COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT

DIVISION OF MINERAL RESOURCES

GEOLOGY OF THE CLINCHPORT QUADRANGLE VIRGINIA

WILLIAM B. BRENT

REPORT OF INVESTIGATIONS 5

VIRGINIA DIVISION OF MINERAL RESOURCES

James L. Calver
Commissioner of Mineral Resources and State Geologist

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Commonwealth of Virginia
Department of Purchases and Supply
Richmond
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GEOLOGY OF THE CLINCHPORT QUADRANGLE

By

WILLIAM B. BRENT

ABSTRACT

The Clinchport quadrangle is in Scott County in southwestern Virginia. Clinch River flows through the center of the area, that extends from the south margin of the coal fields to just north of the Virginia-Tennessee border. All of the bedrock is sedimentary and ranges in age from Cambrian to Devonian. Total thickness of exposed formations is approximately 10,000 feet. The rocks are chiefly Cambrian and Ordovician limestones, dolomites, and shales. Locations of stromatolitic limestone, similar to that recently described in Tennessee, are noted.

The structure consists largely of northeastward-trending reverse faults and formations that dip southward. A notable exception is the Rye Cove syncline that contains many small folds and faults. Three low-angle thrust faults trend to the northeast across the area; they are the Copper Creek, Clinchport, and Hunter Valley faults. A previously unmapped southeastward-trending high-angle reverse fault is described.

Mineral resources of economic importance include deposits of limestone and dolomite. High-calcium limestone for cement manufacture is quarried at Speers Ferry, and dolomite for use as crushed and broken stone is quarried at Glenita. Sphalerite, a zinc sulfide, occurs in dolomite of the Rome formation on the north side of Copper Creek west of Bellamy. North of Marble Point Church thick beds of siliceous hematite are along the unconformity between the Mascot and Blackford formations. Nodules of residual hematite occur as "float" on the lower part of the Mascot formation north-northeast of Manville. Tests conducted on samples of Rogersville shale indicate that it has potential economic value.

INTRODUCTION

LOCATION AND SIZE OF AREA

The Clinchport quadrangle includes an area of about 60 square miles in Scott County in southwestern Virginia (Figure 1). It is within the Ridge and Valley physiographic province and is bounded by latitude 36°37′30″ and 36°45′ N. and longitude 82°37′30″ and 82°45′W.

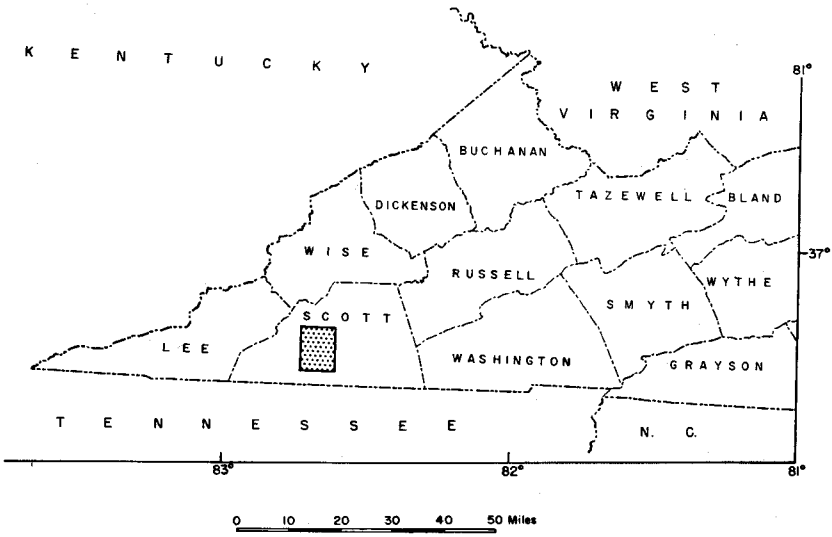


Figure 1. Index map showing location of Clinchport quadrangle.

GEOGRAPHY

Steep hills and narrow short valleys are present throughout much of the area included in the Clinchport quadrangle. Notable exceptions are Clinch Mountain, a long high ridge, and Rye Cove, a relatively level expanse in the northwest. The highest point, slightly more than 2380 feet in elevation, is on the crest of Clinch Mountain about 1.75 miles east of Clinch Mountain tunnel, and the lowest is 1208 feet at Speers Ferry Mill adjacent to the Clinch River. Maximum relief is about 1200 feet, and excluding Clinch Mountain and Rye Cove the local relief averages approximately 500 feet.

Residents of the Clinchport area engage principally in agricultural pursuits on small farms. Tobacco, the chief cash crop, is sold in the

fall of the year, mainly at warehouses in Weber City, Virginia. Much of the fairly level land in Rye Cove is cleared and is used for grazing beef cattle. The remainder of the area within the quadrangle is largely hilly and forest covered, and small-scale lumbering is a part-time occupation of many farmers. Most of the wood is taken by truck to the paper mills of the Mead Corporation in Kingsport, Tennessee, which utilizes hardwoods as well as pine in their operations. Many residents of the area work in Gate City, Virginia or in the nearby industrial city of Kingsport, Tennessee.

Principal routes of travel are U. S. Highway 58 and 23 along the southern and western parts of the quadrangle and State Highway 65 on the northwest side of Clinch River. There are two paved State Roads: State Road 665 between Gate City and Hill Station, and State Road 649, the main north-south road in Rye Cove. The Southern and Clinchfield railways provide freight service for the area. The only municipality within the quadrangle is Clinchport, with a population of 359 in the year 1950.

ACKNOWLEDGMENTS

Field work on which the report is based was done in July - December 1961 and April-May 1962, under authorization from James L. Calver, Commissioner of Mineral Resources and State Geologist. The writer is indebted to Ralph L. Miller, of the United States Geological Survey, for information, advice, and visits in the field.

STRATIGRAPHY

The total exposed thickness of the chiefly marine sedimentary rocks of the Clinchport area is about 10,000 feet. They range in age from Lower Cambrian to Devonian (Table 1). The quadrangle may be divided into three areas containing rock sequences which are separated from each other by reverse faults. The rocks are chiefly Cambrian and Ordovician in age (Table 2) and except for a very small area in the northwest corner of the quadrangle, Silurian and younger rocks occur only in Clinch Mountain and to the south. The quadrangle is divided into three areas: 1) Copper Creek area, between Copper Creek fault and Clinch Mountain; 2) Clinchport area, between Clinchport and Copper Creek faults; 3) Rye Cove area, northwest of Clinchport fault. The formations are relatively constant along strike but show marked lithologic differences from one area to another.

Table 1. Geologic formations in the Clinchport quadrangle.

AGE		NAME	CHARACTER	Thickness in Feet
Devonian		Devonian, undivided	Gray thin-bedded siltstone, gray and greenish shale, and fine-grained sandstone.	1250±
Silurian		Tuscarora and Clinton formations	White to red sandstone and quartz-pebble conglomerate with siliceous cement.	450–500
Ordovician	Upper	Sequatchie formation	Crumbly red shale and sandstone.	300–325
	Middle	Martinsburg formation	Yellow-weathering shale, siltstone and limestone. Equivalent to Trenton and Reedsville.	850–1250
		Reedsville shale	Shale with siltstone and limestone lenses.	?
		Trenton limestone	Gray highly fossiliferous limestone.	300–600
		Moccasin formation	Red and yellow mudstone and gray limestone.	500–600
		Witten limestone	Thin- to thick-bedded, fine-grained, gray limestone.	175–225
		Bowen formation	Red, yellow, and gray limestone and mudstone.	50–90
		Benbolt and Wardell limestones	Argillaceous cobbly-weathering limestone and coarse-grained gray limestone; blue cherty limestone member, Obwu, occurs in upper portion of formation in Rye Cove.	300–425
		Rockdell limestone	Gray and pinkish medium- to coarse-grained limestone.	200–300
		Rye Cove limestone	Dark, fine- to medium-grained, cherty limestone and gray calcilutite. In Rye Cove only.	200–220
		Lincolnshire limestone	Dark-gray, granular, cherty limestone. Thin calcilutite at base in some localities.	35–180
		Elway limestone	Fine-grained gray limestone with bedded black chert.	40–90
		Blackford formation	Dolomite, limestone, calcareous mudstone. Basal conglomerate or sedimentary breccia.	80–115
	Lower	Mascot formation	Fine-grained to dense gray dolomite with much chert. Some pink dolomite and green shale partings.	600±
		Longview and Kingsport formations	Medium- to coarse-grained dark dolomite; much chert.	100–300
		Chepultepec formation	Light-gray, fine- to medium-grained dolomite. Some dark saccharoidal dolomite, and sandstone.	300–850

