THE GEOLOGY OF THE UPPER ROANOKE RIVER VALLEY AREA, MONTGOMERY AND ROANOKE COUNTIES, VIRGINIA

by

Jonathan Edwards, Jr.

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ABSTRACT

The upper Roanoke River Valley area lies in the Valley of Virginia in Montgomery and Roanoke counties, and is about 100 square miles in area. All but the oldest of the mapped units shown on Plate 1 are of Paleozoic age and of sedimentary origin. The Precambrian rocks that crop out on Poor Mountain were not subdivided or studied in detail in the field. The aggregate thickness of the Paleozoic rocks in the area is approximately 5,600 feet. However, parts of these formations are either cut off by faults or are covered by overthrust sheets.

The structure of the area consists of two overthrust sheets and several small anticlinal folds in formations of the overridden block. The lower overthrust sheet (Salem thrust block) has considerable stratigraphic displacement; a formation of Middle Cambrian age has been brought into contact with formations which range in age from Cambrian to Devonian. The upper overthrust sheet (Max Meadows thrust block) has only slight stratigraphic displacement, as the formations on either side of the fault are of Cambrian age. An extensive zone of breccia is associated with the fault beneath the upper overthrust sheet. Minor faults and folds are present in the formations of both overthrust sheets as the result of deformation both prior to and during movement along the faults.

The only operations at the present time which utilize the mineral deposits of the area are quarries in shales to supply a brick plant. Limestone and dolomite for crushed stone have been quarried in the past.

Traces of lead and zinc sulphides and iron are also present.

Ground water in quantities of economic importance may be present within solution channels in dolomites of the Rome and Elbrook formations. In general, the alluvial deposits in the area are too thin and contain too much interstitial clay to be of importance as large sources of ground water.

INTRODUCTION

Location of Area

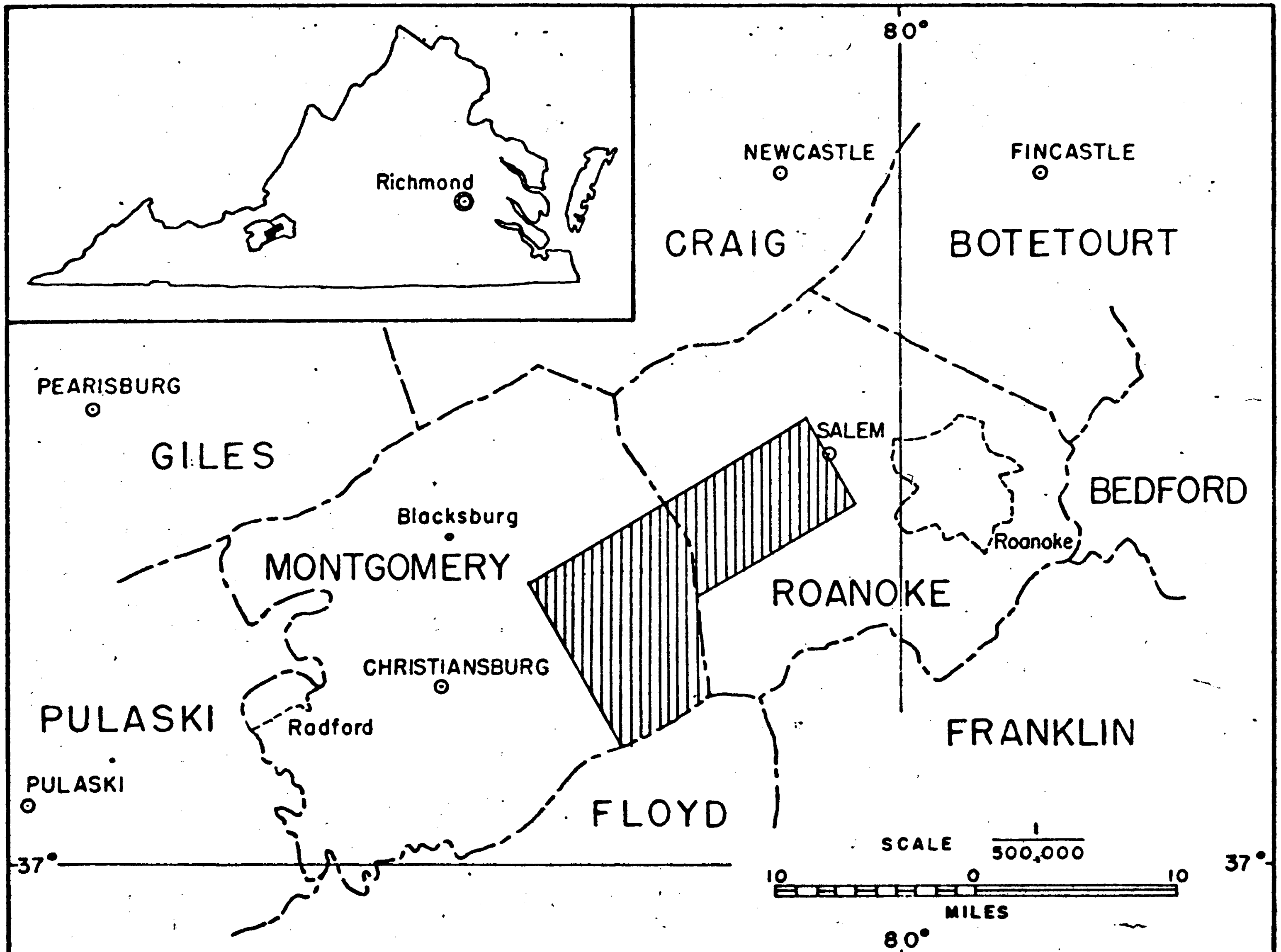
The upper Roanoke River Valley area consists of approximately 100 square miles of the Valley of Virginia in western Roanoke and eastern Montgomery counties, Virginia (Plate 2). The mapped area is bounded on the northwest by the southeast base of Fort Lewis Mountain, on the southeast by the northwest base of Poor Mountain, on the southwest by the east base of Christiansburg Mountain, and on the northeast by the city of Salem. Roanoke lies about seven miles east of Salem beyond the eastern edge of the mapped area and the town of Christiansburg lies about seven miles west of the mapped area.

U. S. Route 11 traverses the entire length of the area. Paved secondary Routes 603 and 637 in Montgomery County and Route 639 in Roanoke County, also give access to various parts of the area. Numerous other paved and unpaved secondary and private roads give the tract a considerable amount of coverage. However, there is no access by travelable roads to the rugged country near the base of Poor Mountain.

Purpose of Report

The primary purpose of this report was to map the areal geology of the upper Roanoke Valley, and to study and interpret the stratigraphy and structure of the bedrock formations. Surficial deposits of late Cenozoic age and mineral deposits of potential economic use were also to be included.

Plate 2



Location of the Upper Roanoke River Valley area in Montgomery and Roanoke counties, Virginia. Small inset map gives county locations.

The base map of the area is taken from the United States Geological Survey topographic maps of the Salem, Blacksburg, and Elliston quadranges, published in 1932, 1937, and 1950, respectively. The map accompanying this report is an enlargement to a scale of approximately 1:31,680 of portions of the quadranges. Distances and sections were measured by means of a Brunton compass and either by pacing or by a tape.

Previous Work

The upper Roanoke River Valley area was mapped by Butts (1933) as part of his reconnaissance of the entire Appalachian Valley region of Virginia. Woodward (1932) mapped the Roanoke area on a scale of 1:125,000, and this map included the entire area covered by the present report. Waesche (1934) mapped the northern third of the Blacksburg quadrangle. The southern third of the Salem quadrangle was mapped by Barlow (1936). Dietrich (1954) mapped that part of the area in Montgomery County which lies south of U. S. Route 11 in a reconnaissance. Portions of the area were mapped by Cooper (1944-b) in conjunction with investigations for industrial limestones and dolomites. Cooper (1946) also first noted the true significance of the breccia zones which occur within the area. Shufflebarger (1953) mapped the area immediately to the southeast of the area covered by the present report. Latta (1956) studied the ground water supplies of the area between Salem and Roanoke, which included the extreme northeast end of the present mapped area.

Geographic Features

The upper Roanoke River Valley lies between Fort Lewis Mountain and Poor Mountain along the west foot of the Blue Ridge Mountains and is a part of the Valley of Virginia. Annual rainfall for the area averages 41.5 inches (Rich and Payne, 1954). The relief ranges from moderate at the eastern end to high at the western end. Maximum relief is about 1,500 feet. The highest point in the mapped area is the 2,540-foot knob at the eastern end of Hightop Mountain, two miles northeast of Fagg. The lowest point is at approximately 1,000 feet, where the Roanoke River leaves the area to the south of Salem. Local relief ranges considerably throughout the area. At the eastern end it is about 200 feet; in the central part, between 400 and 600 feet; whereas at the western end, the local relief can be as much as 900 feet, with the average around 700 feet.

The area mapped is entirely within the Roanoke River drainage system, which empties into Albermarle Sound, North Carolina. Both the North Fork and the South Fork of the Roanoke River flow across the western half of the mapped area and join at about the center of the area mapped. No major tributaries of the Roanoke River originate within the area, but Bradshaw Creek and Ellett Creek, each of which are of considerable size, join the Roanoke within a mile after entering the area. Many lesser tributaries drain the slopes of Fort Lewis Mountain, Poor Mountain, and the Pedlar Hills.

The area is predominantly wooded, with the only cleared land being large farms and pastureland in the alluviated valleys and small farm plots up the many hollows away from the main roads. Around the turn of the century, much of the land near the bases of the mountains was cleared farmland; but it has since been allowed to return to the forested state.

Much of the area is underlain by rock formations which weather readily and leave few good outcrops. The best exposures are along railroads and highways where recent work has resulted in exposing fresh rock in many places. Streams give fair but discontinuous exposures, because the rock is in many places deeply weathered or covered by alluvium. The poorest exposures are on hillsides where the cover of soil and vegetation is thick.

Rural culture predominates throughout the area, except along U. S. Route 11, where a number of commercial enterprises catering to the tourist trade exist. Recently, with the springing up of many new housing developments, the wide valley southwest of Salem has become suburban. The main lines of the Norfolk and Western Railway and the Virginian Railway cross the area from end to end. Several industries are located along the railroads in the valley floor west of Salem.

ACKNOWLEDGMENTS

The writer wishes to express his appreciation to Dr. B. N. Cooper, Head of the Department of Geological Sciences, for his guidance and interest during the work on this report. The writer is also indebted to the other members of the staff of the Department of Geological Sciences, particularly Dr. W. D. Lowry, Dr. C. E. Sears, and Dr. R. V. Dietrich, who also visited the writer in the field and who made suggestions incorporated on the geological map and in this report; and to Commissioner R. V. Long of the Virginia Department of Conservation and Development, and Acting Commissioner G. R. Long of the Virginia Division of Planning and Economic Development for permitting the writer to use the drafting facilities of the latter agency in the preparation of the geologic map and cross sections. The project was supported by the Norfolk and Western Railway Company under Project of the Virginia Engineering Experiment Station.

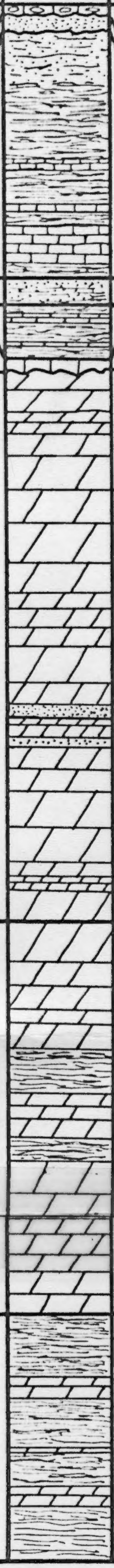
STRATIGRAPHY

General Statement: Although the rocks in the mapped area range in age from Precambrian to Recent, only those from Middle Cambrian to Lower Devonian were studied in detail. The southeastern limit of these rocks is the traces of the Fries and Blue Ridge faults, where Precambrian metamorphic rocks and Lower Cambrian clastic sedimentary rocks are thrust upon the Middle Cambrian shales and carbonate rocks. The northwestern limit of the formations studied in detail is, in general, the trace of the Salem fault, where Middle Cambrian formations are thrust over Middle Devonian shales. Formations in several small folds northwest of the Salem fault were also included. Unconsolidated alluvial and colluvial deposits of Late Cenozoic age, which lie upon the bedrock formations, are also described. The rock units were mapped primarily on the basis of lithology.

