood plain when it stood at a higher elevation (Pl. 6A). These older gravels have apparently slumped as a result of creep, and now locally litter the surface all the way down to the present level of James River. The lowest alluvial deposits are made up of a finer material that forms the flood plains in the present stream valleys. Most of the older gravels were not mapped. Such of the low-lying, slumped, older gravels as were mapped are combined with the most recent alluvial deposits and are shown as a complex on plate 3.

Plate 6

(UPSIDE DOWN)

A

B

A. High-level gravels, approximately 200 feet above the level of James River, on volcanic rocks of the Howardsville ~~formation~~ member 3 miles southwest of Howardsville, Nelson County. Photograph by Allen Sinnott.

B. Cut-and-fill structure in Ballinger fanglomerate, Langhorne Farm, 4½ miles west of Scottsville, Albemarle County.

Direction of Sedimentation

Most of the sedimentation in Scottsville Basin was from west to east. The composition and distribution of the rocks in the basin substantiate this statement. Clastic pebbles and boulders of metavolcanic material from the Howardsville member are found throughout the Ballinger fanglomerate, hence sedimentation from the west. Catoctin and Lynchburg lie to the west and pebbles from these units are found in the fanglomerates. Blue quartz, orthoclase, and granite pebbles in the fanglomerates have been derived from the acid blue-quartz-bearing granitic rocks which lie to the west in the Blue Ridge complex. Finally, very coarse clastic material is found at the apexes of fans close to the source area, -- the west side of the basin. The clastic material becomes successively finer toward the lower margins of fans, -- the east side of the basin. As will be shown later, the relative displacement on the east and west border fault zones also demonstrates a predominantly western source area.

Alluvial Apron

The sedimentary rocks in Scottsville Basin are an erosional remnant of an alluvial apron formed by the coalescence of several alluvial fans. Fan sediments possess characteristics peculiar to their mode of origin. These characteristics are exhibited by the rocks of Scottsville Basin and are as follows:

(a) Coarse material is found at the apexes of fans close to the source area, and this clastic material becomes successively finer toward the lower margins.

(b) Distributary channels and cut-and-fill phenomena are present (Pl. 6A).

(c) Persistent, highly developed bedding is not common; the sedimentary rocks are gradational and lenticular.

(d) The clastic particles are poorly rounded, poorly sorted, and heterogeneous, and individual fragments locally range from clay to boulder size.

(e) The sedimentary rocks are composed of immature clastic particles which show a close relationship to their parent rocks.

Age of the Rocks

The rocks within Scottsville Basin are believed to be of Newark age. Broadly considered they are lithologically and structurally similar to other rocks in Virginia and elsewhere which are of known upper Triassic age.

The late tholeiitic diabse dikes have made possible a generalized dating of the rocks in Scottsville Basin. These intrusives are apparently of the same diabase that constitutes the widely recognized dikes of the eastern United States, and are considered by most authorities to be Newark in age. They have the same textures and chemical and mineral compositions as certain phases of the volcanic rocks in the Howardsville member, and it is therefore suggested that the volcanic rocks in the Howardsville member and the diabase dikes of the map area are magmatically related. Conceivably, both are of Newark age. Clastic pebbles of Howardsville are found throughout the Ballinger fanglomerate, and late Howardsville feeders are intruded into the upper part of the Ballinger. Hence, the volcanic rocks of the Howardsville transgress all of Ballinger time and the Ballinger may be of Newark age. And as these same diabase dikes cut the Ballinger and Hardware, the Hardware may also be of Newark age.

Roberts (1928, pp. 144, 147, 150) records fossil conifer stem fragments and animal trails of upper Triassic age in the rocks of Scottsville Basin. Other than some problematica, possibly worm burrows, the writer was unable to find fossils. The "worm burrows" occur in metamudstones of the Hardware fanglomerate, a mile east of Keene in exposures along Thomas Creek, a tributary to Hardware River.

STRUCTURE AND METAMORPHISM

General Statement

Scottsville Basin is splinter-shaped in plan view, and is bounded on the west, north, and east by high-angled, normal fault zones of Triassic age, the maximum displacement occurring along the west side (Pl. 3). Faulting took place before, during, and after formation of the Triassic rocks.

During sedimentation and vulcanism the basin was displaced relatively downward by movement along the west border fault zone. This displacement hinged on an axis in the east border fault zone where subordinate movement occurred. Successively younger flows and younger sediments were deposited from the west as movement continued in the west border fault zone; consequently, the original eastward dip of the older flows and sediments, and eventually of the younger flows and sediments, was gradually changed to a west dip.

An irregular aureole of hydrothermal alteration follows the west border fault zone and has altered the Hardware fanglomerate, Howardsville member, and part of the Ballinger fanglomerate to the greenschist facies. Post-hydrothermal, tholeiitic diabase dikes have been intruded into, and locally have thermally metamorphosed all rocks in the map area. The dikes formerly transgressed all Triassic fault zones, but have been severed by late movement along the west border fault zone. This late movement has further steepened the westward dip of the Triassic flows and sediments.

West Border Fault Zone

The west border fault zone has an average width of approximately 1½ miles. It parallels the western boundary of Scottsville Basin throughout

the mapped area, and continues great but undetermined distances to the northeast and southwest (Pl. 3). The Hardware fanglomerate and Howardsville member are confined within the limits of this great zone. The fault zone also embraces part of the Ballinger fanglomerate and an appreciable thickness of the pre-Triassic Evington group.