Table 1—Continued

AGE		NAME	CHARACTER	Thickness in Feet
Cambrian	Upper	Copper Ridge formation	Upper: light-gray dolomite. Lower: dark dolomite with fetid odor. Some thin sandstones; much chert.	500–600
		Maynardville formation	Upper: finely laminated light-gray dolomite. Lower: dark-blue limestone with silty partings.	80–230
		Nolichucky formation	Fissile green shale, siltstone, and varying amounts of limestone.	510
	Middle	Maryville limestone	Thick-bedded, fine-grained blue limestone with silty partings. Some dolomite.	695
		Rogersville shale	Fissile green and dark-blue shale. Little siltstone and dolomite.	50–60
		Rutledge limestone	Thick-bedded, fine-grained blue limestone with silty partings. Upper part is dolomite south of Copper Creek.	285–376
	Lower	Rome formation	Shale, siltstone, sandstone, limestone, and dolomite.	1200–1500

CAMBRIAN SYSTEM

Rome Formation

The Rome formation occurs principally in two areas; one of which is north of Clinch River and the other adjacent to Copper Creek. It is characterized by red, green, and gray shale and siltstone with minor amounts of sandstone, limestone, and dolomite. The red and green shales and gray siltstones with thin, irregular, dark laminations are the chief diagnostic beds. Limestones and dolomites are rusty brown on weathered surfaces. Alternating shales, siltstones, and thin sandstones that are commonly micaceous occur in thinly laminated contorted beds. Where these materials are weathered, abundant rock chips that may be used to identify the formation are present in the soil. Thick resistant sandstones are exposed on top of some of the hills north of Copper Creek and Clinch River. Limestone and dolomite beds, commonly up to 75 feet thick, have sharp contacts with associated shales and siltstones. Thick-bedded dolomites form some subordinate knobs south of Copper Creek Knobs area.

Limestone, from 5 to 30 feet thick, crops out in several places along the north side of State Highway 65 for several miles. The thickness, which varies abruptly, is probably greatest at a good exposure about

Table 2. Correlation of Cambrian and Ordovician terminology.

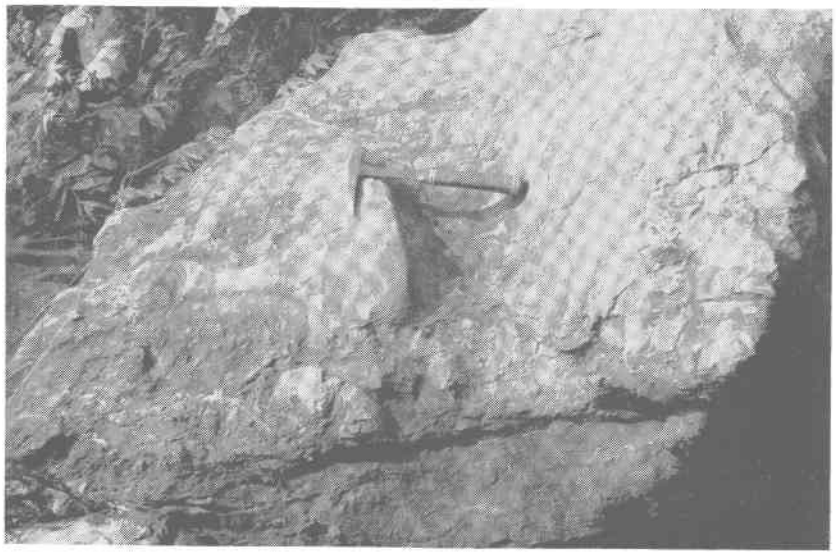
Butts (1940)	Cooper (1945)	Harris and Miller (1958)	This Report: South of Clinchport Fault	This Report: Rye Cove
Juniata fm. (Sequatchie)		Sequatchie fm.	Sequatchie fm.	absent
Martins-burg shale / Reedsville sh. / Trenton ls.	Martinsburg sh.	Martinsburg shale	Martinsburg fm.	Reedsville shale / Trenton limestone
Eggleston ls.	Eggleston ls.			
Lowville - Moccasin formation	Moccasin fm.	Moccasin fm.	Moccasin fm.	Moccasin fm.
	Witten limestone	Witten limestone	Witten limestone	Witten limestone
	Bowen formation	Bowen formation	Bowen formation	Bowen formation
Ottosee limestone	Wardell limestone / Benbolt limestone	Nodular unit	Benbolt and Wardell ls.	Benbolt and Wardell ls.
Holston limestone	Rockdell limestone	Rockdell limestone	Rockdell limestone	----?------?----
Murfreesboro ls.	Lincolnshire ls.	Lincolnshire ls.	Lincolnshire ls.	Rye Cove ls.
	Five Oaks ls.		Five Oaks ls.	
	Elway limestone	Elway limestone	Elway limestone	
	Blackford fm. (Tumbez)	Blackford fm.	Blackford fm.	Blackford fm.
Beekmantown fm.	Knox dolomite	Mascot dolomite	Mascot fm.	Mascot fm.
		Longview and Kingsport dol.	Longview and Kingsport fm.	Longview and Kingsport fm.
---Chepultepec dol.-- (absent locally)		Chepultepec dol.	Chepultepec fm.	Chepultepec fm.
Copper Ridge dol.		Copper Ridge dol.	Copper Ridge fm.	Copper Ridge fm.
------?------	Maynardville mbr.	Maynard-ville fm. / Chances Br. / Low Hollow	Maynard-ville fm. / Chances Br. / Low Hollow	Maynard-ville fm. / Chances Br. / Low Hollow
Nolichucky shale	Nolichucky shale	Nolichucky shale	Nolichucky fm.	Nolichucky fm.
Maryville limestone	Maryville limestone	Maryville limestone	Maryville limestone	Maryville limestone
Rogersville shale	Rogersville shale	Rogersville shale	Rogersville shale	Rogersville shale
Rutledge limestone	Rutledge limestone	Rutledge limestone	Rutledge limestone	Rutledge limestone
Rome formation		Pumpkin Valley shale / Rome formation	Rome formation	not exposed

0.6 mile northeast of State Road 649. The limestone is blue to gray and chiefly fine grained to dense. Some is medium grained, and brown iron-oxide stains are common. Weathered surfaces vary from dull brown to blue. Part of the rock consists of conglomerate or breccia in which individual pieces up to 8 inches in diameter have been squeezed and rotated (Figure 2). Zones several feet thick have wavy siliceous partings that weather in relief. Many particles within the limestone appear to be organic.

Figure 2. Conglomerate or breccia in limestone beds of Rome formation along State Highway 65.

Inconspicuous small-scale cross-bedding is present in the sandstones. Prominent mud cracks and ripple marks are present in roadcuts on the north side of Copper Creek and Clinch River (Figure 3). Unusually large symmetrical ripple marks are well exposed on the upper surface of a very coarse-grained sandstone bed on the north side of State Highway 65 about 0.25 mile east of the town limits of Clinchport (Figure 4). Maximum wave length (crest to crest) is 18 inches, and maximum wave height is about 4 inches.

Structural complications make the selection of a representative stratigraphic section difficult. A dominantly shale zone about 350 feet thick occurs at the top of the formation; east of Hill Station this zone consists of green, red, gray, and brown shales with interbedded siltstones. Less than 200 feet below the top of the formation are several feet of sandstone, and about 50 feet below the sandstone are a few feet of limestone. The uppermost part of the shale zone contains interbedded shale and limestone, and contact with the overlying Rutledge limestone is gradational. The contact is placed at the base of the lowest massive limestone in which shale is a minor component. The maximum thickness of the Rome formation in the quadrangle is about 1500 feet.