Crystalline Rocks

The oldest rocks of the area are metamorphic rocks of supposed Precambrian age. These are part of the overthrust sheet of the Fries fault. On the northeast flank of Twelve O'Clock Knob, east of Route 694 which crosses the mountain, the rock is a highly weathered granitic crystalline rock which forms few outcrops and is usually exposed only in roadcuts and excavations. In the South Fork Valley, along the base of the Blue Ridge uplands west of Route 607, the rock is a greenish gneissic rock which weathers to a dark brownish gray color. It is well exposed in the stream beds which descend the slope from the uplands to

Plate 4



System	Formation	Columnar section	Thickness in feet
Devonian	Huntersville chert		15
	disconformity		
Silurian	Clinch (?) sandstone		50
	disconformity		
Ordovician	Martinsburg formation		900?
	Bays formation		85
	Liberty Hall formation		200
	Effna limestone		15±
	disconformity		
Ordovician / Cambrian	Knox dolomite		2000?
	major fault		
Cambrian	Elbrook formation		1500?
	major fault		
	Rome formation		900?

Columnar section of the bedrock formations in the upper Roanoke River Valley area, Virginia.

the valley of the South Fork of the Roanoke River between Fishers View Mountain and Poor Mountain.

Chilhowee Group

The Lower Cambrian clastic rocks were first named by Safford (Wilmarth, 1938) as the Chilhowee sandstone from Chilhowee Mountain, Blount County, Tennessee. The formation has since been divided into the Unicoi, Hampton, and Erwin formations, in ascending order. These formations are composed of interbedded quartzites, siltstones and shales, and are exposed along the flanks of Poor Mountain. The Chilhowee group was estimated by Woodward (1932) to be at least 2,500 to 3,000 feet thick in the Roanoke area.

The Shady dolomite, which lies above the Erwin formation, does not crop out within the area mapped. Dietrich (1954) shows two small areas of Shady which occur just outside of the area southeast of the trace of the Blue Ridge fault in the South Fork Valley.

Rome Formation

Hayes (1891) named the formation from exposures near Rome, Georgia. It is present throughout the length of the area south of U. S. Route 11. In the western end between Wanless Chapel and Shawsville, the Rome formation is present along the ridge parallel to the highway. This body of Rome appears to be a klippe lying upon tectonic breccia of the Max Meadows fault zone.

The Rome formation is made up of shales, siltstones, and dolomites. The clastic rocks are mostly red or maroon shales and siltstones and buff, gray, and green shales. Thin beds of sandstone are exposed in association with some of the red shales. The dolomites in the Rome formation resemble both the dolomite in the older Shady formation and that of the younger Elbrook formation. In the area mapped, the dolomite probably makes up at least half of the formation. However, the red shales and siltstones are the most noticeable rock types of the Rome, and because of their resistant character, they are usually the best exposed of all the lithologic types in the formation. Therefore, the impression is given that the red shale is the major constituent of the Rome. It is made up of thin laminae of red or maroon clay shale and siltstone. Mudcracks are abundant on some surfaces. The silty or sandy layers exhibit crossbedding and small cut-and-fill structures. In many places the red shale is associated with greenish shales, gray shales, buff shales, and buff siltstones. On Route 639 in Roanoke County, 1.5 miles east of Bend Union Chapel, siltstones dipping steeply southeast to vertical contain fragments of the trilobite <u>Olenellus</u> <u>romensis</u> Resser and Howell (Butts, 1940).

Most of the dolomites in the Rome formation resemble the dolomites of the Elbrook formation. They are thin to medium bedded and are a light-gray to medium-gray where fresh. Some beds are argillaceous. Upon decalcification the rock appears to be shaly. Along Route 639 one mile south of Green Hill Chapel the dolomite is interbedded with red and buff shales which make the entire exposure appear to be of shale. Beds of dolomite in the Rome formation which resemble the

Shady dolomite are found toward what is probably the bottom of the formation. The dolomites which crop out near the Blue Ridge fault are medium bedded, fine grained, and light- to medium-gray. Outcrops of this rock are found in the South Fork Valley between Route 607 north of Piedmont and the Blue Ridge fault. Some white chalcedonic chert is also present in this area. The dolomite is also found just below the Blue Ridge fault on the slope of Poor Mountain between Routes 649 and 612 southeast of Riverside in Roanoke County. It is exposed in cuts along an old mining railroad on the side of the mountain. Zones of black, thick-bedded, crystalline dolomite about 20 feet in thickness are also present in the Rome formation.

Brecciated Rome shale is found at the contact of the Rome formation with the rocks of the Blue Ridge overthrust sheet in Dry Hollow, Dry Branch, and in the stream along Route 737 south of Green Hill Chapel. In the South Fork Valley a silicified breccia is found as float between the Rome and the Chilhowee group. Near the trace of the Max Meadows fault the Rome formation is highly deformed with many tight drag folds. These can be seen in the Norfolk and Western Railway cut half a mile south of Route 639 at Riverside (Plate 6A).

The Rome formation is nonresistant and weathers readily into small chips. The soil is thin and is usually a brown color, but where present above the black, crystalline dolomite the soil is an orange-red color because of small amounts of iron present in the dolomite.

The Rome formation is made up mostly of incompetent rocks which in part lie beneath the overthrust rocks of the Blue Ridge and Fries faults, and has been deformed by shearing stresses and thrown into a great many minor folds. Many of the laminated silty dolomite beds show tight internal drag folds which would indicate that these beds were weak zones and that the deforming stresses affected this type of rock more than other types (Plate 6B). Breccia zones also occur irregularly throughout the formation. Minor thrust faults also are present in the Rome, which repeat the beds in some places and probably delete some beds in other places. Repetition of the lithologic types in the Rome formation is possibly the result of faulting and minor folding. However, it is possible that some repetition is of sedimentary origin. Until reliable key beds are found, the detailed structure of the Rome belt of outcrop in this area will be impossible to determine. The general structure is a syncline whose overturned southeast limb is cut off by the Blue Ridge fault (Plate 3).

Elbrook Formation

The Elbrook formation was named by Stose (1906) from exposures in a quarry near Elbrook, Pennsylvania. It occurs in a belt from one to four miles wide running the length of the area. A small klippe of Elbrook lies on Devonian shales at the sharp bend in Route 603 half a mile northwest of Lafayette.

The Elbrook formation is nonresistant and is rather poorly exposed in most places. The formation is made up chiefly of dolomite but also contains many zones of shaly dolomite (Plate 7A). Some magnesian limestones are also present. The dolomite is fine grained and has a medium-gray to black color. A freshly broken surface has a dull luster. The gray dolomite is medium bedded and weathers to a drab grayish-brown color. Weathering tends to obscure the bedding and often the surface of the rock is covered with lichens. The black dolomite is thin to medium bedded and has a great many calcite- or dolomite-filled fractures. The shaly dolomites are thin bedded and are light-gray to buff. Some beds may even be classified as dolomitic shales because of the large amounts of argillaceous matter present in them. These shales are rarely exposed on outcrop and weathered chips in the soil are the only indication of their presence.

Beds of magnesian limestone occur in the River Ridge-Pedlar Hills region between the valleys of the North Fork and the South Fork of the Roanoke River. These can be detected by the light bluish-gray color and smooth, weathered surfaces. Thin interlaminations of dolomite are present as buff-gray crenulations only slightly more resistant to weathering than the limestone. Lichens do not grow upon these magnesian limestones. On a freshly broken surface, the limestone is very fine grained and cut by fine, calcite-filled fractures. The color of the fresh rock is a very dark gray or black. Light-gray, crystalline, limy beds also occur within the Elbrook formation.

Red shales similar to the red shales in the Rome formation have been reported in the Elbrook. One occurrence was noted on River Ridge where Route 637 up Royal Hollow crosses the crest of the ridge.

Sheared reddish and greenish shales are exposed in the road bank. At several other locations in the River Ridge-Pedlar Hills region, weathered tan and pinkish shale chips were noted in the soil. A highly leached and sheared pink shale is exposed on Route 642 in Roanoke County, about 0.75 mile northwest of the junction of this road with U. S. Route 11.

The soil of the Elbrook is for the most part a sticky, heavy, brick-red clay. The areas underlain by the magnesian limestone have a soil that is thinner and is a darker red than the usual Elbrook soil. Although Woodward (1932) states that the soils of the Elbrook formation are free of chert; masses of chert, both of the white and the chalcedonic types, are found at a number of locations within the Elbrook zone of outcrop.

The Elbrook formation lies in part beneath the Max Meadows thrust sheet and is the only formation of the Salem thrust sheet exposed within the mapped area. Because of the brittle nature of the rocks and their occurrence between two thrusts, the Elbrook formation has been highly fractured and sheared (Plate 7B). The roadcut along Route 626 between U. S. Route 11 and the North Fork Valley gives a good indication of the structure of the formation. Southeast-dipping shear zones and many drag folds are exposed. Attitudes taken along Routes 636 and 637 (Seneca Hollow Road) indicate that exposures of Elbrook in the belt of outcrop exhibit wide ranges of strikes and dips within short distances. It is believed that the entire Elbrook formation is broken up by many fracture zones and faults, and that determination of the detailed structure would be extremely difficult.

According to Butts (1940), the Elbrook formation is present on the southeast side of the Appalachian Valley and is correlated with the Honaker dolomite and the overlying Nolichucky shale of the northwestern side. In the southwestern end of the Valley, the Rutledge limestone, Rogersville shale, and Maryville limestone are equivalent to the Honaker and are overlain by the Nolichucky shale. Woodward (1932) estimated the thickness of the Elbrook to be between 1,000 and 1,600 feet in the Roanoke area, but added that the rocks are so faulted and drag folded that no accurate determination could be made.

Knox Dolomite

The Knox dolomite was named by Safford (1869) for exposures in Knox County, Tennessee. The lower part crops out within the area of the present report only in the extreme southwestern end. The upper part is exposed only along the base of Fort Lewis Mountain between Route 777 northwest of Glenvar and Route 778 northwest of Riverside.

The lower part of the Knox is composed mainly of light-gray, medium- to fine-grained dolomites which weather to a light-gray, almost white color except where stained by clay from the overlying soils. Usually the exposed ledges have a medium-bedded, blockly appearance without any of the rounding effects of weathering. A few beds of dark-gray, medium-grained magnesian limestone occur in the formation. Because of dolomitic laminae in the limestone, these beds weather in a crenulated pattern with small projecting ledges of the more resistant dolomitic layers.

Beds of quartzose sandstone occur at intervals within the lower part of the Knox. The thickest sandstone beds in the area are no more than five or ten feet thick. According to Butts (1940) these beds occur as discontinuous lenses throughout the formation and cannot be traced laterally for long distances. These sandstones consist of coarse, rounded quartz grains cemented by calcite or dolomite. Some are no more than rounded quartz grains in a matrix of dolomite. The cement is dissolved away upon weathering and the rock becomes crumbly and is stained orange.

Beds of a dense, hard quartzitic sandstone, probably Knox sandstones in which the calcite cement has been replaced by silica, are present along the ridge parallel to U. S. Route 11 one mile south of Wanless Chapel. Much white chert and sandstone float is also present on this ridge. The rocks are in a window surrounded by tectonic breccia and partially covered by a klippe of the Max Meadows overthrust sheet. The Knox dolomite is rarely exposed in this window because of the extensive soil and vegetation cover and also because of the lack of artificial exposures.

The lower part of the Knox dolomite is the equivalent of the Copper Ridge and Conococheague formations. Butts (1933) mapped the formation as Conococheague in the area covered by the present report, but it is almost entirely dolomite and is very similar to beds identified elsewhere by Butts (1940) as Copper Ridge.

On previous maps (Woodward, 1932; Butts, 1933: and Waesche, 1934) the lower part of the Knox, which was designated Conococheague, was shown as extending in a synclinal belt from the foot of Christiansburg Mountain to Middle Piece Mountain north of Shawsville. At the foot of Christiansburg Mountain the exposed Knox is broken up and partially brecciated and is in fault contact with the tectonic breccia on the east and north. Quartzite beds of the lower Knox south of the highway between Christiansburg Mountain and Shawsville are in a small window associated with the Max Meadows fault. The Knox belt extends to the southwest for almost 20 miles beyond the limits of the mapped area and terminates north of Snowville, Pulaski County (Butts, 1933).

The Knox dolomite does not cross U. S. Route 11 at Shawsville as Woodward (1932), Butts (1933), and Waesche (1934) indicate. Only the tectonic breccia and blocks of Elbrook dolomite are exposed in cuts along the highway at Shawsville. None of the distinctive lower Knox sandstones were found north of Shawsville on Middle Piece Mountain. As cherts occur within the Elbrook formation as well as light-gray dolomite, the rocks in this area were all considered to be Elbrook.