Poor outcrops and lack of marker horizons make impossible the mapping of individual fault slices in this complex. However, empirical field evidence has led the writer to believe this faulting to be similar in complexity to the intricate normal fault zones exemplified by the clay-cake models of Cloos (1930, pp. 741-747 and 1931, pp. 241-247). For example, in the Keene sector where exposures, though poor, are better than in most of the mapped area, 20 individual fault slices were recorded on a two-mile traverse across the zone. On contiguous traverses where only ten to fifteen individual fault slices were recorded, matching of more than a few of them with faults in adjacent traverses was impossible.

The Triassic rocks within the west border fault zone are jointed, brecciated, highly contorted, locally mylonitized, and show reversal of dip and changes of strike within short distances. Pre-Triassic rocks within the zone are highly contorted and commonly mylonitized. In many places drag has flattened their high angles of inclination to attitudes approaching the horizontal. As a specific example, drag phenomena in a rotated fault block of Evington phyllite, approximately a third of a mile wide are well exhibited and easily accessible in road cuts along Secondary Road 602, about a mile northwest of Howardsville, Albemarle County.

The west border fault zone is apparently high-angled and normal. The straightness of its trace and the local exposures of high-angled, east-dipping normal faults and west-dipping antithetic faults substantiate this statement.

However, lack of key beds and good exposures precludes absolute field proof. For similar reasons the vertical displacement within the fault zone cannot be determined. The general magnitude of the minimum vertical displacement is 16,000 feet. This figure, by no means exact, is an approximation based on the attitude of the Triassic rocks and the width of the basin.

Movement along the west border fault zone began early in the history of Scottsville Basin, possibly before the earliest Triassic sedimentation and vulcanism; it was continuous during the course of later Triassic sedimentation and vulcanism, and persisted even after the last of the Triassic rocks had been formed. That this is true is indicated by several lines of reasoning:

All exposed feeders of the flows in the Howardsville member lie within the west border fault zone, strike parallel to the zone, and rose along it. Sedimentation was generally from west to east, and the oldest exposed sedimentary rock in the basin, -- the lower Ballinger on the east side of the basin, -- includes clastic fragments of volcanic rocks from the Howardsville member. The oldest Ballinger is a typical fanglomerate tht owed its existence to relief along the scarp of the west border fault zone. Another indication that movement along the zone was continued during sedimentation and vulcanism is the monotonous repetition, throughout the fanglomerate, of alternating coarse and fine lenses of irregular distribution and attitude, and the poor sorting of the constituents of these lenses -- a reflection of continuing rejuvenation in the source area. Furthermore, since the youngest phases of the Howardsville are post-Ballinger, the faults must have been reopened as channelways for the flows. Finally, continued movement along the west border fault zone even subsequent to emplacement of all the Triassic rocks is proved by the fact that the youngest Triassic rocks in the basin, the late tholeiitic diabase dikes, formerly transgressed the west border fault zone and havebeen displaced by the later movement along the zone (Pl. 3).

East Border Fault Zone

The east border fault zone bounds Scottsville Basin along its eastern margin. It dies out immediately north of the map area, and at the southern end of the basin converges with the west border fault zone. The faulting is high angled and normal like that of the western zone, but its outcrop width is usually less than an eighth of a mile (Pl. 3). Displacement in the east zone is much less than that along its western counterpart. This is indicated in several ways: (a) sedimentation was largely from west to east, (b) the initial easterly dip of the sediments has been reversed to a westerly dip by the greater movement along the west border fault zone, (c) the grain size of the clastic fragments in the sedimentary rocks increases erratically to the west, (d) late tholeiitic diabase dikes that transgressed all fault zones have been displaced by late movement along the west zone whereas they have not been severed along the east zone, and (e) features characteristic of fault zones are not as prolifically developed in the east zone as they are in that to the west.

Previous workers did not recognize the east border fault zone. That this zone exists is indicated by mylonite, slickensides, drag folds, drag, tectonic breccia and gouge, joints and fracture cleavage, repetition and omission of strata, abrupt changes in strike and reversal of dip, and numerous individual faults within the zone. Two such individual faults within the east border fault zone are easily accessible and are well exposed in road cuts along County Route No. 726, approximately 100 yards northeast of the Totier Creek bridge, Albemarle County.

North Border Fault Zone

The north border fault zone marks the northern boundary of the basin. It is well exposed in several places in the bluffs along Hardware River, but a large part of its outcrop is obscured by Hardware River alluvium (Pl. 3). This makes it impossible to measure its average outcrop width. The zone meets the west and east border fault zones at high angles and is terminated by them. Like the other fault zones described above, the faulting is high angled and normal.

The north border fault zone is recognized on the basis of evidence identical with that on which recognition of the east and west zones was based.