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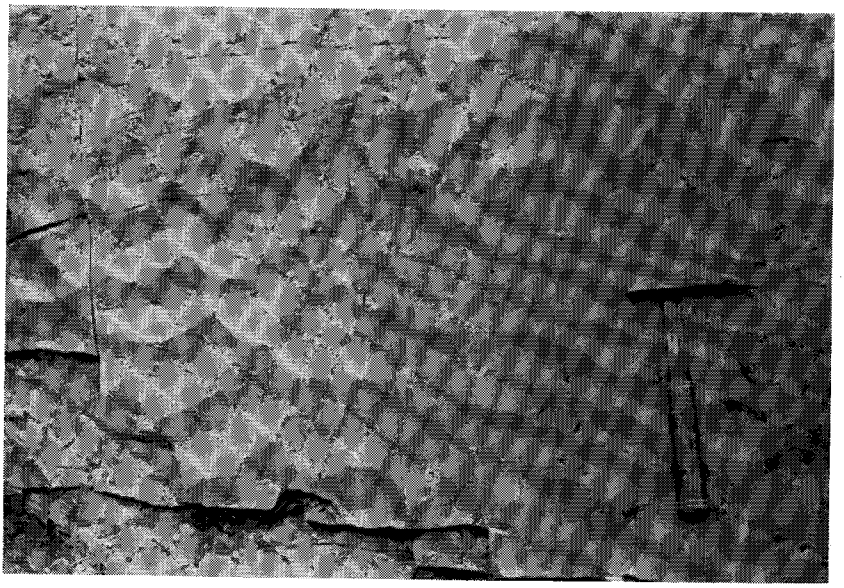

Figure 3. Ripple-marked fine-grained sandstone within the Rome formation along Copper Creek.

Figure 4. Large ripple marks in very coarse-grained sandstone within the Rome formation along State Highway 65 about 0.25 mile east of Clinchport.

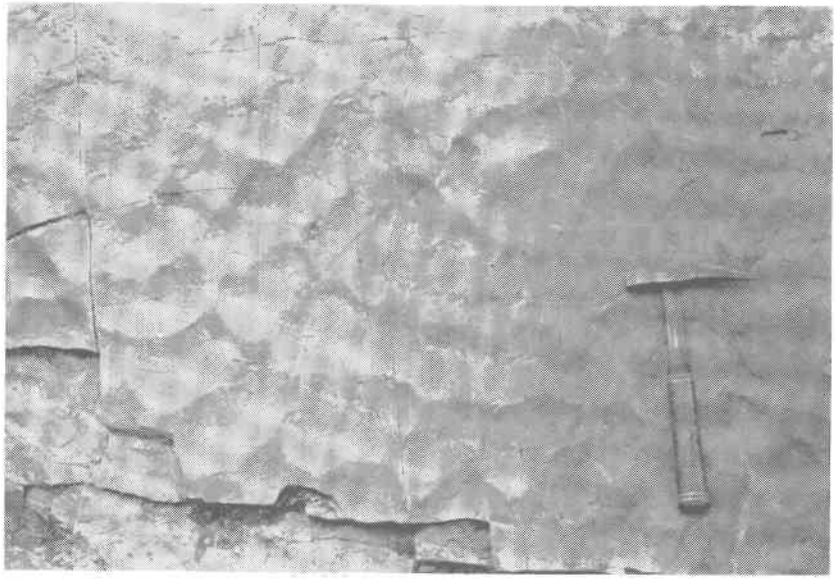

Figure 3. Ripple-marked fine-grained sandstone within the Rome formation along Copper Creek.

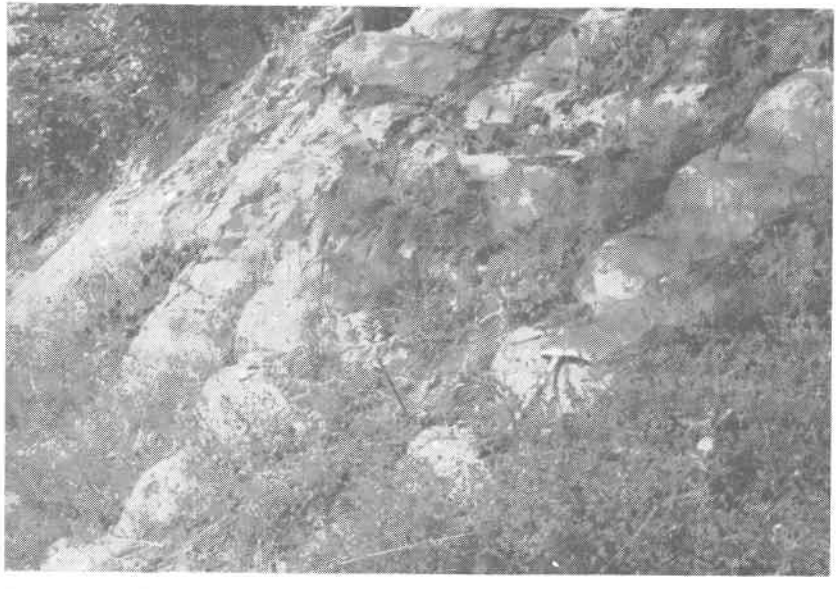

Figure 4. Large ripple marks in very coarse-grained sandstone within the Rome formation along State Highway 65 about 0.25 mile east of Clinchport.

Rutledge Limestone

Prominent exposures of Rutledge limestone occur along a bluff on the southeast side of Clinch River, and extend from Boulder, south of Clinchport, to the east edge of the quadrangle. A relatively isolated exposure extends from north of Speers Ferry Mill to east of Smith Chapel. Rutledge is present in the bluffs along the south side of Copper Creek.

Along the southeast side of Clinch River the formation is dominantly fine-grained thick-bedded blue limestone with some mottled blue and gray limestone. Clay or silt partings, less that 0.5 inch thick, occur at approximately 1-inch intervals in the limestone beds. On fresh surfaces the partings project in relief after weathering. In the lower part of the Rutledge are shale beds up to 1 foot in thickness; beds of blue dolomite occur in the upper half of the formation. South of the Bellamy fault the lower part of the formation consists of limestone similar to the Rutledge along Clinch River. The upper part of the formation is dolomite. Rutledge limestone in Copper Creek Bluff is generally similar to that south of Bellamy fault. The gray fine-grained, to dark medium-grained dolomite is in sharp contact with the underlying limestone. Weathered surfaces have a gnarly, dark, gritty appearance, and cobble-size fragments of "rotten" dolomite, commonly litter the red soil. Several feet of chert occurs at the contact between limestone and dolomite about 1 mile southeast of Bellamy. Part of the chert is dense and white; the rest consists of closely packed light and dark siliceous oolites with siliceous cement. The chert weathers to tan pebble- and cobble-size particles with smooth surfaces. The formation is 376 feet thick south of Hill Station (Geologic Section 1); this is probably its maximum thickness in the quadrangle. South of the Bellamy fault the formation is about 285 feet thick.

Geologic Section 1. Along State Roads 645 and 665 southeast of Hill Station. Strike N. 50° E., dip 30° SE.

		Thickness Feet
Rogersville shale		
Rutledge limestone (376 feet)		
11	Limestone, blue with silty or clayey partings, 1 to 2 feet thick. Some blue dolomite. Solution channels, cave breccia, travertine. Minor faulting and brecciated zone 6 or 8 feet thick. Edgewise conglomerate zones 1 to 5 inches thick. Small fault or slump at upper contact	158
10	Covered; probably blue limestone with clayey or silty partings	48
9	Limestone, blue, massive, with thin silty or clayey partings about 1 inch apart. Thin zones of intraformational conglomerate or breccia. Solution channels, collapse structures, travertine	50

		Thickness Feet
8	Covered; probably blue limestone with clayey or silty partings	20
7	Limestone, blue, massive, with thin shaly laminations that project on weathered surfaces. Some layers weather to brownish shale	30
6	Shale, greenish, with calcareous and silty layers	10
5	Limestone, blue, with interbedded shale	10
4	Limestone, blue, in beds about 6 inches thick. Clayey or silty partings. Gash fractures filled with white calcite	11
3	Limestone, blue, thin-bedded. Interbedded shale. Shale thickens and thins as a result of squeezing	25
2	Limestone, blue, thin-bedded. Interbedded greenish shale	1
1	Limestone, dark-blue, fine-grained, with clayey or silty partings. Blue and gray mottled limestone. Gradational contact	13

Rome (Pumpkin Valley) formation

Rogersville Shale

The Rogersville shale forms a thin caprock on Rutledge limestone bluffs on the southeast side of Clinch River and Copper Creek. In the Speers Ferry Mill-Smith Chapel area the shale crops out on relatively flat benches that are along the lower parts of the north slope of Moccasin Ridge. Non-calcareous, fissile, green to dark-blue shales characterize the Rogersville (Geologic Section 2). Weathered shale chips are gray with dark perimeters. There are some siltstones and dark, medium-textured dolomite lenses. About 0.5 mile south of Bellamy Church a limonite lens is at the base of the formation. The Rogersville is in sharp contact with adjacent formations and ranges in thickness from about 50 feet to 60 feet.