The upper part of the Knox dolomite is in the belt of rocks northwest of the Salem fault which lies between the Elbrook formation and the Devonian shales. The formation is covered in most places by soils and gravel from Fort Lewis Mountain, but is partially exposed in all of the stream valleys which cross the belt (Plate 8A). The upper Knox is the lowest formation present in the belt of rocks exposed along the southeast foot of Fort Lewis Mountain, which is an overturned section containing rocks that range in age from Early

Ordovician to Early Devonian.

The upper Knox, which is correlated with the Beekmantown formation of northern Virginia, is made up of medium- to dark-gray, medium-grained dolomites and a very fine-grained limestone, or calcilutite. The dolomites weather to a buff-gray color and usually have mosses or lichens on the surface of the outcrop. The fracture is roughly conchoidal, but granular, with thin flakes of the rock adhering to the fracture surface. These flakes are buff-colored when contrasted with the gray color of the fresh rock. The limestone weathers to a pale bluish-gray color and has a rounded, "water-worn" surface with no lichens. The fracture is conchoidal and fresh surfaces show small calcite "eyes". Small, thin fragments of this limestone give a ringing sound when struck. In one locality, the second branch to the west of Stypes Branch, the dolomite contains a sedimentary breccia of dark-gray dolomite fragments within a lighter gray dolomitic matrix.

The upper part of the Knox is structurally separated from the lower Knox formations by the Salem overthrust. Because only a small portion of the lower Knox is present in the area and it is poorly exposed, no thickness was measured. The upper Knox is at least 500 feet thick in the belt along Fort Lewis Mountain, and is probably much thicker.

Between the Knox and the next youngest beds exposed there is a disconformity which corresponds to the disconformity at the top of the Lower Ordovician elsewhere in the Appalachian region. On Stypes Branch, a fragmental limestone considered to be the Middle Ordovician

Effna limestone overlies the Knox. The contact zone is silicified and contains about one or two feet of chert gravel and weathered, friable dolomite (Plate 8B). Elsewhere along this belt of outcrop the Knox is in contact with the Liberty Hall formation, with the lower Middle Ordovician limestones missing.

Effna Limestone

The Effna limestone was named by Cooper (1944-a) for exposures near the village of Effna, Bland County, Virginia. The rock occurs in Stypes Branch stratigraphically above the overturned Knox dolomite, and is considered to be Effna partly on the basis of fossil evidence and partly by lithology (Plate 9A).

The formation in Stypes Branch is a medium-gray, coarse-grained biostromal limestone composed mainly of fossil fragments. Lenses of fine-grained limestone are also present. The rock weathers to a drab, gray-brown color with rough surfaces except where it has been worn smooth by stream action. Fossil brachiopods in the formation include <u>Sowerbyella negritus</u> (Willard), <u>Oxoplecia depressa</u> Cooper, and <u>O. holstonensis</u> (Willard), (Cooper, G. A., 1956). Bryozoans and crinoid "buttons" can be seen on the weathered surfaces.

In only one other locality was this type of rock found. At the head of Deyerle Hollow a block of limestone resembling the Effna in Stypes Branch occurs in the ravine beside the road along with blocks of the upper Knox dolomite. As Devonian shales are to the northwest and a small belt of rocks involving the Clinch sandstone, the Martinsburg formation, and Devonian shales lies to the southeast, it is believed that the limestone and dolomite blocks are fragments brought up along the Salem fault zone from the buried formations.

Because of the local relief of the disconformity at the top of the Knox, the thickness of the Effna limestone in Stypes Branch ranges from 10 to 16 feet within a horizontal distance of 50 feet. The Effna limestone is correlated with the Arline and Fetzer limestones of Tennessee and southwestern Virginia and the Botetourt member of the Edinburg formation of central and northern Virginia (Cooper, G. A., 1956).

Liberty Hall Formation

The Liberty Hall formation was named by H. D. Campbell (Wilmarth, 1938) for exposures near Liberty Hall, Rockbridge County, Virginia; and the name has been revived by Cooper, B. N. and Cooper, G. A. (1946), because the name used before, Athens, had too restricted a use. The name Liberty Hall was given to a particular facies and was not intended for use as a time-stratigraphic term (Cooper and Cooper, 1946). The formation is exposed in the belt of rocks along the southeastern foot of Fort Lewis Mountain and around the northwestern and northeastern slopes of Little Brushy Mountain.

The lower part of the formation is predominantly a fissile, chocolate-brown to black, calcareous shale. Thin interbeds of black argillaceous limestone are more abundant toward the top. Everywhere in the area the Liberty Hall formation has been subjected to deforming stresses with the result that in many places the bedding in the shales has become disrupted, and the limestones have been cut by many calcite-filled fractures (Plate 9B). The shales weather to a greenish-gray or greenish-tan color and decompose into irregularly shaped splinters or chips. The limestones weather to a pale blue-gray color stained tan by the included argillaceous matter. The calcite-filled fractures weather out in relief. In Stypes Branch, black shales in the Liberty Hall contain graptolites of the genera Dicellograptus and Dicranograptus.

Bays Formation

Keith (1895) named this formation from exposures on Bays Mountain, Hawkins and Green counties, Tennessee. Within the mapped area it is exposed around the western, northern, and eastern slopes of Little Brushy Mountain; throughout the length of the belt of rocks exposed along the southeast foot of Fort Lewis Mountain; and possibly in several localities along the Salem fault zone in the North Fork Valley, where Bays-type sandstones occur. From Falls Hollow southwestward to the limits of the mapped area, exposures of sheared red shale or mud-rocks are beneath the recrystallized dolomites of the Elbrook formation at the sole of the Salem overthrust sheet.

Dark-red to maroon siltstones or mudrocks and greenish-gray siltstones or mudrocks make up the formation along with thick beds of impure sandstone (Plates 10A and 10B). The siltstones are lumpy, calcareous, and weather to crumbly splinters. The sandstones are dark-gray, medium to thick bedded, and argillaceous with spots of brown limonite showing on freshly broken surfaces. The weathered sandstones range from drab-brown to pale-gray in color. Thin beds of sandstone from one to six inches in thickness occur with the red siltstones.

The formation is considerably less than 100 feet thick in the area. It is possible that this is the result of deformation which has deleted parts of the formation, but it is also possible that the formation is substantially thinner than on the other flank of the Salem syncline. The thickness measured along Stypes Branch is 50 feet whereas the thickness in the next stream to the southwest is only 15 feet.

Geologic Section 1. Bays formation along the Forest Service Road 0.5 mile northwest of Big Hill Church, Roanoke County, Virginia.

	Thickness feet
Martinsburg formation	
Bays formation (84 feet)	
6. Siltstone, maroon and brown with shaly layers, thin-to medium-bedded, lumpy and non-fissile------	5
5. Sandstone, greenish-gray, impure, medium-to thick-bedded; flakes of mica on bedding planes----	6

4.	Siltstones, maroon and brown, sandy, thin-and medium-bedded with blocky jointing; some red and green shales------------------------------	22
3.	Sandstone, pale brownish-gray to green; some red and green siliceous shales----------------	14
2.	Siltstone, light-brown, thin-to medium-bedded; some green and brown shales and thin-bedded, blocky jointed, gray-green sandstones; also a few thin beds of maroon shale-----------------	17
1.	Sandstone, dark-to medium-gray, impure, medium-to thick-bedded; small brown spots of limonite on fresh surfaces-----------------------------	20

Liberty Hall formation

Martinsburg Formation

Geiger and Keith (1891) named the Martinsburg for exposures near Martinsburg, West Virginia. The formation crops out around the western, northern, and eastern slopes of Little Brushy Mountain, throughout the length of the belt along Fort Lewis Mountain, and along the North Fork Valley west of Seneca Hollow. Everywhere it has been sheared and drag folded as a result of deformation during folding; and, therefore, its true thickness within the area cannot be determined. The thickness of the formation in the belt along Fort Lewis Mountain is at least 270 feet. It appears to be much thicker northeast of Little Brushy Mountain. Shale chips resembling the Martinsburg formation are associated with Devonian shales along the trace of the Salem fault in the North Fork Valley and may indicate that the Martinsburg is beneath the thrust sheet and that fragments were brought up along the fault zone as the thrust sheet moved toward the northwest.

The lower part of the Martinsburg formation is composed mostly of grayish-tan, fossiliferous, calcareous shale with many interbedded lenses of highly fossiliferous, coarsely crystalline limestone (Plate 11A). Brachiopods and bryozoans are exposed in profusion on the smooth, rounded, weathered surfaces. Hard, silty limestones are also present near the bottom of this sequence.

The upper part of the formation is composed of gray shales and gray-green, impure, friable sandstones which weather to a reddish-brown color. This sequence is best exposed in the cut along Route 603 in Montgomery County, about 0.25 mile west of Fagg. About 50 feet below the top is a silty bed which weathers into spheroidal masses up to four feet in diameter and resembles concretions. The bed is crowded with brachiopod fossils of the genera Lingula and Byssonychia (Plate 11B). Above the "concretionary" zone is a succession of evenly bedded, blocky jointed, unfossiliferous sandstones and siltstones. These beds weather to a rusty-brown color but the fresh rock has a greenish-brown color. The Orthorhynchula zone was not identified in the beds at this locality.

The only other exposures of the upper Martinsburg are in the first two creeks to the southwest of Stypes Branch, and also along the lower ends of Ginger Hollow and Seneca Hollow at their junction with the North Fork of the Roanoke River. Elsewhere, the upper Martinsburg is covered by float and debris from the overlying Clinch sandstone.

A hiatus, indicated by the absence of the Oswego sandstone and the Juniata formation, occurs at the top of the Martinsburg formation. The Clinch sandstone rests disconformably upon the Martinsburg throughout most of the area.

Clinch (?) Sandstone

This formation was first named by Safford (Wilmarth, 1938) as the Clinch Mountain sandstone from Clinch Mountain, Hancock and Hawkins counties, Tennessee. It originally included both the white sandstone of the present Clinch sandstone and the underlying red sandstones which are now known as the Juniata formation. Safford (1869) later restricted the term Clinch to the upper sandstone.

Butts (1940) considered the sandstone on Green Ridge (on the older topographic maps this ridge was called Smith Ridge), which is in line with the strike of the low knobs northwest of the summit of Little Brushy Mountain, to be the upper division of the Clinton formation, known as the Keefer sandstone member, instead of the Clinch sandstone which he believed to have pinched out. The true relationship could not be determined from the small area of outcrop within the writer's area. Therefore, for convenience in mapping, the formation was assumed to be Clinch, and is here designated Clinch (?) sandstone.

The Clinch (?) sandstone occurs on the southeast slope of Little Brushy Mountain, which is a dip slope. The line of low knobs northeast of the mountain, between the crest and Route 619, is also held up by the Clinch (?), which here is vertical and thinner than on Little Brushy Mountain. Between Route 777 (Stypes Branch) and Route 778 the overturned Clinch (?) sandstone underlies a line of low knobs along the base of Fort Lewis Mountain. Butts (1940) stated that the formation is ten feet thick at Fagg; however, the formation here is represented by a bed of Silurian quartzitic conglomerate about five feet thick overlain by about fifteen feet of dark gray, impure sandstone (Plates 12A and 12B) which is possibly of Early Devonian age. This belt, complicated by faulting, extends eastward along the south side of the North Fork Valley for two miles before it disappears beneath the Salem thrust sheet. On the north side of the valley, the Clinch (?) belt occurs well down the slope of Hightop Mountain and appears to thicken eastward. The actual crest of the ridge is capped by the Martinsburg formation. The Clinch (?) sandstone wraps around the eastern end of Hightop Mountain and forms a prominent dip slope (Plate 13A). Then it trends northwest beyond the mapped area. Clinch (?) float indicated that the formation has been recently removed from the summit of Mill Knob in the North Fork Valley and from the 1,280-foot hill one mile southeast of the summit of Little Brushy Mountain. Clinch (?) sandstone float is also present along Deyerle Hollow.

The Clinch (?) is thickest on Little Brushy Mountain where it is at least 50 feet thick and very probably is thicker (Plate 13B). Along the southeast slope of Fort Lewis Mountain it is about 20 feet thick but occurs only on the tops of the associated low knobs. In stream beds the Clinch (?) is either very thin or absent with the Martinsburg formation in contact with the Devonian shales. This is probably the result of sedimentary lensing of the formation which would account for the streams crossing the outcrop belt where the Clinch (?) is thinnest or absent, as described by Butts and Edmundson (1939) along Little North Mountain in Frederick and Shenandoah counties, Virginia. The Clinch (?) is six feet thick in the first stream to the southwest of Stypes Branch. Three-quarters of a mile due south of Ironto, along the foot of the Pedlar Hills, the Clinch (?) is exposed beneath the Salem thrust sheet. To the east and west of this locality, however, the Clinch (?) is absent, and the underlying Martinsburg formation is in contact with the Devonian Millboro shale. Woodward (1932) states that in the Roanoke area, the thickness of the Clinch sandstone ranges from 10 to 100 feet.