Major Structural Relationships of the Basin

To summarize the overall aspects of the structures of Scottsville Basin: In plan view the basin is shaped like a long splinter (Pl. 3) and is bounded on its three sides by high-angle normal fault zones of Triassic age. The west border fault zone is a complex of normal faults that continues great but unknown distances beyond the confines of the mapped area. The east border fault zone is much less extensive for it dies out along its trace just north of the mapped area and converges with the west border fault zone at the southern end of the basin (Pl. 3). The north border fault zone cuts into the west and east zones at high angles and connects the west and east border fault zones at the northern boundary of the basin (Pl. 3). Thus, when the above structural relations are considered on a broad scale, Scottsville Basin appears to be a relatively small, local fault slice which has been caught in a great Triassic fault zone. The east and north border fault zones are subsidiary localized rupture zones along which a slice, Scottsville Basin, was downdropped and caught in this great fault zone. Accordingly, a relatively small portion of a vast Triassic alluvial apron has been preserved from erosion by the down dropping of the wedge-shaped chip now

comprising Scottsville Basin. This alluvial apron probably extended the entire length of the great fault zone making Scottsville Basin merely a locally preserved fragment, a small part of that great alluvial apron, most of which has long since disappeared through erosion.

If the other Triassic basins in Virginia may be considered similar to Scottsville Basin, it is conceivable that the Virginia Piedmont may have had a basin-and-range type topography in Triassic time, and that Triassic sediments were probably much more widespread than has been believed.

Horsts and Grabens

Several subsidiary horsts and grabens are recognized in the map area (Pl. 3). In overall aspect, they are minor fault slices within the limits of the fault zones.

A conspicuous graben that stands as a topographic high is located a mile and a half west-northwest of Midway Mills. Here a block of Howardsville has been downdropped and is bordered on all four sides by Evington phyllite. Two of the outstanding horsts of Evington phyllite surrounded by Ballinger fanglomerate are located as follows: (1) two miles southwest of Howardsville, and (2), three miles east-northeast of Glendower. Numerous other smaller horsts and grabens are present within the mapped area, some of them too small to be recorded on plate 3.

Tectonism, Vulcanism, and Sedimentation

The Triassic sedimentary rocks of Scottsville Basin were derived predominantly from a western source area composed of Triassic volcanic and sedimentary rocks and pre-Triassic crystalline rocks. The sediments were transported eastward and deposited as coalescing alluvial fans. During the penecontemporaneous sedimentation and vulcanism, the area of deposition

underwent relative downward displacement by faulting along the west border fault zone. This downfaulting hinged on an axis in the east border fault zone of the basin. Thus, the Triassic sediments of Scottsville Basin were deposited in a sinking trough, bordered on the west by the west border fault zone, and on the east by a hinge area, the east border fault zone. Minor downfaulting of a subordinate nature occurred along the hinge area. Thus, the rocks of Scottsville Basin lie within a wedge-shaped fault-bounded trough (Pl. 3). Flows were extruded through openings in the west border fault zone early in the history of the basin. Fanglomerate composed of clastic pieces of Triassic and pre- Triassic rocks was spread from west to east across the basin. As the westwardly tilting fault wedge was further rotated, successively younger sediments and flows were being deposited over the older Triassic sediments and flows whose initial dips were being gradually decrease and finally reversed from eastward to westward. Even the youngest sediments and flows acquired a western dip as rotation progressed, a phenomenon which continued throughout Ballinger-Howardsville time. Later downward movement along the west border fault zone further increased the degree of westward dip of the rocks. Thus, a gradual east to west decrease in dip is displayed in the outcrops of the present Scottsville Basin (Pl. 3). Dips are highest along the east border of the basin and decrease to the west through successively younger beds of the stratigraphic section (Pl. 3).

Metamorphism

General Statement

Three types of metamorphism, --regional, hydrothermal, and thermal, --- have been operative in the mapped area. The pre-Triassic rocks were altered to the greenschist facies by a pre-Triassic regional metamorphism. Part of the Ballinger and all of the Howardsville and Hardware members were subjected

to a Triassic hydrothermal alteration that incompletely reconstituted these rocks to the greenschist facies. All the rocks of the mapped area locally have been baked, -- thermally metamorphosed, -- adjacent to the late Triassic tholeiitic diabase dikes.

Regional Metamorphism

The pre-Triassic rocks were reconstituted by a pre-Triassic regional metamorphism which produced in them a typical regional metamorphic fabric. So pronounced and distinctive is this regional fabric that it serves as a megscopic and microscopic method of differentiating between the pre-Triassic and certain of the hydrothermally metamorphosed Triassic rocks. This pre-Triassic regional metamorphism is outside the scope of this paper and will not be considered further.

Thermal Metamorphism

The aureoles of thermal metamorphism surrounding the late tholeiitic diabase dikes vary in outcrop width from a few inches to about 110 feet. An aureole may be divided into two zones: (1) an inner zone of incomplete reconstitution where the country rock is discolored and contains megascopic porphyroblasts; and (2) an outer lower-rank zone of less discolored country rock exhibiting very little reconstitution and lacking megascopic porphyroblasts.

The inner zone may be present or absent, and rarely reaches its maximum observed width of approximately 10 feet. Porphyroblasts, half an inch or smaller in size, occur abundantly in this zone. The porphyroblasts are composed of chlorite, sericite, biotite, or magnetite and decrease in size and number away from the dikes. The sedimentary rocks within an inner zone were subjected to so little reconstitution that most of the original clastic minerals have remained essentially intact. Color change is the most obvious alteration. The red ferric-iron stain responsible for the typical brick-red

color of unmetamorphosed sedimentary rocks of the Triassic has been reduced to the ferrous state, with the result that the inner zone rock is green, gray, or black in color.