Geologic Section 2. State Road 665 southeast of Hill Station. Strike N. 75° E., dip 35° SE.

		Thickness Feet
Maryville limestone		
Rogersville shale (58.5 feet)		
4	Shale, greenish, non-calcareous. Some silty layers	27
3	Dolomite, dark, medium-grained, sandy	1.5
2	Shale, greenish, non-calcareous, some silty layers	15
1	Shale, dark-blue, non-calcareous	15
Rutledge limestone.		

Maryville Limestone

Outcrops of the Maryville limestone, on the northwest slope of Copper Ridge and the north slope of Moccasin Ridge, generally parallel those of the Rutledge limestone and Rogersville shale. Good exposures are about 0.5 mile southeast of Hill Station and just north of Speers Ferry Mill.

The Maryville is chiefly a thick-bedded, fine-grained blue limestone with thin siliceous partings, about 1 inch apart, that weather in relief. Mottled blue and gray limestone, magnesian limestone, and dolomite occur throughout the formation. Zones of intraformational (edge-wise) conglomerate and thin shales are present. On the north slope of Moccasin Ridge are beds of dark, gritty, fine- to medium-grained dolomite and beds of dark coarse-grained dolomites. These lithologies are more common near the lower and middle parts of the formation. The upper contact zone of magnesian limestone, shaly limestone, and shale is gradational with the Nolichucky formation. The thickness of the formation southeast of Hill Station is about 696 feet (Geologic Section 3).

Geologic Section 3. Along State Road 665 southeast of Hill Station. Strike N. 75° E., average dip 25° SE. Several offsets in measuring reduced thickness accuracy.

Nolichucky formation		Thickness Feet
Maryville limestone (696 feet)		
15	Limestone, shaly. Magnesian limestone and shale. Gradational contact with Nolichucky	25
14	Limestone, blue. Magnesian limestone and dolomite. Clayey or silty partings. Some shaly limestone	42
13	Covered; some shaly limestone	42
12	Limestone, blue. Magnesian limestone and dolomite; some shale	42
11	Covered, probably shaly limestone	27
10	Limestone, blue and gray. Blue and gray magnesian limestone and dolomite, fine- to medium-grained. Some shale and shaly-weathering limestone	12
9	Limestone, blue and gray, fine- to medium-grained. Siliceous partings. Magnesian limestone and dolomite, some mottled blue and gray	231
8	Limestone, blue with siliceous or clayey partings. Thin shales. Intraformational conglomerate zones. Probable fossil fragments. Slightly sheared zones with white carbonate veins	84
7	Limestone, blue. Some gray dolomite. Siliceous or clayey laminations about 1 inch apart. Dense to medium-grained limestone. Intraformational conglomerate	100
6	Limestone, blue, with clayey or siliceous partings. Some mottled admixed magnesian limestone and dolomite	42
5	Dolomite, gray to dark-gray. Some sandy layers. Some white carbonate streaks	34
4	Covered, probably gray dolomite	1.5
3	Dolomite, gray	1
2	Covered, probably gray dolomite	11
1	Dolomite, gray. Contact covered	1.5
Rogersville shale.		

Nolichucky Formation

Nolichucky formation occurs at the top of a subordinate row of hills on the northwest slope of Copper Ridge and occupies a similar position on the north slope of Moccasin Ridge. Another exposure of Nolichucky is on the north-facing slope of Greasy Valley, north of the Clinchport fault. A nearly complete section is exposed along State Road 665 southeast of Hill Station (Geologic Section 4).

The Nolichucky is chiefly non-calcareous, fissile, green shales, silty shales, and thin siltstones. Some shale, especially in the upper part, is dark blue. At various horizons are thin layers of green and purple calcareous siltstones, medium- to coarse-grained gray to greenish limestones and dolomites, and a little sandstone. Much of the limestone contains glauconite. One-foot conglomerate zones contain limestone, siltstone, and shale fragments up to 1 inch in diameter. Shale and silt layers, with clay pellets that weather and leave hollows resembling fossil molds, are common at some localities. Carbonate beds are not prominent here, but about 1 mile to the northeast an aggregate thickness of 50 feet or more of limestone is present, demonstrating the lenticular nature of the carbonate beds.

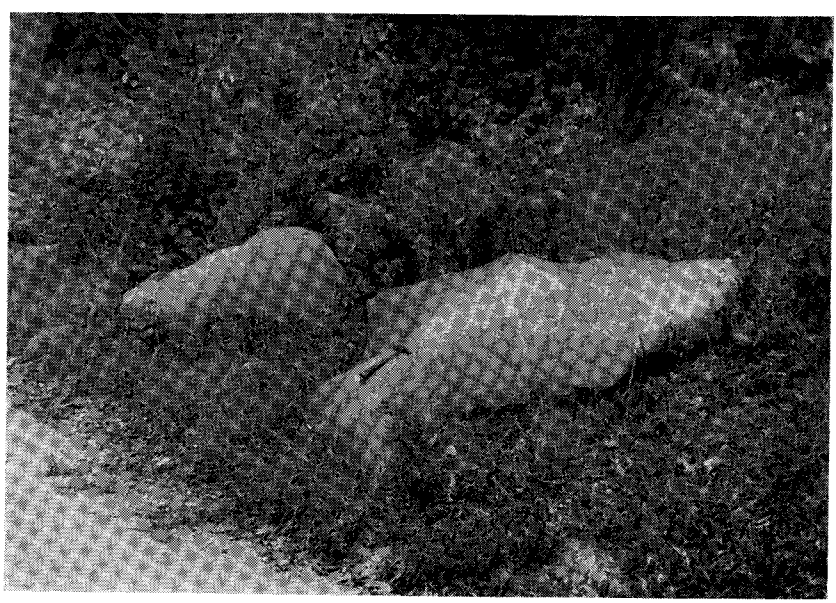

Figure 5. Stromatolitic limestone in Nolichucky formation along State Road 645. Note "intercolony filling" near center of rock in foreground.

Nolichucky Formation

Nolichucky formation occurs at the top of a subordinate row of hills on the northwest slope of Copper Ridge and occupies a similar position on the north slope of Moccasin Ridge. Another exposure of Nolichucky is on the north-facing slope of Greasy Valley, north of the Clinchport fault. A nearly complete section is exposed along State Road 665 southeast of Hill Station (Geologic Section 4).

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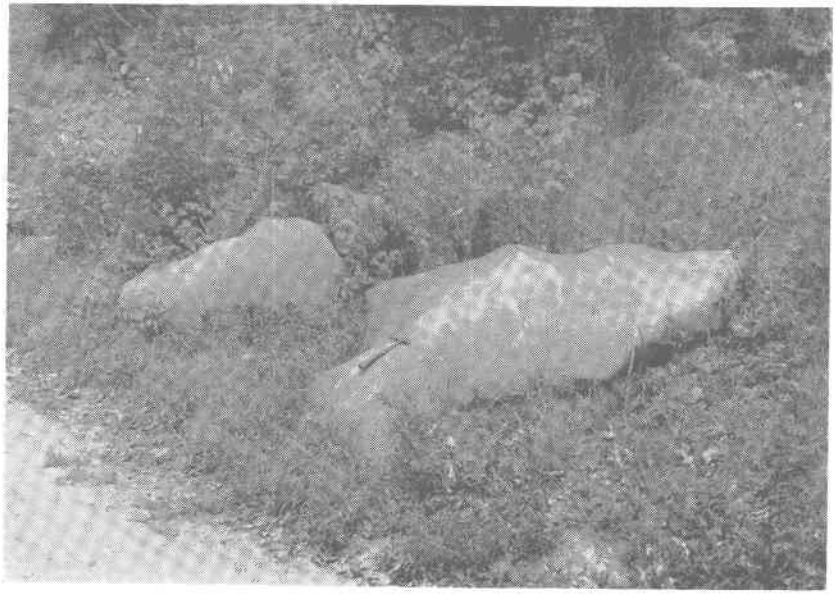

Figure 5. Stromatolitic limestone in Nolichucky formation along State Road 645. Note "intercolony filling" near center of rock in foreground.