The formation in the area mapped is composed of medium- to thick-bedded quartzitic sandstones with interbeds of unctuous clayey mudstone. The sandstones are cross-bedded, and locally conglomerates occur, which contain quartz pebbles up to half an inch in diameter. Usually the fresh rock is white and weathers gray or tan. Many of the exposures show that the rock is stained with traces of manganese and limonitic iron. Interstitial deposition of silica has made the rock almost a quartzite, but prolonged weathering on the outcrops has removed the cement locally and the rock is very friable. Slickensided surfaces cut across the bedding in many places within the formation. The dark-colored, friable sandstones ~~which occur above the quartzitic~~

sandstones may be of early Devonian age. These beds are reddish brown or dark gray and weather brown.

Geologic Section 2. Clinch (?) sandstone in cut along Route 603 at Fagg, Montgomery County, Virginia.

	Thickness feet
Huntersville Chert	
Clinch (?) sandstone (20.5 feet)	
3. Sandstone, dark-gray; weathers red; interbedded lenses of medium-gray, quartzitic sandstone; also some crumbly, ferruginous beds, possibly Lower Devonian	15
2. Sandstone, dark reddish-brown, ferruginous, with thin quartzitic conglomerate layer, possibly Lower Devonian	0.5
1. Sandstone, white to light-gray, weathers to white, very hard, almost quartzitic; 6-inch bed of conglomerate two feet above base	5
Martinsburg formation	

The Clinch sandstone is correlated with the Tuscarora sandstone of northern Virginia, Maryland, and Pennsylvania, and with the Brassfield formation in extreme southwestern Virginia, Tennessee, and Kentucky. Between the Clinch (?) and the overlying Huntersville chert there is a hiatus marked by the absence of the Middle and Upper Silurian formations and also most of the Lower Devonian formations, which at most can be represented only by units 2 and 3 of Geologic Section 2.

Huntersville Chert

Price (1929) named the formation for exposures near Huntersville, West Virginia. The Huntersville chert occurs disconformably above the Clinch (?) sandstone. It is poorly exposed on Little Brushy Mountain and in the belt of rocks along Fort Lewis Mountain, where it shows up mostly as float blocks on the slopes. The best exposure is on the eastern end of Hightop Mountain in a cut along Route 603 (Plate 14A). At this locality it is at least ten feet thick. Farther west at Fagg, it is only three feet thick. In the first stream southwest of Stypes Branch it is five feet thick.

The formation is a dark brownish-gray, dense, chalcedonic chert which occurs in gnarly or knotty beds of irregular thickness. A few thin interbeds of siliceous shale are also present. Upon weathering, the surface of the rock becomes white and chalky. Cooper (1944-a) states that the Huntersville chert is the same as the Onondaga chert of Butts (1940).

Devonian Shales

Bedrock formations younger than the Huntersville chert were not differentiated into separate formations, but were mapped together as Devonian shales. From Ironto westward to Fagg in the North Fork Valley, Millboro shale is exposed on the overridden block of the Salem fault. It is highly fissile black shale and it has been thoroughly brecciated as a result of its proximity to the fault. Northeast of Ironto as far as Bradshaw Creek, shales of Naples and Portage age are present. They are less fissile than the Millboro and are composed of tan and gray clay shales stained with iron oxide. Many thin interbeds of brown sandstone are also present throughout the formation. East of Bradshaw Creek and extending almost to Little Brushy Mountain, beds of Chemung age occur. They are similar to the shales of Naples and Portage age but are darked and more siliceous, and the sandstones become thicker and more numerous. Just southwest of Little Brushy Mountain shales of Naples and Portage age are again exposed and exhibit much drag folding and minor thrusting. Probably 15 to35 feet of brown, lumpy to fissile shale directly above the Huntersville chert represents a partial equivalent of the Needmore shale of Onondaga age.

Tectonic Breccia

The age of the tectonic breccia is post-Devonian as it is younger that the Devonian shales which are the youngest bedrock formations in the area mapped. Cooper and Haff (1940) described the tectonic breccia associated with the Max Meadows fault as consisting of three types; near the Rome formation it is composed of sheared, macerated, and metamorphosed fragments of shale or phyllite; near the Elbrook formation it is composed of crushed and broken blocks of dolomite; and located roughly between the two zones is a third zone of crush conglomerate composed of subangular particles of the Rome and Elbrook formations in a matrix of finely ground rock flour.

Within the upper Roanoke River Valley area the zone of tectonic breccia is not too well exposed, as the crushed and broken rocks weather readily. The best exposures are in the western part of the area in the cuts along the Norfolk and Western Railway between Montgomery and Elliston, where all three types can be seen. In the area between the Norfolk and Western Railway and the South Fork Valley, the tectonic breccia is composed mostly of crushed and broken blocks of the Elbrook formation. Some outcrops of sheared and metamorphosed shale of the Rome formation are exposed along Porter Hollow 1.5 miles southwest of Shawsville.

The crushed and broken blocks of Elbrook dolomite are cut by many calcite-filled fractures and exposures exhibit a wide range of strikes and dips. The Rome fraction of the tectonic breccia ranges from broken chips of red, buff, and gray-green shale to a light-buff or pinkish-gray phyllite which has a micaceous sheen. The crush conglomerate, which is squeezed into these two breccia types as dikes (Plate 14B) is composed of pebble-sized fragments of the Rome and Elbrook formations enclosed in a groundmass of what appears to be finely ground Rome shale cemented with calcite (Plate 15A). It is a soft, porous, highly soluble rock which does not resist weathering.

The zone of tectonic breccia is poorly exposed in the eastern part of the area, where it is mostly covered by alluvium. The few exposures appear to be of crushed and recemented Elbrook dolomite.

Quaternary Surficial Deposits

The surficial deposits of the upper Roanoke River Valley area appear to be of three types. No distinct limits of these deposits could be determined; therefore, the geologic map gives only the general areas of their occurrence.

Colluvial deposits which resemble colluvial fans are present along almost the entire northwestern slope of Poor Mountain. The best development of these colluvial deposits is along Brake Branch and its tributaries. The colluvium is composed mainly of coarse gravel and angular cobbles, but a large percentage of subangular boulders between one and six feet in diameter are also present. These deposits along Poor Mountain do not have much interstitial clay. The fine fraction of the colluvium is primarily sand produced from the corrasion and disintegration of the boulders and cobbles.

A mile north of Piedmont in the South Fork Valley is a small hill with a large number of quartzite fragments on the eastern slope. This, however, is not part of a former thick colluvial deposit, but is probably float descending the hillside from a former klippe of the Erwin formation which once capped the hill (Dietrich, 1954).

Colluvial fan deposits similar to the ones on Poor Mountain but less well developed are present along Fort Lewis Mountain between Paint Bank Branch and the branch that descends the mountain at Big Hill. The boulders in these deposits are smaller than the ones on

Poor Mountain. These deposits also contain more clay which probably was derived from the Devonian shales on Fort Lewis Mountain. The deposits in Paint Bank and Big Bear branches are about 20 or 30 feet thick in the vicinity of the Salem fault.

One mile east of Fagg is a colluvial deposit containing large blocks of Clinch (?) sandstone and large amounts of sand and clay, derived from both the Clinch (?) and Martinsburg formations. There deposits represent talus creeping down from the formations which crop out on the steep slopes above Route 603.

The next type of surficial deposit is the high-level alluvium which represents river valley cobbles, gravels, and clays that were deposited by the Roanoke River when the valley floor was at higher levels than at the present time. These deposits are presumed to be younger than the colluvial deposits nearer the mountains.

The high-level alluvium is predominantly sandy clay and locally contains old stream channel deposits where gravels and cobbles are present, along with a greater percentage of sand. The cobbles are subangular to subrounded and range from about one foot in diameter down to pebble size.

The alluvium appears to be present on at least two terrace levels. Remnants of the higher level are preserved at about an elevation of 1,200 feet near Salem and rise to an elevation of around 1,300 feet west of Glenvar. Cobbles preserved on the 1,200-foot hills between Route 619 and Paint Bank Branch west of Little Brushy Mountain are very crumbly which indicates that they have undergone profound weathering over a long period of time. A good cross-section of an old channel is exposed in the roadcut along the south side of U. S. Route 11, one mile east of Lafayette. The higher alluvium has been removed from many of the hillsides both north and south of the Roanoke River.

The lower terrace is better preserved and ranges from an elevation of about 1,100 feet near Salem to about 1,320 feet at Shawsville. Good exposures of this terrace may be seen between Routes 693 and 694 south of Salem, 0.25 mile west of Wabun in the north bank of the Roanoke River, in the suburban development northeast of Fort Lewis School, and along U. S. Alternate Route 460 through the western part of Salem (Plate 15B). Near Salem, these old river valley deposits are up to 20 or 30 feet thick where situated upon the Elbrook formation. Ground water in the alluvium has dissolved the underlying Elbrook and thus produced a trap for the alluvium by lowering the bedrock surface. North of Fort Lewis School, shallow, saucer-like sinks and actual sink holes are present in the alluvial cover. Pinnacles of Elbrook beneath the alluvium are exposed at the intersection of Route 619 and U. S. Route 11 just west of the Salem city limits (Plate 16A).

Where it is situated above the Rome formation, the alluvial cover of the terrace is considerably thinner as this is a cut terrace and not one of depositional origin. The thickness ranges between five and ten feet; however, the underlying Rome is usually thoroughly leached. In the area between Route 693 and 694 in Roanoke County, the Rome is so thoroughly leached that small chips of tan shale are the only features to distinguish it from the overlying alluvium. Between Shawsville and Elliston, along the east bank of the South Fork of the Roanoke River, the alluvium on the terrace appears to be only a few feet thick. In the quarry of the Old Virginia Brick Company, half a mile south of Lafayette along U. S. Route 11, the alluvium is between five and ten feet thick, and the leached zone in the Rome is exposed to a depth of 10 to 15 feet. The leached Rome shale beneath the alluvial cover of the higher terraces was produced as the river cut its valley deeper and thus lowered the level of the water table from the alluvium into the underlying bedrock. Ground water in the alluvium precolated downward and dissolved the carbonate fraction of the Rome formation.