The outer zone is marked by absence of megascopic porphyroblasts on its inner side and a gradual gradation into unaltered country rock on its periphery. The outer zone ranges in width from approximately 5 to 100 feet. The only significant change wrought by thermal metamorphism in the zone is the reduction of the ferric iron, which has changed the rock's color.

The thermal metamorphism is in essence a localized baking of the country rock contiguous to the very "dry" dikes.

Hydrothermal Alteration

An irregular aureole of hydrothermal alteration follows the west border fault zone throughout the length of the basin; its width varies notably but reaches a maximum of about 7000 feet. The textures, lithology, and mineralogy of these hydrothermally metamorphosed rocks, -- the Hardware, Howardsville, and part of the Ballinger, -- have been described earlier in this paper. Here it is pertinent only to emphasize the "wet" nature of the secondary metamorphic minerals so as to substantiate the hydrothermal character of the metamorphism. Such secondary minerals, present in profusion, are epidote, chlorite, sericite, amphiboles, albite, calcite, ankerite, and quartz. In addition, the rocks are cut by numerous veins of these carbonates and quartz, and more rarely of specular hematite and barite.

The Triassic age of the hydrothermal alteration is substantiated by several lines of evidence: hydrothermally altered Triassic rocks are cut by the late Triassic tholeiitic diabase dikes which are "fresh" and not metamorphosed; clastic pebbles of metamorphosed volcanic rocks from the Howardsville member are found in many of the conglomerate lenses within

the unmetamorphosed parts of the Ballinger fanglomerate; contiguous feeder intrusives of the volcanic phases of the Howardsville possess vastly differing degrees of reconstitution and preservation of relic textures, thus indicating late feeders metamorphosed the earlier ones; and finally, the latest Howardsville feeders are intrusive into the youngest Ballinger.

All Triassic metamorphism in the mapped area is believed to be related to the consanguineous "dry" tholeiitic rocks. The thermal aureoles are related to the late diabase dikes, and the hydrothermal aureoles to the volcanic phases of the Howardsville member -- movement of the introduced material being accomplished by connate rather than juvenile waters.

The reason for thermal aureoles in the one instance and hydrothermal in the other may be a function of time. The dikes and their thermal aureoles are the result of a single magmatic injection covering a short span of time, whereas the flow feeders and associated hydrothermal zone are the result of multiple magmatic pulsations covering a much longer period of time. Thus, the hydrothermal aureoles may be a cumulative effect of heat from the feeders of the recurrent volcanic activity, plus the presence of connate waters.

ECONOMIC GEOLOGY

General Statement

Scottsville Basin has rich, fertile soils and a supply of ground water adequate for domestic use. Agriculture and lumbering are the most important economic activities of the area.

Many of the rocks of the map area are of economic value under favorable conditions of occurrence and favorable markets. In the past, rock was quarried for building purposes and road stone.

Soil

Scottsville Basin is mantled for the most part by two soils, the Bucks and the Penn silt loams (Devereux 1940, pp. 20-21). Both are derived from Triassic rocks and are reddish-brown and purplish-red; both have mellow silt loam textures. The Bucks occupies the interstream areas and ranges in depth from 36 to 40 inches, whereas the Penn is confined to stream valleys, its depth ranging between 12 and 24 inches. The Bucks is a soil which can be built up and maintained in an excellent state of productivity. It has the same agricultural value as the best soils of the Piedmont area (Devereux, 1940, p. 20). Though the Penn, too, is a good soil, it is not as productive as the Bucks because it is thinner, erodes rather easily, and holds moisture less well during the dry seasons of the year. For these reasons, only a small proportion of the Penn is under cultivation, the rest being forested.

The Nason, a yellow-gray silt loam, is developed on the pre-Triassic crystalline rocks of the map area (Devereux, 1940, p. 25). It is shallow, droughty, and inherently poor. It does not readily absorb rain water, washes severely, and lacks bases, --- potassium, magnesium, and calcium, --- which are essential for good productivity.

Ground Water

Scottsville Basin is fairly well supplied with ground water. The bedrock in large part forms an ideal reservoir because as previously stated, it is a fossil alluvial apron composed of immature, poorly sized,

poorly indurated, clastic sediments, and therefore porous enough to hold much water. With the exception of areas of Triassic igneous rocks and the zones of hydrothermal alteration and thermal metamorphism, successful wells can be brought in at almost any location in the basin.

Good wells are almost nonexistent in the pre-Triassic crystalline areas surrounding the basin. There the low permeability due to the "tight" nature of these rocks restricts successful wells to fractured zones and areas of contact between subsoil and bedrock.

Due to limited time and funds the hydrologic data are far from complete. Such information as was obtained from well owners, was based entirely on their memories. Though the water data, therefore, are not accurate, the following generalizations can be made: (a) The Triassic rocks, excluding the igneous and metamorphic, are fair aquifers and should yield 5 to 10 gallons of water per minute; (b) All Triassic rock in any one drill hole has about the same permeability, with the consequence that a deeper well will expose a greater surface of rock and thus yield more water than a shallow well; (c) The Triassic igneous and metamorphic rocks and the pre-Triassic rocks in the mapped area are poor aquifers and most of the wells drilled into them are failures.