Stromatolitic limestone, similar to that described by Oder and Bumgarner (1961), was identified for the writer near Hill Station (Geologic Section 4) and 1 mile to the northeast of that location by Robert C. Milici. The stromatolitic limestone is blue to gray, fine grained to dense, and on weathered surfaces has a smooth undulatory appearance. Brown iron-oxide stained bands, several inches wide, cut through the limestone and commonly meet to form the apex of a triangle (Figure 5). These bands, the intercolony fillings of Oder and Bumgarner, divide the limestone into discrete "colonies" that range from several inches to 4 feet in diameter. Along State Road 665 the stromatolitic limestone is about 3 feet thick and occurs about 160 feet from the top of the formation. About 1 mile along strike to the northeast, the stromatolitic zone is approximately 35 feet thick, and the top of the zone is about 105 feet below the base of the Maynardville (Figure 6).

In the upper half of the Nolichucky along Moccasin Ridge is a glauconite-bearing limestone that ranges in thickness from about 20

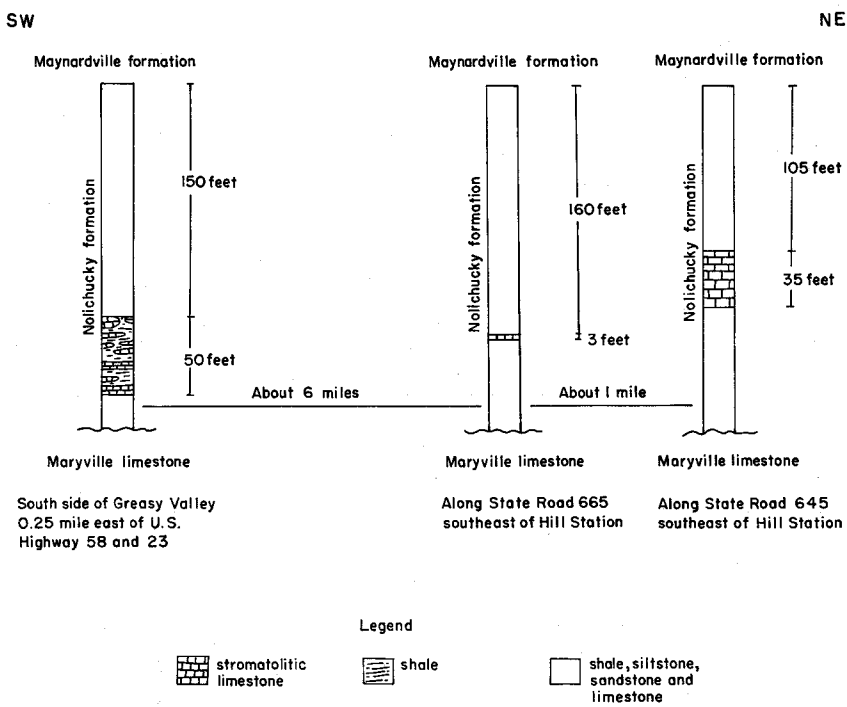

Figure 6. Sketch showing relations of stromatolitic limestone in the Nolichucky formation.

to 50 feet and that appears to be continuous along strike. Dense green limestone, dense gray limestone with rusty streaks and stains, dark-blue to gray medium coarsed-grained limestone, limestone with dark oolites, and argillaceous cobbly-weathering limestone are present. In places weathering has produced isolated masses of limestone, several feet in diameter, that resemble boulders surrounded by shale. Stromatolitic limestone from this zone was identified by Robert Milici.

On the south side of Greasy Valley less than 0.25 mile east of U. S. Highway 58 and 23, an aggregate thickness of about 50 feet of glauconite-bearing limestone lenses, separated by shale, crop out. Limestone beds range from a few inches to 8 feet in thickness, and stromatolitic limestone occurs throughout much of the interval (Figure 6). The limestone commonly is blue to gray and fine grained to dense. Some rough-weathering, coarse-grained, brown limestone is partly oolitic, and contains much glauconite. Conglomerate zones and "intercolony filings" are prominent. The top of this stromatolitic limestone zone is about 150 feet stratigraphically below the base of the Maynardville formation. Small fossils, probably trilobite fragments and cystid or crinoid plates, were found in all areas of Nolichucky in both limestone and shale. The formation is approximately 510 feet thick. The character of the Nolichucky along the north slope of Copper Ridge is shown in Geologic Section 4.

Geologic Section 4. Along State Road 665 southeast of Hill Station. Strike N. 60° E., dip 25°-30° SE.

Maynardville formation

	Nolichucky formation (510 feet)	Thickness Feet
20	Shale, green and blue interbedded. Fossils in green shale. Siltstone layers and fossiliferous bluish-gray, medium-grained limestone. Gradational contact with Maynardville	38
19	Shale, dark-blue. Some siltstone and carbonate	26
18	Shale, green. Some dark-blue shale, siltstone and carbonate	42
17	Shale, green. Siltstone. Red shale and limestone lenses. Fossils in green shale. Some foot-thick limestone conglomerates, siltstone, and shale with fragments up to several inches in diameter	32
16	Shale, green, fossiliferous. Small trilobites and many cystid or crinoid plates. *Dicellomus appalachia, Kingstonia walcotti?, Terranovella buttsi?* Some layers contain clay balls	21
15	Limestone, gray, medium coarse-grained. Stromatolitic zone	3
14	Shale, green	15
13	Covered, probably shale	19
12	Shale, green, fissile	38
11	Silty and clayey layers with clay pellets that weather out and leave depressions that resemble fossil molds	1
10	Shale, green, fissile. Some thin siltstones and limestones	84
9	Shale and limestone	2

		Thickness Feet
8	Limestone and dolomite, some purple, some medium- to coarse-grained. Glauconite	1
7	Shale, green, fissile. Some silty zones	20
6	Shale, greenish. Greenish siltstone and calcareous layers	56
5	Siltstone, green and purple, calcareous. Limestone and purple shale	14
4	Limestone, gray to greenish, medium- to coarse-grained, silty. Some dolomite and thin shales	3
3	Shale, green. Some green calcareous siltstone	10
2	Limestone, gray, medium-grained	1
1	Shale, green, and silty shale, non-calcareous. Thin siltstone. Thin, greenish, medium-grained, silty limestone and dolomite, up to 8 inches thick. Contact covered but probably gradational	84

Maryville limestone.

Maynardville Formation

The Maynardville formation is present on the north slope of Moccasin Ridge, the northwest slope of Copper Ridge, and near the bottom of the north-facing slope of Greasy Valley. In areas south of Clinch River the Maynardville commonly occurs where north slopes on Copper Ridge and Moccasin Ridge merge with relatively flat-topped hills of Nolichucky.

The Maynardville formation consists of two members, the Low Hollow limestone member and the overlying Chances Branch dolomite member. The Low Hollow member is typically dark-blue, fine-grained, limestone with closely spaced clayey or silty partings (Figure 7). It

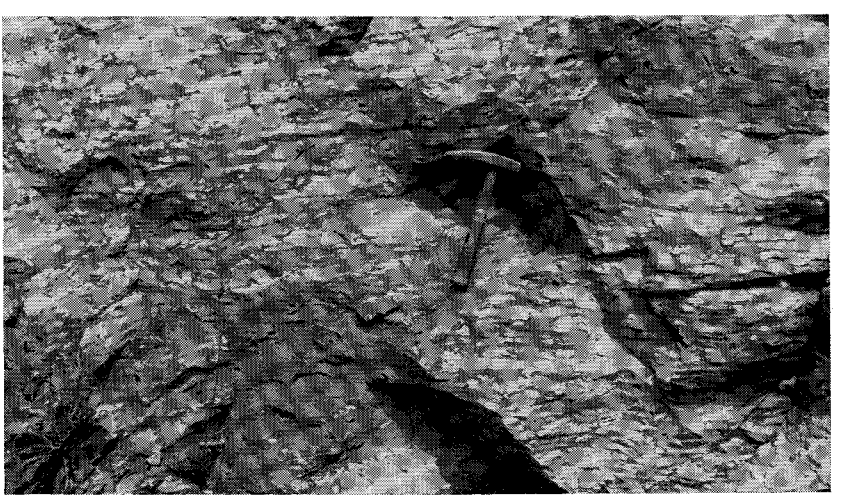

Figure 7. Low Hollow member of Maynardville formation along U. S. Highway 58 and 23 southwest of Clinchport.