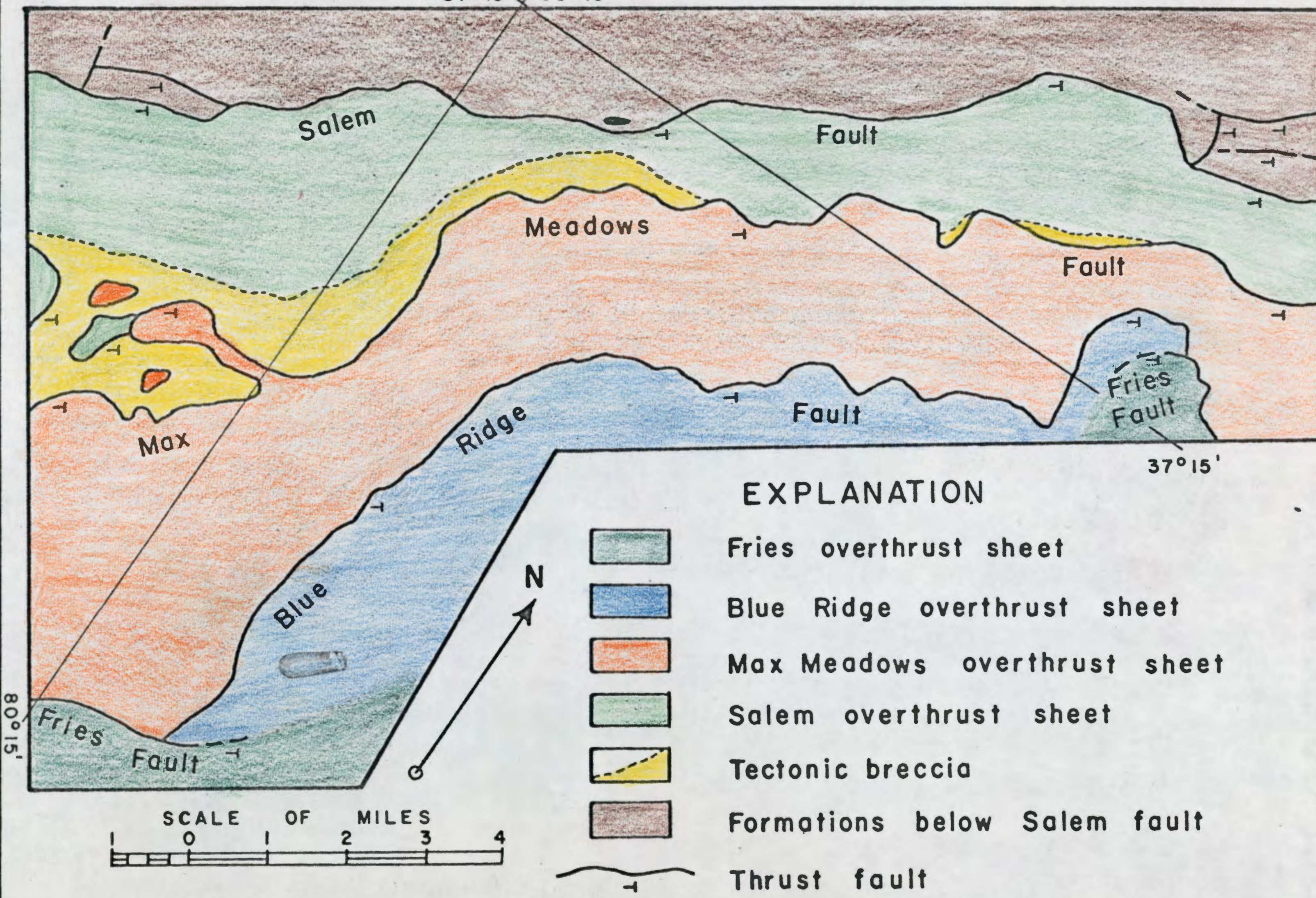
The youngest surficial deposits are the cobbles, gravels, and clays of the present valley bottom, which are similar to the higher level alluvial deposits in that they are composed mostly of sandy clay except for the present channel and abandoned channels where cobbles predominate. Although these coarse gravels and cobbles in the present channel and in the channels of the tributary streams are mostly reworked gravels and boulders from the colluvial deposits along the mountain slopes, they do show more rounding as the result of additional transport and corrasion. The thickness of the present strath level is about 25 feet or less as bedrock is exposed in the channel of the Roanoke River in many places.

The colluvium and alluvium are believed to be of Quaternary age. Possibly the upland gravels are late Tertiary age but so far as known there is no local evidence to establish this.

STRUCTURAL GEOLOGY

General Statement: The geologic structure of the upper Roanoke River Valley area is composed primarily of two overthrust sheets, the Salem thrust sheet and the Max Meadows thrust sheet (See geologic map, Plate 1; and structure sections, Plate 3, and reference map, Plate 5.) Two thrust faults occur within the mapped area at the soles of the overthrust sheets. The most northwesterly fault of the mapped area, known as the Salem fault has considerable stratigraphic displacement, as it has brought formations of Cambrian age into contact with formations which range in age from Cambrian to Devonian. The Max Meadows fault, which passes through the center of the mapped area, has only slight stratigraphic displacement, as the formations on either side of the fault are of Cambrian age, but an extensive zone of breccia has been developed along the fault. The formations comprising the overthrust sheets exhibit drag folds and are cut by minor faults as the result of deformational stresses set up by the thrusting. Brecciated zones also occur within these formations. The southeastern boundary of the mapped area is the trace of a third thrust fault, the Blue Ridge fault, which lies beneath the Fries overthrust sheet in the extreme eastern and southern ends of the mapped area. Several small anticlinal folds which have been broken by thrust faults are located on the overridden block northwest of the trace of the Salem fault.

Plate 5



Faults and overthrust sheets of the upper Roanoke River Valley area, Virginia.

Salem Fault

The Salem fault was named by M. R. Campbell (1925) from the city of Salem, near which this fault passes. It is a low-angle overthrust which involves the thrusting of the Elbrook formation of Cambrian age upon younger beds to the northwest. These younger beds range in age within the area from Early Ordovician in the belt of rocks along Fort Lewis Mountain to Middle Devonian elsewhere along the southeastern flank of Fort Lewis Mountain.

The trace of the Salem fault passes through the western end of the area about half a mile south of the North Fork of the Roanoke River. Toward the east it follows Ginger Hollow south of Mill Knob, and east of Seneca Hollow it occurs near the top of the southeastern wall of the North Fork Valley. ~~East~~ West of Lafayette, the fault trace leaves the river valley and follows the foot of Fort Lewis Mountain to Little Brushy Mountain, where it swings to the southeast in a deep re-entrant around that mountain.

Max Meadows Fault

The Max Meadows fault was named by Cooper (1939) for the thrust fault between the Rome and Elbrook formations near Max Meadows, Virginia. Dietrich (1954) called it the Christiansburg thrust. In the area of the present report it involves the thrusting of the Rome over the Elbrook and also younger formations, and lies southeast of the Salem fault. When compared with the other thrust faults in the region, the Max Meadows fault has only slight stratigraphic displacement, which is probably the reason why it was not recognized earlier as a major fault. However, it is important because of the extensive development of tectonic breccia and crush conglomerate along the fault trace.

The Roanoke River flows approximately along the trace of the Max Meadows fault throughout the length of the area. Near Salem, the fault leaves the immediate vicinity of the river valley and continues eastward through the city of Salem south of Main Street. South of Shawsville, the fault trace leaves the valley of the South Fork of the Roanoke River and continues on toward the southwest beyond the mapped area.

In the western part of the area, the lower part of the Knox dolomite is in a window surrounded by the zone of tectonic breccia and the Max Meadows fault. A small klippe of Rome surrounded by the Max Meadows fault is present on the ridge between U. S. Route 11 and the South Fork Valley. Quartzites of the lower Knox are also present on this ridge, which indicates that a small window of that formation exists beneath the Rome and the tectonic breccia.

Blue Ridge Fault

The Blue Ridge fault in the mapped area is actually a zone composed of many faults which includes the Poor Mountain thrust of Dietrich (1954). The fault is supposedly younger than the Max Meadows fault and involves the thrusting of the Lower Cambrian clastic rocks over the Rome formation. Along the trace of the fault the Rome has been crushed, at least locally, into a dense, highly macerated breccia which in places has been partially replaced by limonite. Silicification of the breccia into a jasper-like rock has taken place in the South Fork Valley.

The Blue Ridge fault crops out along the northwestern base of Poor Mountain. The Blue Ridge thrust sheet is overridden by crystalline rocks of the Fries thrust sheet on the northeastern side of Twelve O'Clock Knob in the eastern end of the area and also southwest of Piedmont along the base of the Blue Ridge uplands in the southern end of the area.

Fries Fault

The Fries fault marks the contact of the crystalline rocks of the Blue Ridge province with the Paleozoic sedimentary rocks to the northwest. The Fries fault is present in two places within the mapped area. West of Piedmont, along the Floyd-Montgomery County line, the crystallines are thrust over the Rome formation. The same relationship exists on the northeast slope of Twelve O'Clock Knob, east of Route 694. The contact swings southward across the mountain and roughly parallels Route 694 to expose the rocks of the Blue Ridge thrust sheet to the west.

Structures Northwest of Salem Fault

Several small folds are present on the overridden block northwest of the Salem fault and were probably formed prior to the development of the Salem fault. These are: the overturned anticline at Little Brushy Mountain, the overturned anticline at Mill Knob, and the overturned belt of rocks exposed along the southeastern foot of Fort Lewis Mountain; all of which are structural complications of the southeast limb of the large Salem syncline whose trough lies northwest of the mapped area.

Little Brushy Mountain (Plate 16B) is an anticline overturned to the northwest and with a plunge toward the southwest. It is also broken by minor thrust faults. A cross fault appears to complicate the structure of the northwestern corner. Mill Knob is situated on an anticline which is partially covered by the Salem thrust sheet. The formations are repeated as a shingle on the northeast limb by small thrust faults. A cross fault appears to cut across this same anticline at Fagg, as east of the village there are two belts of Clinch (?) sandstone which dip to the southeast, and west of Fagg there is only one belt of Clinch which dips to the northeast. Between this anticline and hightop Mountain lies the Salem syncline, the nose of which at Fagg is plunging 10 degrees toward the east.

Along the southeast base of Fort Lewis Mountain, between Riverside and Glenvar in Roanoke County, is a belt of rocks ranging from the Lower Ordovician Knox dolomite up to the Devonian shales. This belt is overturned to the northwest and the formations are in line with the strike of Green Ridge northeast of Salem. This belt represents the southeast limb of the large Salem syncline whose trough lies northwest of the mapped area. The incompetent formations in the belt show the effects of deforming stresses, as these formations exhibit a wide range in thicknesses and contain many drag folds. The buried southeastern synclinal limb is also exposed along Deyerle Hollow northeast of Lafayette, and along the foot of the Pedlar Hills south of Ironto.

However, the only formations exposed there are the Martinsburg, Clinch (?), and Huntersville.

Minor Folds and Faults

The Elbrook formation, which makes up the Salem thrust sheet, and the Rome formation, which makes up the Max Meadows thrust sheet, have been greatly contorted by drag folds and cut by minor thrust faults. Fracturing and faulting are the major deformational feature of the brittle Elbrook formation. The complicated structure of the Elbrook was produced as the formation was subjected to deformational forces, and it folded and broke into individual blocks which were subsequently rotated out of their original positions. These blocks were crushed and brecciated as the faulting and rotation took place.

The Rome formation was deformed primarily by drag folds and to a lesser degree by small thrust faults. Shearing stresses set up both prior to the formation of the Max Meadows, Blue Ridge, and Fries faults, and also during the times when these faults were active, produced the drag folds in the incompetent Rome formation. Many beds show evidence of having undergone intense deformation, as sheared zones and brecciated zones occur throughout the formation.

GEOMORPHOLOGY

The upper Roanoke River Valley area lies in the Valley and Ridge physiographic province, and owes its existence to the relatively non-resistant Rome and Elbrook formations that make up the valley floor. Poor Mountain, formed on the resistant members of the Chilhowee group, marks the western shoulder of the Blue Ridge province and is the eastern boundary of the valley. The western boundary of the valley is Fort Lewis Mountain, a ridge held up by Devonian and Mississippian sandstones preserved in the axial portion of the Salem syncline which lies to the northwest of the Roanoke Valley. Low knobs and ridges along the northwestern side of the valley are held up by lenticular occurrences of the Clinch (?) sandstone.

The Roanoke River between Lafayette and Salem roughly follows the trace of the Max Meadows fault. The easily eroded and highly soluble brecciated zone along the fault is the probable controlling factor. Between Shawsville and Lafayette the South Fork of the Roanoke River follows this same breccia zone (Plates 17A and 17B). Upstream from Shawsville, the South Fork cuts across a wide belt of the Rome formation, whereas the brecciated zone west of Shawsville is followed by Big Spring Branch. The North Fork follows approximately the trace of the Salem fault until it reaches Lafayette, where it joins the South Fork. No major streams follow the trace of the Salem fault between Lafayette and Salem.

In the western end of the area the extreme ruggedness of the topography is the result of recent encroachment of the Roanoke River into the drainage area of the New River. Remnants of the New River erosion level are present as the summits of several of the hills west and south of Shawsville at elevations of 2,000-2,200 feet. Dissection has destroyed nearly all of the old surface and most of the alluvial cover has been removed from the remnants of the old surface. However, rounded boulders of Erwin and Unicoi quartzites, which range from eight to sixteen inches in diameter, were found on the eastern summit of the 1,920-foot hill two miles southeast of Ironto, at the head of Falling Spring Hollow. Weathered boulders of the lower Knox sandstone, which exhibit case-hardened rinds, are present on top of the ridge between U. S. Route 11 and the South Fork Valley at an elevation of 2,000-2,100 feet. An old Roanoke River erosion surface with a floodplain type of alluvial cover is preserved at elevations between 1,200 feet near Salem and 1,300 feet near Glenvar.

Hills underlain by the Rome formation show a distinct linear pattern which parallels the strike of the bedding of the Rome. This reflects the relative resistance of the various rock types in the Rome. The marked linearity of Bonys Run, a tributary to the South Fork of the Roanoke River south of Shawsville, has been suggested by Dietrich (1954) to be related to either the shifting of a stream down the leg of a fold or the headward cutting of a stream along an obscured fault. Park Run and Brake Branch also tend to follow the strike of the Rome beds.