Marble

Lime-bearing rocks are important to residents of Albemarle, Nelson, and Buckingham counties because the local soils are lime-deficient. Little agricultural lime is being produced locally; consequently, most of the supply must be hauled, at great expense, across the Blue Ridge Mountains from the Valley of Virginia.

The thin, disontinuous lenses of marble present in the pre-Triassic, Evington group rocks in the map area, though not of dimension-stone quality, are nevertheless suitable for agricultural lime and crushed-stone.

Localities where marble occurs and which deserve attention if a local supply of agricultural lime is desired are:

(a) May Creek, four-fifths of a mile northwest of Midway Mills, Nelson County.

(b) Warminster, Nelson County.

(c) Bluffs along James River in the horst west of Highland, Nelson County.

(d) Bluffs along Rockfish River, one and one-half miles southwest of Howardsville, Nelson and Albemarle Counties.

(e) J. T. Irving farm, one and one-tenth miles south of Howardsville, Buckingham County.

(f) Mount Pleasant farm, in the horst south of Hardware River, approximately three and one-half miles east of Keene, Albemarle County.

(g) Mount Pleasant farm, in an abandoned quarry north of Hardware River, Albemarle County.

Brick and Tile Clay

Scottsville Basin includes areas underlain by mudstones and residual clays that are possible sources of brick and tile clay and are well located for working and transportation. The term "clay" usually is applied to a stiff, sticky earth or rock material that has plasticity when wet and hardens after drying or baking.

Some of the mudstones appear to be suitable for brick and tile making. A sample of mudstone from the Ballinger fanglomerate, collected from a cut along the Nelson and Albemarle Railroad near Warren, Albemarle County, was

analyzed for brick making by the United States Bureau of Mines, Norris, Tennessee, with the following results:

PH 6.12 Unfired color: red

Raw Properties

Fairly plastic and smooth working, requiring 28% water for plasticity with 3.5% drying shrinkage. No drying defects.

Fired Properties

Temp.	Color	Hardness	%Shk.	%Abs.	Ap.	sp.	gr.
1800	Orange-red	Soft, crumbly	2.0	21.7	2.78		
2050	Medium red-brown	Hard	9.0	9.6	2.68		
2100	Dark red-brown	Very hard	11.0	4.7	2.58		
2200	Dark brown	Vitreous	Expanded	22.6	2.13		
		Pressed Specimen 2" x 1" x ½"					
1900		Very hard	5.5	10.0	2.74		
2000		Steel hard	7.1	7.8	2.69		
2050		Steel hard	7.9	5.5	2.69		

The specimen expands with slow heat treatment, but not with quick heating which indicates a high iron content. The briquettes show slight scumming, but this was eliminated in the pressed specimen by adding a small amount of barium carbonate.

These data suggest that certain of the mudstones in the Ballinger fanglomerate have good possibilities for yielding dark-burning, red-brown brick and tile and also quarry tile for patios, hallways, and other uses.

Trap Rock

Large dikes of tholeiitic diabase, one of the rocks known commercially as trap, are widely distributed within the Scottsville area (Pl. 3), and several are located favorably for working and transportation.

Trap possesses the properties necessary for construction and architectural stone, but is not much used for these purposes in the United States, probably because of the dark color. Trap takes a high polish, is durable, has a high crushing strength, and is much easier to work than the popular building stone, granite. Trap also makes an excellent crushed stone for use as roadstone, concrete aggregate, and railroad ballast. The quality and quantity of the Scottsville trap are more than adequate for all such uses.

"Brownstone"

The red Triassic sandstones, graywackes, and arkoses ("brownstone") of the Ballinger fanglomerate were formerly quarried near Howardsville and Midway Mills. The locations of these now abandoned quarries are as follows:

(a) Howardsville quarries, three different openings, approximately a mile east of Howardsville, Buckingham County.

(b) Midway Mills, two openings, approximately 300 yards south of the old mill, Nelson County.

These quarries produced stone for buildings, foundations, gateway structures, walks, walls, and numerous other purposes in the local area. According to Roberts (Roberts, 1928, p. 19): "The Norfolk and Western Railway station at Bedford City is built of sandstone ["brownstone"] from this quarry [Midway Mills] as is part of the Federal Court building at Abingdon, and many uses are made of it in Lynchburg and Richmond."

"Brownstone", in general, has inferior durability and is considered by most authorities to make dimension stone of poor quality. Also, "brownstone" homes long ago ceased to be in vogue; in fact, all quarries in the area have been abandoned for approximately 60 years.

Crushed Stone

In the past, hydrothermally altered volcanic parts of the Howardsville member and similarly altered and unaltered Ballinger fanglomerate were quarried for use as roadstone, concrete aggregate, and "black-top" aggregate. Many of the local county and state roads are constructed of these materials. The three large quarries which have supplied this crushed stone are located as follows:

(a) Harry Langhorne farm, four and one-quarter miles west of Scottsville on State Route 6, Albemarle County.

(b) J. W. Castiel farm, two miles northeast of Howardsville on County Road 626, Albemarle County.

(c) Larkin Londree farm, five miles north of Scottsville on County Road 795, Albemarle County.

The above listed quarries were operated as WPA projects in the early thirties.