		Thickness Feet
8	Limestone and dolomite, some purple, some medium- to coarse-grained. Glauconite	1
7	Shale, green, fissile. Some silty zones	20
6	Shale, greenish. Greenish siltstone and calcareous layers	56
5	Siltstone, green and purple, calcareous. Limestone and purple shale	14
4	Limestone, gray to greenish, medium- to coarse-grained, silty. Some dolomite and thin shales	3
3	Shale, green. Some green calcareous siltstone	10
2	Limestone, gray, medium-grained	1
1	Shale, green, and silty shale, non-calcareous. Thin siltstone. Thin, greenish, medium-grained, silty limestone and dolomite, up to 8 inches thick. Contact covered but probably gradational	84

Maryville limestone.

Maynardville Formation

The Maynardville formation is present on the north slope of Moccasin Ridge, the northwest slope of Copper Ridge, and near the bottom of the north-facing slope of Greasy Valley. In areas south of Clinch River the Maynardville commonly occurs where north slopes on Copper Ridge and Moccasin Ridge merge with relatively flat-topped hills of Nolichucky.

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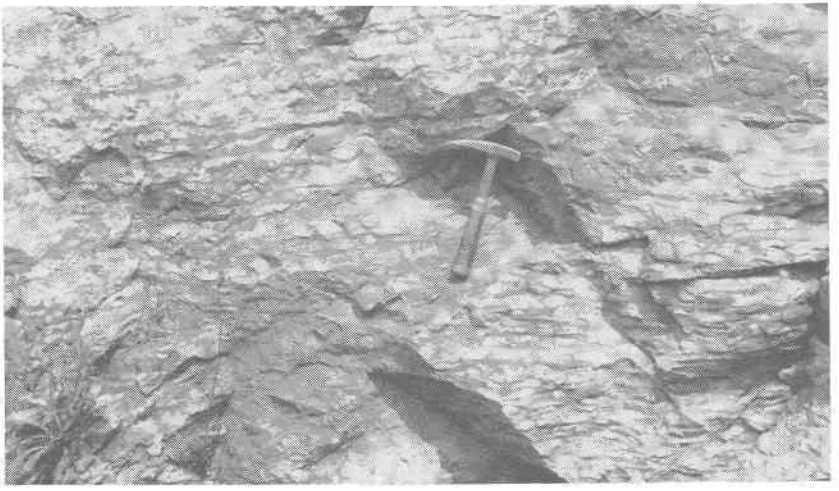

Figure 7. Low Hollow member of Maynardville formation along U. S. Highway 58 and 23 southwest of Clinchport.

differs from the Rutledge and Maryville limestones chiefly in having thicker and slightly more irregular partings, although in places it is similar to them. In places the Low Hollow is a cobbly, blue limestone that weathers to shale. South of Hill Station along State Road 665, the member consists of dark-blue fine-grained limestone, magnesian limestone, and dolomite with silty or clayey partings (Geologic Section 5). Weathering commonly imparts an irregular blue and gray splotchy appearance to carbonate beds. The Low Hollow is about 105 feet thick in this locality, but only about 37 feet thick 1 mile to the northeast. Incomplete exposures along the north slope of Moccasin Ridge indicate that the Low Hollow member consists of about 10 feet of dark-blue to gray, fine-grained, thin-bedded, argillaceous dolomite overlain by about 20 to 25 feet of fine-grained blue limestone with shaly partings.

Geologic Section 5. Along State Road 665 southeast of Hill Station. Strike N. 70° E., dip 25° SE.

		Thickness Feet
Copper Ridge formation		
Maynardville formation (231 feet)		
	Chances Branch member:	
4	Dolomite, light- to dark-gray, fine- to medium-grained. Some black chert and dark, sugary, vuggy dolomite. Contact gradational with Copper Ridge...	49
3	Covered. Some dolomite and shale exposed.....	63
2	Dolomite, dark-blue to gray, fine-grained. Black chert.....	14
	Low Hollow member:	
1	Limestone, magnesian limestone and dolomite; dark-blue, fine-grained. Silty or clayey laminations. Weathers to shale. Some blue and gray splotchy carbonate beds. Gradational contact.....	105
Nolichucky formation.		

The Chances Branch member is usually in sharp contact with the underlying Low Hollow. The lower part of the Chances Branch consists of dark-blue or gray, fine-grained dolomite, and some black chert. The upper part of the member contains light- to dark-gray, fine- to medium-grained, thinly laminated dolomite; black chert and some dark, sugary-grained, vuggy dolomite, similar to the lower part of the Copper Ridge, are also present. Near the east edge of the quadrangle the bottom of a 3-foot bed of quartz sandstone with dolomite cement was arbitrarily taken as the top of the Chances Branch member and the base of the Copper Ridge formation. The Chances Branch is between 77 and 125 feet thick along Copper Ridge and estimated to be between 50 and 100 feet thick on Moccasin Ridge.

Gradational contacts above and below the Maynardville contribute to variations in thickness determinations. Along Copper Ridge the formation varies from approximately 114 to 230 feet in thickness and probably is less than 200 feet thick along Moccasin Ridge.

Copper Ridge Formation

The Copper Ridge formation is exposed on the upper slopes of the north side of Moccasin Ridge and the northwest side of Copper Ridge. North of Clinch River the formation crops out in Greasy Valley and on the northwest slope of Cove Ridge. The Copper Ridge consists chiefly of dark dolomite in the lower part and light-gray dolomite in the upper part. The base is gradational with the Chances Branch member of the Maynardville formation and contains different amounts of light-gray fine-grained dolomite. Near the east edge of the quadrangle, along Copper Ridge, the lower contact is arbitrarily placed at the bottom of a 3-foot sandstone bed. In other places weathered exposures have from 6 inches to several feet of sandstone at the base. In the lower half of the formation weathering of light and dark mottled dolomite causes the development of irregular bedding surfaces on which small, dark, subrounded areas project above light-colored areas. The soil covering these beds contains abundant angular chert fragments several inches in diameter. There are many dark granular dolomite layers, commonly with red streaks or stains, that have resinous luster and granular weathered surfaces. Where freshly broken, these beds emit a petroliferous odor. Vugs, lined with crystals of white dolomite or quartz, are common. Light-colored fine-grained dolomite with subordinate dark granular beds characterize the upper half of the formation. Sand grains occur in the Copper Ridge as scattered grains in dolomite and chert, and as thin sandstone lenses. Chert that is most abundant in the upper half of the formation is porous to chalcedonic and light- to dark-colored; it occurs as small fragments to pieces several feet in diameter. Oolitic chert, containing both light and dark oolites, is present in layers up to 1 foot thick. In Rye Cove the Copper Ridge has a large amount of sandstone, especially in the upper part. At Vicar Hollow chert, limonite, and hematite and white oolites in dolomite are conspicuous components of the formation. The Copper Ridge and Chepultepec are conformable; and because there is no well-defined boundary, the top of the Copper Ridge is placed at the base of the first prominent thick sandstone above which sandstones are common. The thickness of the formation is between 500 and 600 feet.

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Chepultepec Formation

The distribution of the Chepultepec formation parallels that of the Copper Ridge formation. The Chepultepec is present along the crestal portion of Copper Ridge and part of Moccasin Ridge. Natural Tunnel, a well-known scenic feature, is in dolomite of the Chepultepec formation. The base of the formation commonly is placed at the bottom of the first sandstone above prominent oolitic chert near the top of the Copper Ridge formation. The lower part of the Chepultepec contains light-gray, fine- to medium-grained dolomite and some dark gritty-weathering dolomite. The upper part of the formation has much light-gray cryptocrystalline dolomite with subconchoidal fracture interbedded with dark-colored medium-grained beds. Sandstone occurs near the top of the formation. Scattered quartz grains and beds of sandstone are present throughout the formation. Commonly, the sandstones are composed of medium-grained, fairly well-rounded quartz with dolomite cement. Where fresh, the sandstones resemble dolomite beds; dissolution of the cement leaves a brown-stained friable sandstone.