The drainage developed upon the Elbrook formation in the wedge-shaped area between the valleys of the North Fork and the South Fork of the Roanoke River is believed to follow obscured faults, fracture zones, and brecciated zones within the formation. The sharp eastward turn of the creek in Falls Hollow, and the upper part of Senecca Hollow are in brecciated zones. Pedlar Hollow and Clinkum Hollow probably owe their linearity to faults or fracture zones.

The larger streams which descend the slopes of Fort Lewis Mountain and Poor Mountain are choked with large boulders from the ridge-forming formations. Along the bases of both mountains, Poor Mountain in particular, are deposits of boulders and cobbles which resemble colluvial fans. Present climatic conditions are insufficient to produce these colluvial deposits. Dietrich (1954) states that there is a talus cover on the side of Poor Mountain almost to the crest, and suggests that it may have been formed by frost action during the last glacial stage.

The lower terraces along the Roanoke River between Shawsville and Elliston and between Glenvar and Salem are cut terraces and not depositional terraces. Rome bedrock is exposed at the foot of the terraces beneath a thin cover of alluvium. The Roanoke River is still cutting down its channel into bedrock as is shown by the many rapids that occur throughout its course within the area.

Between Big Hill Church and Salem the Elbrook formation is covered by a thick deposit of alluvium, laid down when the Roanoke River was at higher levels than at present. Dissolution of the Elbrook by ground water in the alluvial cover lowered the bedrock surface and formed a trap which has collected up to 20 or 30 feet of this alluvium. The less soluble Rome formation does not have this thick alluvial cover. Thin layers of gravel and clay are present above the Rome adjacent to the river and locally thick deposits in old, abandoned river channels do occur. Between Salem and Twelve O'Clock Knob the Rome has a thicker cover of alluvium and colluvium somewhat similar to that usually found on the Elbrook. Beneath its alluvial cover the Rome has been leached to a depth of about 10 to 20 feet. The thick red soil at Shawsville is weathered and leached tectonic breccia beneath a thick cover of alluvium. The alluvium has collected above the breccia in the same manner that it has collected above the Elbrook nearer to Salem.

On the topographic map it is interesting to note that where the flood plain of the Roanoke River is more than half a mile wide, the bedrock is either the Elbrook formation or the tectonic breccia associated with the Max Meadows fault, both of which are composed of soluble rocks. On the other hand, where the valley flats are less than half a mile wide, the river is flowing upon the Rome formation, which is composed primarily of insoluble shales and siltstones.

GEOLOGIC HISTORY

All of the Paleozoic bedrock formations within the upper Roanoke River Valley area are of sedimentary origin and were deposited in the Appalachian geosyncline from Cambrian time to Middle Devonian time. Some time after the latest known deposition of Mississippian time, the rocks of the area were folded toward the northwest and broken by four great overthrust faults, and the tectonic breccia was produced. A period of erosion which is still in progress followed the period of orogenic activity. Further sedimentation in the area has been restricted to local alluvial and colluvial deposits of Late Cenozoic age.

The heterogeneous character of the Rome formation indicates that from time to time conditions in the sedimentary environment changed. The sediments of which the Rome is composed were derived from a source beyond the area studied. Cross-bedding, mud cracks, and cut-and-fill-structures suggest that the Rome was deposited in a very shallow marine environment. Fossils are not numerous, but life may have been abundant and conditions for preservation may have been very poor.

The boundary between the periods of Rome sedimentation and of Elbrook sedimentation is not definite, as Elbrook-type dolomites are found in the Rome and Rome-type shales are present in the Elbrook. Probably the change from Rome sedimentation to Elbrook sedimentation was gradual, and as time progressed, less and less argillaceous material was carried into the depositional environment from the outside source. Therefore, carbonates precipitated from solution and reworked carbonate materials were the only sediments which accumulated. This condition persisted during the time that the Knox dolomite accumulated. However, near the end of Cambrian time, clastic sediments in the form of rounded quartz grains were introduced from an outside source.

A disconformity between the Knox dolomite and younger Ordovician formations suggests that some time after the deposition of the Knox and before the deposition of the younger formations, the Ordovician seas withdrew from the land, either by a drop in sea level or by a slight uplift of the sea bottom, and weathering and erosion of the newly formed land surface took place. Submergence certainly was resumed in Middle Ordovician time as the Effna limestone was deposited above a layer of chert gravel and weathered dolomite which lies upon the surface of disconformity. The abundance of fossil fragments in the Effna suggests that the material was transported from a source some distance away from the present location of the Effna. However, because the material is fairly coarse, it apparently was not carried by currents for any great distance.

The predominance of black shales in the Liberty Hall formation indicate that the sediments were laid down under reducing conditions. During the time of Bays deposition, muds and fine clastic sediments were carried into the depositional environment from an outside source. The range of rock types in the Martinsburg formation suggests fluctuating or variable sedimentation in the basin. Shales indicate that fine, argillaceous sediment was being carried in, thin lenses of fossiliferous limestone indicate that there were areas of fairly clear water where carbonate deposition could take place and fossils could be preserved, and the silty beds of the upper Martinsburg indicate that clastic materials were being introduced. A hiatus at the top of the Martinsburg formation, indicated by the missing Orthorhynchula zone, suggests that erosion or non-deposition occurred.

The lenticular character and relatively clean sands of the Clinch (?) sandstone suggest that the formation was deposited in a near-shore, shallow water or beach environment (Butts and Edmundson, 1939). After a period of nondeposition, the Huntersville was deposited, probably as a limestone in Early Devonian time, but replacement by colloidal silica in the depositional environment turned the limestone into chert. In Middle Devonian time, great quantities of clastic material, predominantly clay and silt, were carried by currents into the area from a distant source area, probably an uplifting landmass. The proportion of sand to the finer particles, such as clay and silt, increased as time went on, as is indicated by the increase in the number of sandstones within the younger Devonian formations. In the Salem syncline northwest of the mapped area, rocks of Early Mississippian age occur, which indicate that sedimentation in the area continued at least into Early Mississippian time.

In the upper Roanoke River Valley area orogenic activity took place some time after the deposition of the sediments in Early Mississippian time. At first, the deforming stresses were relieved by folding, and the small folds now exposed in the North Fork Valley and along the southeast foot of Fort Lewis Mountain were formed on the southeast flank of the Salem syncline, which lies to the northwest of the mapped area. As the deforming stresses continued, these small folds were broken by thrust faults. The Rome and Elbrook formations were also deformed by drag folds and faults. Finally the rocks yielded to the deforming stresses to form the Salem, Max Meadows, Blue Ridge, and the Fries faults. The Fries fault brought crystalline rocks of the Blue Ridge province upon the sedimentary rocks of the Valley and Ridge province.

Erosion of the Appalachian region began with the uplift of the old Paleozoic sea bottom in Late Permian or Early Triassic time. This erosional period is still in progress. Local alluvial deposition has probably occurred in the area throughout geologic time since the uplift. Talus deposits along Poor Mountain and Fort Lewis Mountain, which resulted from erosion during the Pleistocene glacial epoch, and recent alluvial deposits from old river floodplains represent the only sediments preserved in the area since Paleozoic time.

ECONOMIC GEOLOGY

General Statement: Although the upper Roanoke River Valley area has been prospected many times for mineral deposits of economic value, the only major operations at present are shale quarries for the production of common brick. In addition to the brick shales, other materials of possible economic consideration are crushed stone and ground water. Less important occurrences of lead and zinc, limonite, and shales for light-weight aggregate are also present.

Brick Shales

The Old Virginia Brick Company operates two quarries within the mapped area to supply its plant at Salem. One quarry is in the Rome formation near Lafayette (Plate 18A) where the shale lies beneath a cover of high-level alluvium and has been leached of almost all calcareous matter to a depth of at least 15 or 20 feet. The other quarry is in Devonian shales on the southeast slope of Little Brushy Mountain. (Plate 18B). The shales at this locality have been intensely folded and deformed. The material from both quarries is carried by truck to the plant where it is used in making common brick.

The belt of Devonian Millboro shale in the North Fork Valley between Fagg and Ironto may yield good rock which can be used in the production of brick. Paved Route 603 gives easy access to this area.

Stone

Small, abandoned quarries are present in several places in the Elbrook belt of outcrop where the dolomite has been used locally for crushed stone. In the wedge-shaped region between the North Fork and South Fork valleys the high relief would give quarries in the Elbrook dolomite a high working face above road level. However, the brecciated condition of the formation may militate against quarrying operations. Detailed structural mapping cannot be done as the exposures are too poor. Core drilling at prospective quarry sites would be helpful.

The massive dolomite beds in the Rome formation may be suitable for aggregate, but within the mapped area these beds usually occur at some distance from the main roads. Also, the complicated structure of the Rome formation may present difficult problems in quarrying operations. Unless the rock was to be used locally, it would be advisable to obtain it from a different formation in a more accessible area. Weathered shales of the Rome have been used locally for fill material. The Knox dolomite is quarried for rock aggregate immediately west of the mapped area.

In the wide valley east of Glenvar, the high-level river deposits are thick enough to be excavated economically for fill material. West of Glenvar, the alluvial deposits are thinner, less extensive, and are less well drained as they are nearer river level.

The rocks within the mapped area are, in general, too broken to be of much use as building stone. The dolomites of the upper Knox in the belt of rocks along the southeast foot of Fort Lewis Mountain appear to be massive and relatively unbroken in the few available exposures in stream channels. However, the inaccessibility of the rock in this area precludes its exploitation at present. Cobbles from the various types of alluvial and colluvial deposits could be used as building stone or ornamental stone.

Ground Water

According to Latta (1956), the predominant water-bearing formations of the Roanoke-Salem area are the limestone and dolomite beds of the Rome formation. About half of the springs and wells used as public and industrial water supplies are in this formation. Solution channels and fracture systems are the water-carrying zones. The next most important formation in regard to ground water is the Elbrook, in which nearly all of the remainder of the springs and wells used for water supplies occur. This formation is primarily made up of soluble dolomites which provide many water-bearing solution channels. The fractured condition of the Elbrook formation and the relatively low percentage of shale as compared with the Rome formation may actually make the Elbrook a better water-bearing formation than the Rome in the upper Roanoke River Valley area.

The alluvial deposits are, in general, too thin to be important sources of ground water and contain enough interstitial clay to fill up the pore spaces (Latta, 1956). Lenses of gravel which occur within the alluvial deposits may yield suitable amounts for local use but not for industrial use. The high-level alluvial deposits are usually situated upon soluble bedrock above the general ground-water table. Recent alluvium in the valley bottoms may be suitable as a source of ground water where it is subject to constant recharge by the adjacent river.

Streams descending Poor Mountain and Fort Lewis Mountain disappear beneath the gravel deposits in the stream channels at the bases of the mountains. However, this underground flow is confined to the immediate channel and does not supply any extensive ground-water zone.

The breccia zone associated with the Max Meadows fault is composed of highly broken and soluble materials and may be a formation which contains large amounts of ground water. However, the hardness of the water in this zone would be extremely high as the result of dissolution of the carbonate material.

The hardness of the water in the Rome formation ranges from about 100 parts per million to as much as 1,400 parts per million (Latta, 1956). Water from the Elbrook formation is usually softer than water from the Rome (Latta, 1956). There is no record of the hardness of the water from the river alluvium but it is assumed to be soft (Latta, 1956).

Sulphide Deposits

The only sulphide deposit within the area is in the ravine of the westward-flowing tributary of Bonys Run, about one and one-fourth miles southeast of Shawsville. Sphalerite and galena occur in a bed of medium-gray, fine-grained dolomite in the Rome formation. Both minerals are in disseminated crystalline masses throughout the rock, along with white, coarse-grained, crystals of secondary dolomite. The sphalerite crystals are both light yellow and bright red in color. Several prospect holes have been made, but the deposit has never been exploited commercially.

Limonite

Along the trace of the Blue Ridge fault on the northwest flank of Poor Mountain is a gossan which consists of a breccia cemented with limonite. Locally this gossan has been prospected and along the northwest slope of the mountain south of Riverside it has been mined. However, the limonite is of low grade and is not considered to be of economic value at present.

Light-Weight Aggregate

Red shales in the Rome formation bloat with a cellular internal structure when heated to 1,250 degrees centigrade in an electric furnace. Because these red shales are found in readily accessible areas, they may be of future importance as raw material for making light-weight aggregate. Devonian shales from northwest of the Salem fault between Fagg and Lafayette may be suitable for bloating purposes.