Iron, Copper, and Barium

Specularite (Fe_2O_3), pyrite (FeS_2), Malachite ($Cu_2(OH)_2\ CO_3$), azurite ($Cu_3(OH)_2\ (CO_3)_2$), and barite ($BaSO_4$) are found in the zone of hydrothermal alteration, but are not present in commercial quantities and are thus of scientific interest only. Several very old prospect pits were discovered in the area; however, there is no field evidence of past production nor any written record of production of these minerals from the mapped area.

Specularite, pyrite, and barite occur in fracture fillings and vugs and are believed to be hydrothermal in origin. These minerals can be found in traces in many fresh exposures in the zone of hydrothermal alteration. Secondary thin "scums" and casts of azurite and malachite are locally associated with the iron minerals.

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Sample Locations, Covesville Quadrangle

C-101	Candler - Road cut between Keene and Carters Bridge (Va. Route 20).
C-102	Candler (green) - Road cut 50 yards west of Esmont (Va. Route 6).
C-103	Candler (thin quartzite) - Road cut 30 yards east of Esmont (Va. Route 6).
C-104	Candler (slate) - Esmont slate quarry.
C-105	Evington greenstone flow - 200 yards east of Porters.
C-106	Same as 105.
C-107	Sediment in Catoctin - County Route 712 road cut west of Keene. Top most sediment in Catoctin.
C-108	Evington greenstone flow - County Route 715 SW of Keene - same flow as C-105 and C-106.
C-109	Triassic float from C-108 locality.
C-110	Lynchburg - Crest of first large anticline west of Schuyler along State Route 6.
C-111	Lynchburg - State Route 6, 50 yards west of where largest syncline in Lynchburg "plunges out".
C-112	Lynchburg - Faber.
C-113	Soapstone, Largest dike on State Route 6.
C-114	Lynchburg, Road cut along State Route 6 at Nelson-Albemark County line.
C-115	Lynchburg - Crest of first large anticline east of Schuyler Road along State Route 6.
C-116	Metagabbro dike - 1000 feet west of Schuyler Road along State Route 6.
C-117	Lynchburg - .6 mile east of Albemark-Nelson County line along State Route 6.
C-118	Lynchburg - intersection of State Route 6 and Schuyler Road.
C-119	Catoctin - Bluffs along Rockfish River between Schuyler and Howardsville.
C-120	Same as C-119.
C-121	Evington greenstone flow? Caught in west fault zone along Scottsville Triassic basin, west of Howardsville along Rockfish River.
C-122	Basement - west side of Mt. Oliver, elevation 1205'.
C-123	Basement - South side of Heard Mtn., elevation 1820'.
C-124	Basement - North side of Heard Mtn., elevation 2240'.

C-125 Basement - Batesville Quarry

C-126 Same as C-125.

C-127 Basement - Israel Gap.

C-128 Metagabbro - Chalk Mtn., same dike goes through Cross Roads.

C-129 Basement - Batesville Quarry.

C-130 Same as C-129.

C-131 Triassic diabase dike, Batesville.

C-132, 133 Batesville Quary

C-134 Basement, Central Rectangle in bluffs along South Fork of Harris Branch.

C-135 Basement, East side of Heard Mtn., elevation 2170'.

C-136 Basement - Highwest crest of Chalk Mtn.

C-137 Metagabbro - Masses Crossing.

C-138 Batesville Quarry.

C-139 Same as C-138.

C-140 Basement - North side Heard Mtn., elevation 2360'.

C-141 "Lynchburg like sediment" faulted into Basement, Batesville.

C-142 Sheared basement, intersection of County Routes 692 and 696.

C-143 Same as C-142.

C-144 Basement, SE side of Sharp Top Mtn.

C-145 Same as C-144.

C-146 Basement - Dike or shear? Israel Gap.

C-147 Pebble from "lynchburg like metasediment" faulted into basement. Crest of Sharp Top Mtn.

C-148, 149, 150 - "Lynchburg like metasediment" faulted into basement. Bluffs along Whiteside Branch (near Batesville).

Sample Locations, Covesville Quadrangle

C-301	Basement - State Route 6. Two feet below base of Lynchburg at Faber.
C-302	"Basal" Lynchburg - Fifty feet above basement at Faber.
C-303	Triassic diabase dike - Faber.
C-304	Lynchburg - Metagraywacke 1125 feet east of Faber.
C-305	Lynchburg - "Metafeldspathic grit" - Shilo Church, Nelson County.
C-306	Lynchburg - Schist 50 yeards west of intersection of Va. Route 6 and County Route 639.
C-307	Hornblende metagabbro dike 50 feet thick - 50 yards southwest of intersection of Va. Route 6 and County Route 639.
C-308	Lynchburg - "meta-blue quartz, feldspathic grit" north end of Butler Mtn. just west of Albemorle-Nelson line.
C-309	Lynchburg - "metamud" or mylonite 150 yards north of Albemorle-Nelson County line, Va. Route 6.
C-310	Lynchburg - alternating layers of metasilt and graphite schist - 400 feet east of Nelson-Albemorle County line along Va. Route 6.
C-311	Lynchburg - "well-bedded metamud facies" - Ivy Creek.
C-312	Hornblende metagabbro dike or "crazy soapstone relative" - 300 feet east of intersection of Va. Route 6 and County Route 630.
C-313	Lynchburg - metagraywacke facies - 1000 feet east of intersection of Va. Route 6 and County Route 630.
C-314	"Hard soapstone" or metagabbro west of Schuyler on Coffey Farm.
C-315	Soapstone - Coffey Farm west of Schuyler.
C-316	Lynchburg "metamud" facies - 50 yards east of Coffey Farm east fence line.
C-317	"Soapstone relative" - first dike east of Tillman Store.
C-318	"FRDK" (funny rock don't know) - dike that is part soapstone - 2nd dike east of Tillman Store.
C-319	Hornblende metagabbro dike - Moses Crossing.
C-320	Hornblende metagabbro dike - Bluffs of Rockfish River, extreme southwest corner of map area.
C-321	Lynchburg - Bedding and slip cleavage north of Moses Crossing along County Route 639.
C-322	Metagabbro inclusion (approx. 50' x 5') in Triassic diabase dike 1/2 mile south of Faber.