On the southward-facing slope of Greasy Valley dolomite of the Chepultepec formation is poorly exposed, and white, fine-grained, friable sandstone float is abundant. South of Johnson Springs are several feet of white orthoquartzite near the top of the Chepultepec, adjacent to a fault. Exposures of Chepultepec to the north, on the west slope of Cove Ridge, indicate a moderate amount of sandstone in the formation. At the base of the south entrance of Natural Tunnel, disturbed zones within the Chepultepec are well exposed. The lower 50 to 75 feet on the west wall are intricately folded and faulted, but the structures stop abruptly in an upward direction. Deformation, that was possibly the result of submarine slump or sliding, probably occurred prior to complete consolidation.

Although there are apparent disconformities within the Chepultepec, the formation is conformable with the overlying Longview; and no sharp contact exists. A gradational contact between the formations was noted by Miller and Fuller (1954) and emphasized by Bridge (1956). The vague boundaries of the Chepultepec contribute to variations in thickness measurements. In Moccasin Ridge the Chepultepec is between 750 and 850 feet thick and in Copper Ridge between 600 and 800 feet. North of the Clinchport fault, in the Rye Cove area, it is about 300 to 500 feet thick.

Longview and Kingsport Formations, undivided

The Longview and Kingsport formations have a parallel distribution to that of the underlying Chepultepec formation and occur at the top of Cove Ridge along the west side of Rye Cove. The Longview formation and the overlying Kingsport formation were mapped as a single unit because no lithologic break was observed. It is typically medium- to coarse-grained, brown to gray dolomite with abundant nodular and massive-bedded chert. Beds of light-colored, fine-grained to dense dolomite and irregular masses of chert are common. Scattered quartz grains are present in some dolomite beds, and thin green shale partings occur in the upper half of the formation. Along State Road 665, north of Manville, are conglomerate zones composed of jumbled chert fragments, silicified dolomite, and shale which probably mark minor disconformities. At Speers Ferry the top of a dense, light-gray limestone and dolomite unit, more than 20 feet thick, was taken as the contact with the overlying Mascot formation.

The unit has differing thickness measurements because of disconformities within it and gradational contacts. South of Clinch River the thickness is approximately 300 feet; in the Rye Cove area, north of Clinch River, the thickness is commonly between 100 and 350 feet. Gastropods, probably specimens of *Lecanospira*, were found in loose chert.

Mascot Formation

The Mascot formation is exposed on the south slope of Moccasin Ridge and on the southeast slope of Copper Ridge. North of Clinch River the formation crops out at the crest and on the east side of Cove Ridge and along the southeast flank of the Rye Cove syncline as far east as Rhoton Mill. Erosion has exposed the Mascot in an inlier north of Johnson Springs. In the Clinchport area the Mascot consists of light-gray, fine-grained to dense dolomite. Dark-gray, medium-grained dolomite contains vugs, scattered quartz grains, and chert. Red to pink stains and streaks color some dolomite, especially toward the top of the formation. In the lower half of the Mascot are many thin partings of green shale. Minor disconformities within the formation are indicated by disturbed zones several feet thick; these zones, composed of chert, dolomite, silicified dolomite, and shale fragments, vary greatly in thickness within a single exposure.

Along Moccasin Ridge the Mascot is largely dolomite, similar to that described above, but the lithology varies appreciably along strike. Sandstone lenses, up to 1 foot thick, and dense gray limestone inter-

bedded with dolomite occur in the lower part of the formation. Oolitic chert and red, pink, and green compact dolomite are in the middle and upper parts of the Mascot. East of Speers Ferry a massive bedded chert near the top of the formation projects from the ground in a near vertical position.

In the upper part of the Mascot in Rye Cove some exposures have thin conglomerates. Abundant banded red and white chalcedonic chert occurs in pink and greenish dolomite with narrow dark bands and green spots. The upper few feet contain sandstone lenses 1 to 2 inches in thickness separated by dolomite with scattered quartz grains. Within 30 feet of the top of the formation is a zone of massive, commonly rounded chert. Some of the chert masses are more than 12 inches in diameter and are associated with light and dark fine-grained vuggy dolomite. The vugs are lined and partly or completely filled with small, clear quartz crystals that project in relief on weathered surfaces. Erosion at the top of the Mascot has caused variations from the average thickness of approximately 600 feet. Thickness of the formation in Rye Cove is difficult to determine because folds, low dips, and irregular topography are present.

A widely recognized unconformity at the top of the Mascot (Beekmantown) is marked by conglomerate or sedimentary breccia, but the amount of erosion cannot be accurately determined. In Tennessee 200 feet of relief on the original eroded top was noted by Rodgers and Kent (1948, p. 32), and Cooper (1944, p. 33) recorded 400 feet of thickness variation in the Beekmantown within approximately 0.25 mile. Regional studies indicate that beds above and below the erosion surface are generally parallel.

The Mascot and Blackford appear to have slightly angular relationships in exposures along State Road 665 about 0.25 mile north of Manville school. The possibility of a fault of small displacement was suggested to the writer by Ralph L. Miller. Above the Mascot is 3 to 4 inches of red clay with small chert particles, overlain by about 6 inches of dark chert and dolomite particles several inches in diameter. Above is 6 inches of greenish silty material containing small chert particles, overlain by several feet of thick-bedded grayish dolomite that contains angular chert and dolomite fragments up to 1 inch in diameter.

In the Rye Cove area the conglomerate is several feet thick. It is red, yellow, green, purple, or gray and commonly crowded with chert and dolomite fragments, averaging 1 to 2 inches in diameter; some particles are more than 6 inches in diameter. In places conglomerates occur 20 feet above the Mascot and angular chert fragments are 30 feet higher.

About 0.25 mile north of Jennings Mission (church) the Mascot-Blackford contact is marked by an iron oxide-rich zone composed chiefly of hematite and quartz. Individual massive beds are more than 1 foot thick, and the total thickness of the zone may be as much as 40 feet. The hematite is not present in stream valleys along strike to the east and west.

Blackford Formation

The Blackford formation occurs low on the south slopes of Moccasin Ridge and Copper Ridge and on the northwest flank of the Rye Cove syncline. Fault zones along the southeast side of Rye Cove contains slivers of Blackford. The Blackford is largely carbonate rock south of Clinch River and largely argillaceous material in Rye Cove. On the south slope of Moccasin Ridge poor exposures indicate that the formation consists of fine- to coarse-grained, gray limestone, commonly with a greenish or faint reddish tinge, and calcareous shale. The character of the formation at Speers Ferry is described in Geologic Section 6. In the next exposure to the north, 7 feet of fine-grained, gray dolomite containing angular chert and dolomite fragments is overlain by cherty, red and gray carbonate beds and green to red shales and mudstone. About 1 foot of greenish-gray shale is at the top of the unit.

Geologic Section 6. Along Clinchfield Railway tracks, Speers Ferry. Strike N. 70° SE., dip 70° SE.

		Thickness Feet
Elway limestone		
Blackford formation (114 feet)		
11	Limestone, gray, shaly, or gray calcareous shale	2
10	Limestone, gray, fine- to medium-grained, massive	2
9	Limestone, greenish and grayish, shaly. Some medium-grained and some fine-grained, gray limestone	10
8	Limestone, gray, fine- to medium-grained. Beds 6 inches or more thick	14
7	Limestone, greenish-gray and gray, shaly. Possibly sheared	5
6	Limestone, gray and reddish-gray, medium-grained	2
5	Limestone, greenish, grayish, shaly	2
4	Limestone, reddish-gray, medium-grained. Grainy weathered surface. Chert fragments. Lenticular and nodular light-colored chert in upper 1 foot of unit. Beds about 1 foot thick	8
3	Limestone, gray, fine-grained, possibly sheared. Gray and greenish shaly-weathering mudrock. Interval partly covered	47
2	Limestone, medium-grained. Some is shaly-weathering	19
1	Limestone, gray, fine-grained, angular chert fragments. Scattered quartz grains in limestone	2
Mascot formation.		

In Rye Cove the low-dipping, brightly colored, argillaceous rocks are well displayed on gentle hill slopes. The bottom part of the Blackford is red, green, gray, purple, and yellowish calcareous mudstone, shale, and dolomite. Above are interbedded shales and beds of light-gray to green fine-grained limestone and dolomite that commonly contain red or pink areas and some chert. Massive, fine-grained, gray to brown limestone is at the top. The thickness probably varies from about 80 to 115 feet.