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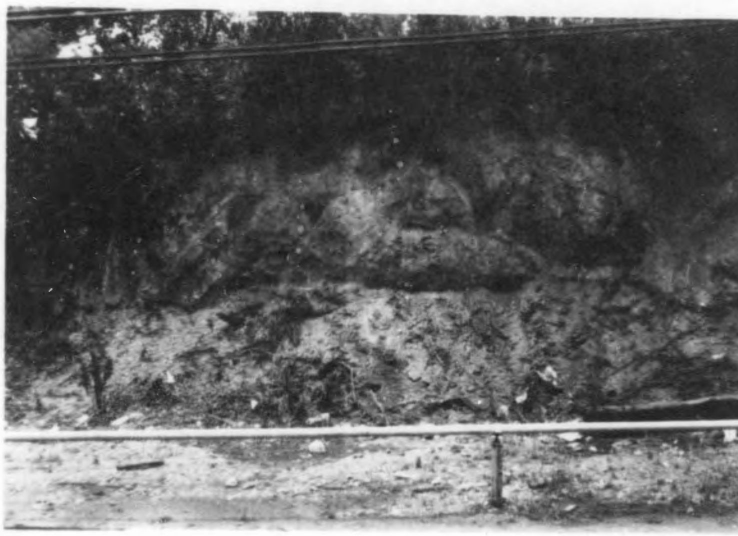
Plate 6.

A. Chevron folds in shales of the Rome formation near the Max Meadows fault. The beds are exposed in a cut along the Norfolk and Western Railway half a mile south of Route 639 at Riverside in Roanoke County.

B. Contorted shaly dolomite beds of the Rome formation in Dry Branch Hollow, half a mile south of Route 639 in Roanoke County.

Plate 6.

MAY 59



A

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B

Plate 7.

A. Dolomites of the Elbrook formation along U. S. Route 11 at Riverside which also contain beds of shaly dolomite. The pick rests on a small disconformity. Beds dip 30 degrees to the southeast.

B. A drag fold on the Elbrook formation along U. S. Route 11 at Riverside. The view is to the west.

Plate 7.

A

B

Plate 8.

A. Overturned Knox dolomite in Stypes Branch.

B. Overturned disconformity in Stypes Branch. The pick rests upon a layer of chert gravel and weathered dolomite at the disconformity. The Knox dolomite is to the left above the pick and the Effna limestone is to the right below the pick.

Plate 8.

A

B

Plate 9.

A. Effna limestone in Stypes Branch.

B. Sheared argillaceous limestones of the Liberty Hall formation along Route 619 east of Little Brushy Mountain. The view is to the east.

Plate 9.

A

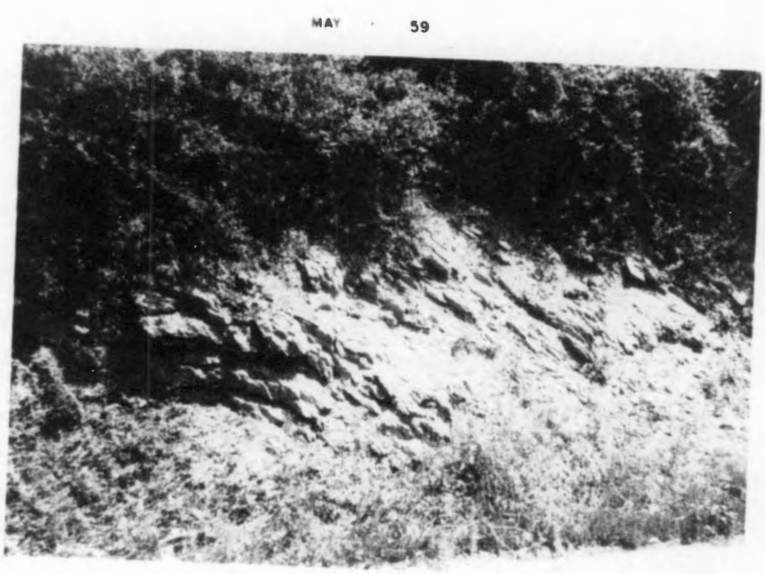

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Plate 10.

A. Sandstone beds of the Bays formation in the creek beside the Forest Service road half a mile northwest of Big Hill Church, Roanoke County.

B. Maroon shales and sandstones of the Bays formation. Same location as at A.

Plate 10.

A

B

Plate 11.

A. Thin limestones and shales of the Martinsburg formation in Stypes Branch.

B. "Concretionary" siltstone bed of the upper Martinsburg formation along Route 603 in Montgomery County, about 0.25 mile west of Fagg.

Plate 11.

A

B

Plate 12.

A. Conglomerate bed in the Clinch (?) sandstone, along Route 603 in Montgomery County at Fagg.

B. Dark red and gray sandstones of the Clinch (?) formation which lie above the conglomerate bed at "A" at Fagg. These beds may possibly be of Early Devonian age.

Plate 12.

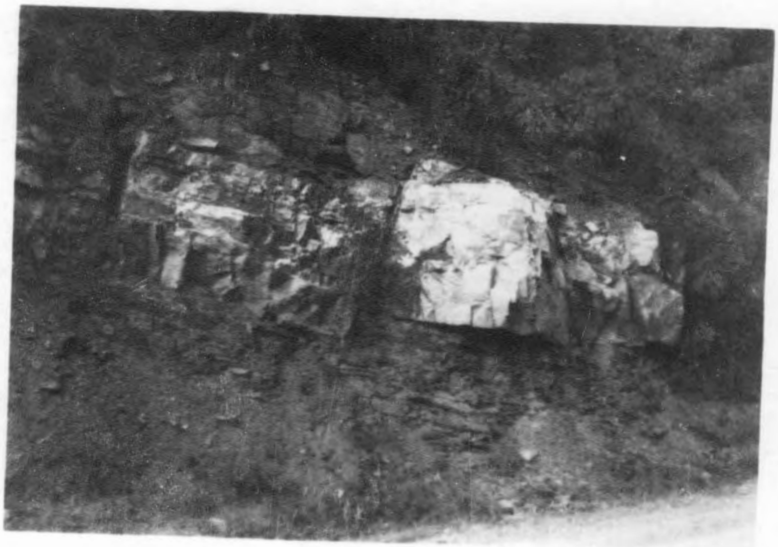

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Plate 13.

A. Clinch (?) sandstone along Route 603 two miles east of Fagg. This is a dip slope at the east end of Hightop Mountain. View is to the west.

B. Clinch (?) sandstone at the summit of Little Brushy Mountain. View is to the east.

Plate 13.

A

B

Plate 14.

A. Huntersville chert along Route 603 two and a half miles east of Fagg on the east end of Hightop Mountain.

B. Tectonic breccia along U. S. Route 11 about 0.25 mile east of Wanless Chapel. The large block of Elbrook dolomite is surrounded by dikes of crush conglomerate.

Plate 14.

MAY 59

A

MAY 59

B

Plate 15.

A. Crush conglomerate along U. S. Route 11 about 0.25 mile west of Wanless Chapel.

B. Alluvial deposits in a terrace exposed during construction along U. S. Alternate Route 460 through Salem.

Plate 15.

MAY 59

A

MAY 59

B

Plate 16.

A. Pinnacle of Elbrook dolomite exhumed from beneath a cover of alluvium at the intersection of Route 619 and U. S. Route 11, west of Salem.

B. Little Brushy Mountain as seen from the Roanoke Valley. View is to the northeast. Notice the quarry in the Devonian shales to the left in the picture.

Plate 16.

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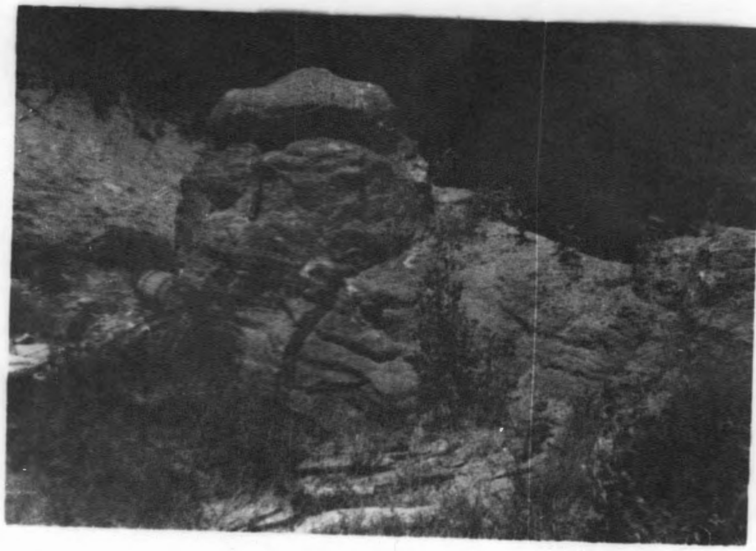

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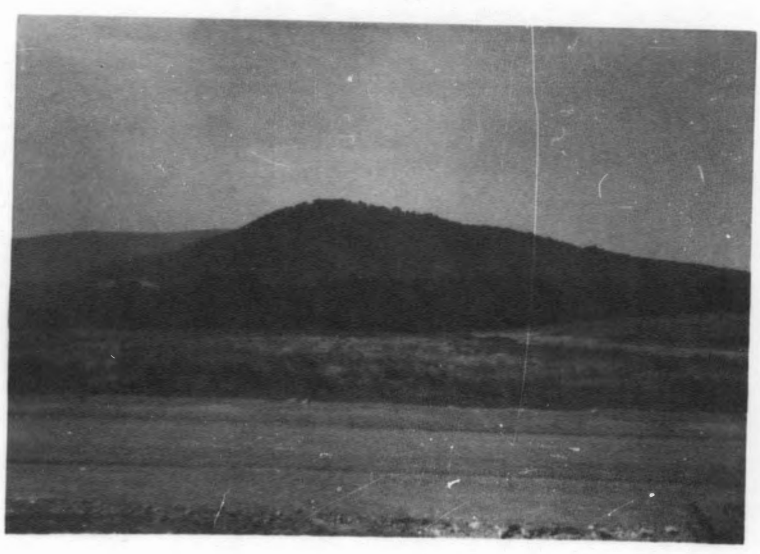

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Plate 17.

A. Roanoke Valley at Elliston as seen from Poor Mountain. View is to the northwest. The Rome formation underlies the hills in the foreground. Beyond the river valley (middle distance) which is in the zone of tectonic breccia, the hills are underlain by the Elbrook formation. The southeast end of Fort Lewis Mountain appears at the right of the picture.

B. Roanoke Valley at Shawsville as seen from Poor Mountain. View is to the west. The hills in the foreground are underlain by the Rome formation. U. S. Route 11 (middle distance) is in the valley bottom developed along the tectonic breccia zone. The hills to the right of the highway are underlain by the Elbrook formation. The large hill beyond the highway in the center of the picture is capped by a klippe of Rome.

Plate 17.

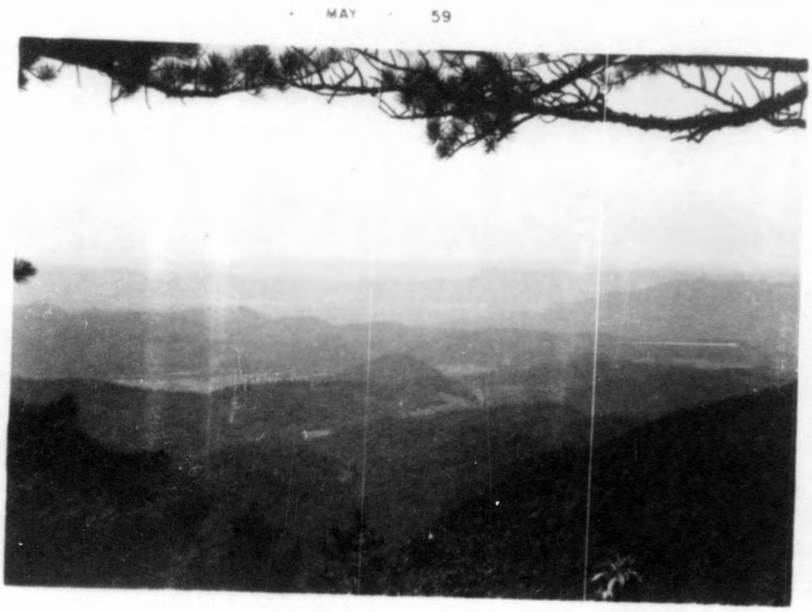

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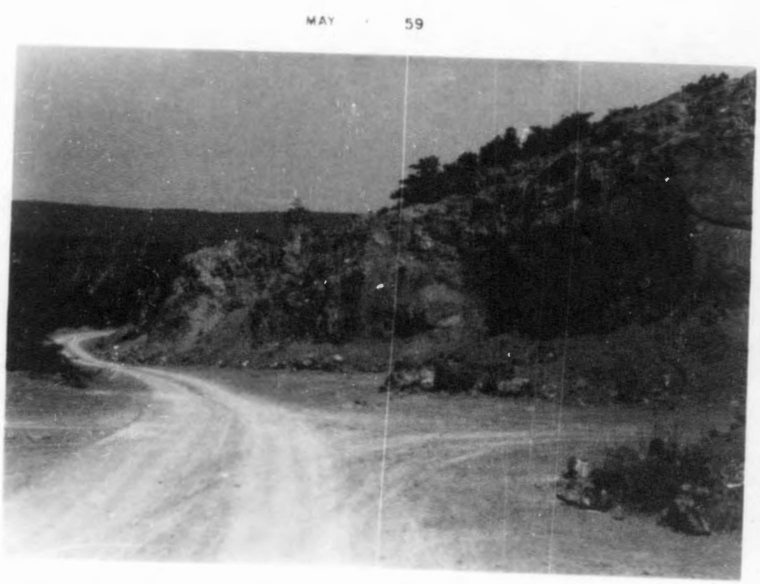
Plate 18.