C-323	Lower most metasediment in Catoctin (approx. 100' above lower most flow), Route 644, Nelson County.
C-324	Lynchburg - Top of Lynchburg just above eastern most, thin soapstone dikes. 200' to 300' SW of Curds Ford Bridge along Rockfish River.
C-325	Same as C-324 except 100' farther up in section.
C-326	Soapstone. Thin talc schist dike (soapstone relative) in top of Lynchburg. Albemarle County side of Rockfish River between Schuyler and Curds Ford.
C-327	Catoctin. "Massive catoctin" flow, lowest flow west of Curds Ford in bluffs along Rockfish River.
C-328	Amygdaloidal Catoctin - 200' east of C-327.
C-329	Metasediment - uppermost Lynchburg or lowermost Catoctin. West side of Green Mtn., 300' south of Va. Route 6.
C-330	Metasediment - same as C-329, southwest of Curds Ford on south side of Rockfish River.
C-331	Metagabbro dike against soapstone body - Route 630 between Old Dominion and Schuyler.
C-332	"Soapstone relative" - uppermost soapstone in Lynchburg, west side of Eden Farm.
C-333	Lynchburg - Top of Lynchburg against Catoctin, John Gibson Farm east of Alberene.
C-334	Catoctin - Lowest flow in Catoctin against top of Lynchburg, John Gibson Farm east of Alberene.
C-335	Lynchburg - first railroad cut in Lynchburg, south of Faber.
C-336	Candler - Base of Candler 4' above Catoctin contact bluffs along Rockfish River.
C-337	"Soapstone relative" - Eastern most dike.
C-338	Lynchburg - graphite schist. Hardware Baptist Church.
C-339	Soapstone - eastern most dike in top of Lynchburg, 150 yards north of County Route 708 between Carters Bridge and Red Hill.
C-340	Lynchburg - "recomposed granite", basal Lynchburg, Walker Farm north of Red Hill.
C-341	Lynchburg - Forest Lodge Farm off old Lynchburg Pike.
C-342	Metagabbro dike - east side of Forest Lodge Farm near top of Lynchburg.
C-343	Catoctin - sediment in Catoctin 200 yds southwest of Tillman General Store, Va. Route 6.
C-344	Basement - Phyllonite from Lovingston; west side of Batesville

"fault block" - intersection County Routes 693 and 635.

C-345 Basement - phyllonite same as C-344.

C-346 Basement - same as C-344.

C-347 Basement - Phyllonite from east side of Batesville fault zone.

C-348 Basement - Phyllonite from east side of Batesville fault zone, approximately 150 yards south along the fault strike from C-347.

C-349 Lynchburg - C. B. Jones farm at Powells Corner.

C-350 Basement - Cataclasite along corss fault in Batesville fault zone on south side of Sharp Top Mtn.

C-351 Basement - Cataclasite as C-350 except 100 yards north west of C-350.

C-352 and 353 Catoctin - metasediment (75' to 100' thick) about 800' below top of youngest Catoctin flow, Bradley and Sherwood Farms, Carters Mtn.