A. Quarry of the Old Virginia Brick Company in leached shales of the Rome formation along U. S. Route 11, half a mile south of Lafayette.

B. Quarry of the Old Virginia Brick Company in Devonian shales on the southwest side of Little Brushy Mountain.

Plate 18.

A



B

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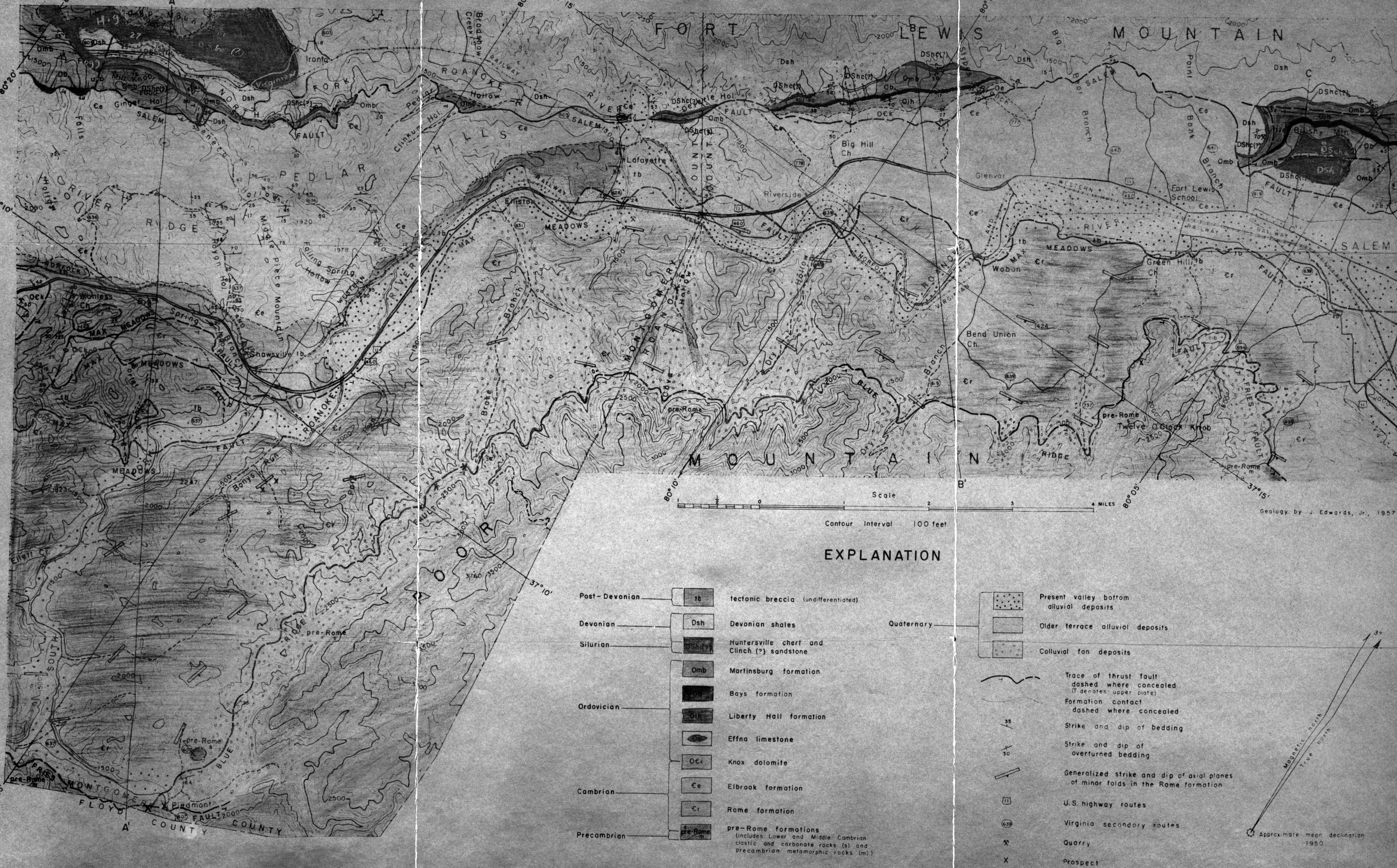
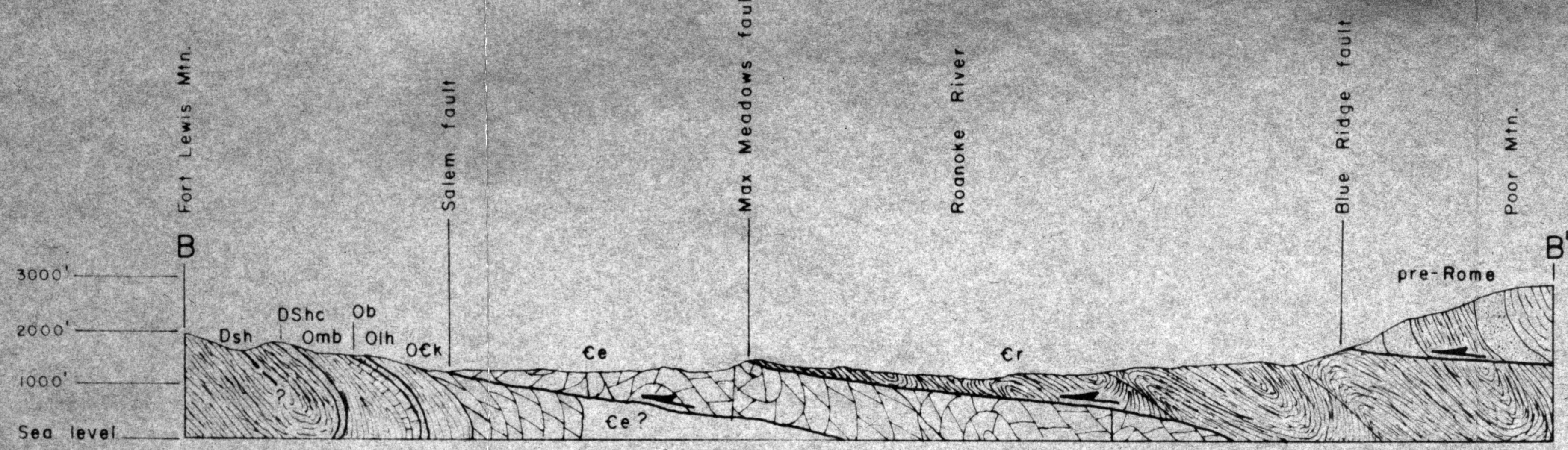


GEOLOGIC MAP OF THE UPPER ROANOKE RIVER VALLEY AREA, VIRGINIA

Plate 3



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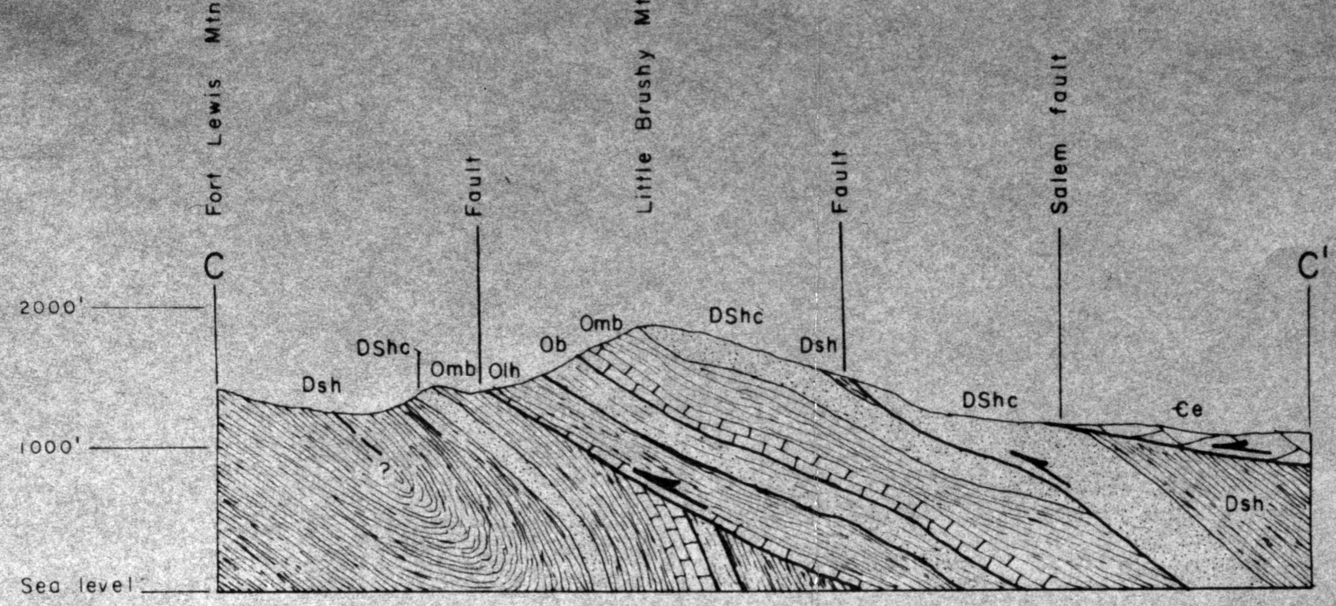

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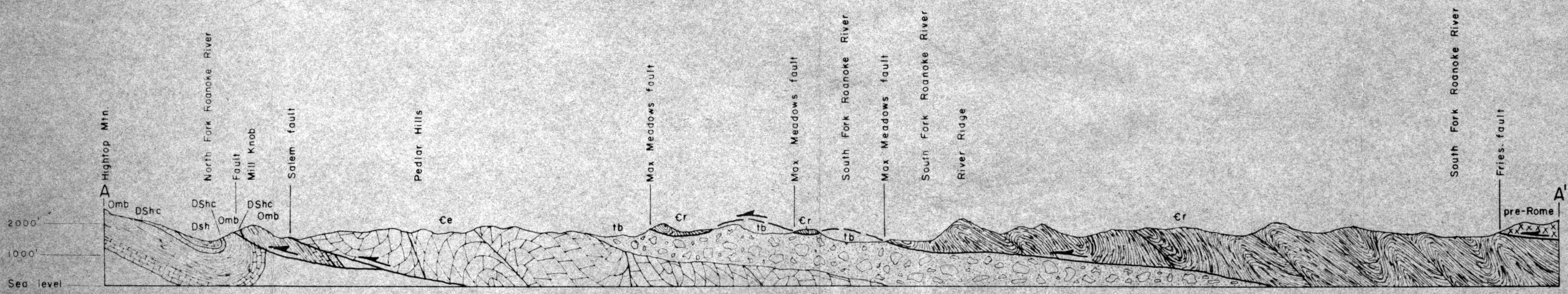

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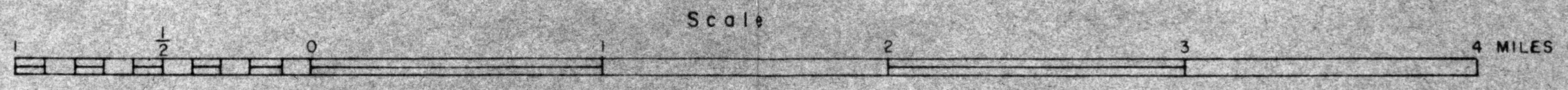

GEOLOGIC STRUCTURE SECTIONS OF THE UPPER ROANOKE RIVER VALLEY AREA, VIRGINIA.