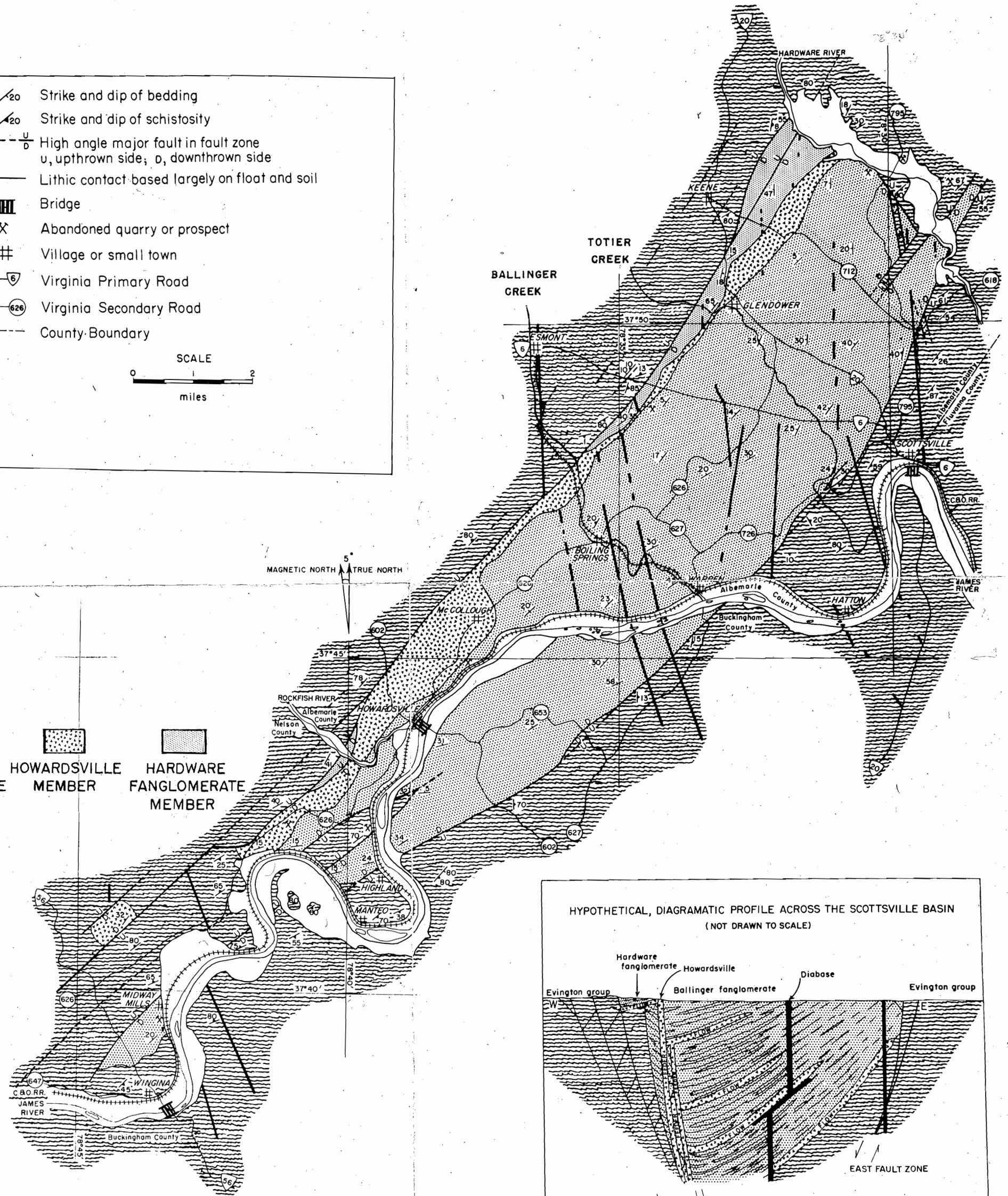
C-354 Catoctin - volcanic breccia, west side of Redlands Farm, west of Carters Bridge.

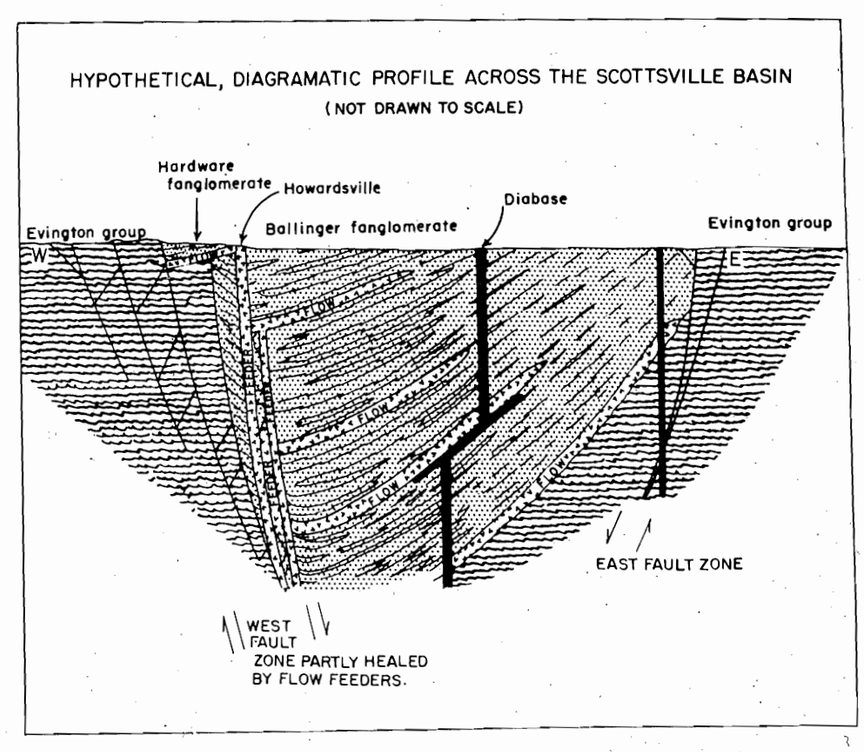
C-355 and 356 Basement - Cataclasite along high angle fault, about 300 yards north of the intersection of Rockfish Road and U.S. Route 29.

C-357 and 358 Candler - Esmont Quarry.

GEOLOGIC MAP AND CROSS SECTION OF THE SCOTTSVILLE TRIASSIC BASIN, VIRGINIA

PLATE 3





GEOLOGY BY H.C. SUNDERMAN — 1954 AND 1955