Elway Limestone

South of Clinch River the distribution of the Elway limestone is parallel to that of the Blackford. In Rye Cove approximately the lower 40 feet of the Rye Cove limestone is probably equivalent to the Elway. About 0.3 mile north of Manville School, on State Road 665, the Elway is composed of mostly thin-bedded fine- to medium-grained gray limestone with bedded black chert. In the area to the south the Elway is fully exposed along the Clinchfield Railway tracks at Speers Ferry (Geologic Section 7). The formation consists of blue to gray, fine- to coarse-grained limestone, and blue to gray calcareous shale. Black chert occurs at intervals throughout, and some limestones are abundantly fossiliferous. A 14-foot calcareous shale unit near the middle of the formation separates the lower and upper limestone units. The Elway limestone equivalent in Rye Cove is included at the base of the Rye Cove limestone. It consists of fine- to coarse-grained gray limestone in which black chert and fossils are common. Near Manville the Elway is about 63 feet thick and at Speers Ferry about 87 feet thick.

Geologic Section 7. Along Clinchfield Railway tracks, Speers Ferry. Strike N. 65°-70° E., dip 65°-70° SE.

		Thickness Feet
	Lincolnshire limestone	
	Elway limestone (87 feet)	
13	Limestone, blue to gray, fine- to medium-grained, thin-bedded. Brachiopods fairly common. Some bedded black chert	7
12	Limestone, blue to gray, fine- to medium-grained. Slightly cobbly-weathering. Abundant brachiopods and bryozoans	9
11	Limestone, blue to gray, thin-bedded. Bedded black chert	5
10	Limestone, dark-blue to gray, medium-grained. Abundant brachiopods and bryozoans	2
9	Limestone, blue to gray, thin-bedded. Some bedded black chert and some calcareous shale	3
8	Limestone, blue to gray, shaly, thin-bedded	12

		Thickness Feet
7	Limestone, gray, medium- to coarse-grained, cobbly-weathering. Abundant small brachiopods	2
6	Shale, blue to gray, calcareous	14
5	Limestone, blue to gray, nodular-weathering. Some medium-grained calcarenite	16
4	Limestone, gray, medium-grained, fossiliferous. Thin-bedded black chert near base of unit. Some nodular-weathering layers	12
3	Limestone, blue, shaly, nodular-weathering	2
2	Shale, gray, calcareous. Gray, medium-grained, cherty limestone	2
1	Limestone, gray, medium-grained. Lenticular bedded black chert	1

Blackford formation.

Lincolnshire Limestone

Lincolnshire limestone crops out the entire length of the Copper Creek area. In the Clinchport area it is offset by faults south of Clinchport. The Lincolnshire equivalent is included in the upper part of the Rye Cove limestone north of Clinch River. North of Manville School the Lincolnshire is chiefly gray to dark-blue, granular limestone with bedded black chert; scattered chert nodules and fine-grained limestone are present. At the base is a 12-foot zone of sheared and cherty dove-gray calcilutite. The upper part of the formation has some dense blue limestone with white calcite specks and irregular shaly partings (Geologic Section 8). Along State Road 665 at the intersection with 664 is an irregular, organic-appearing structure about 1 foot in diameter that is probably of algal origin. Silicified bryozoans and crinoid stems are present, and Cooper (1945, p. 245) noted the occurrence of *Acrolichas* and *Dinorthis atavoides*. The lower contact is distinct, but the upper contact with the Rockdell is gradational.

Geologic Section 8. Along State Road 665 north of Manville School. Strike N. 80° E., dip 30° SE.

Rockdell limestone

Lincolnshire limestone (179 feet)		Thickness Feet
8	Limestone, dark-blue, fine- to medium-grained. Nodular bedded black chert abundant. Some dense blue limestone with calcite "eyes" Also irregular shaly partings and silicified crinoid stems and bryozoans. Somewhat arbitrary contact with Rockdell	88
7	Limestone, dark-gray, mostly fine- to medium-grained, little chert	20
6	Limestone, gray, medium- to fine-grained. Bedded black chert nodules and lenses	59
5	Limestone, calcilutite, dove-gray, calcite "eyes", blue-white weathering	2.5
4	Limestone, gray, fine-grained, sheared and fractured	1
3	Limestone, calcilutite, dove-gray, calcite "eyes"	3.5
2	Limestone, gray, fine-grained, cherty. Sheared and fractured	1
1	Limestone, dull-gray and dove-gray, fine-grained, cherty. Slightly sheared	4

Elway limestone

At Speers Ferry the Lincolnshire is fine- to medium-grained limestone with abundant black chert. Chert in the Lincolnshire is generally larger and more abundant than in the underlying Elway; the overlying Rockdell contains little chert. Near Manville the Lincolnshire is about 179 feet thick; this is probably the maximum thickness in the Clinchport area. At Speers Ferry the formation is 36 feet thick.

Rye Cove Limestone (new)

The Rye Cove limestone crops out in the Rye Cove area, north of Clinch River. It is composed of gray to brown, fine- to medium-grained limestone and calcilutite. Many beds have abundant nodular black chert. Calcilutite is most common in the lower part of the formation. Some beds in the lower 50 feet are coarse grained and have abundant silicified bryozoans, crinoid stems, and other fossil fragments. The formation is between 200 and 220 feet thick.

The Rye Cove limestone is named for exposures in the Rye Cove area, north of Clinch River. The type section is about 0.8 mile southwest of Brick Church and 0.2 mile southeast of Carter Cemetery.

The Rye Cove limestone contains the equivalents of the Elway and Five Oaks limestones and Lincolnshire formation; some beds in the upper part of the formation may represent the Rockdell limestone (Table 2). In the type section (Geologic Section 9) units 2 through 7 are probably the Elway, unit 8 the Five Oaks, and units 9 through 15 the Lincolnshire, or possibly a combination of Lincolnshire and Rockdell. The sequence is considered to be a single formation in Rye Cove because separation into discrete units cannot be satisfactorily accomplished.

Geologic Section 9. About 0.8 mile southwest of Brick Church and 0.2 mile southeast of Carter Cemetery. Strike ranges from N. 10° E. to N. 30° E., dip 10°-15° SE.

		Thickness Feet
Benbolt and Wardell limestones (lower 3 feet)		
16	Limestone abundant silicified bryozoans. Also corals, sponges, cephalopods and other forms	3
Rye Cove limestone (216 feet)		
15	Limestone, gray to blue-gray, fine-grained. Nodular, bedded, black chert	26
14	Limestone, dark blue-gray, fine-grained, cherty. Nodular-weathering	26
13	Limestone, gray, medium coarse-grained, massive	19
12	Limestone, dark-gray, fine- to medium- grained; black chert. Discontinuous outcrop	28
11	Limestone, brown to gray, medium-grained, cherty	17

		Thickness Feet
10	Limestone calcilutite, gray, greenish-gray, and brown	25
9	Limestone, gray to brown, fine- to medium-grained. Bedded black chert	23
8	Limestone, calcilutite, greenish-gray, gray and brown	12
7	Limestone, gray to brown, fine- to medium-grained. Bedded black chert	12
6	Limestone, brown, fine-grained, black chert	3
5	Limestone, gray, fine-grained, black chert	6
4	Limestone, calcilutite, some black chert	12
3	Limestone, calcilutite, sheared	2
2	Limestone, calcilutite, gray, black chert	5
Blackford formation (upper 10 feet)		
1	Limestone, greenish-gray to brownish-gray, fine-grained, soft, crumbles easily	10

Rockdell Limestone

The Rockdell limestone crops out in the Copper Creek and Clinchport areas. The Rockdell is chiefly gray to pink, medium- to coarse-grained, thick-bedded limestone. There are some fine-grained to dense beds and scattered black chert. Argillaceous, cobbly-weathering zones and highly fossiliferous beds are present. Upper and lower contacts are gradational, and formational boundaries must be somewhat arbitrarily chosen. Near Manville School the Rockdell is about 217 feet thick; it has a thickness of approximately 290 feet at Speers Ferry. Several measured sections are listed by Cooper (1945).

Benbolt and Wardell Limestones, undivided

The Benbolt limestone and Wardell formation of Cooper and Prouty (1943) were mapped as a unit. South of Clinch River its outcrop parallels that of the Rockdell limestone. The basal contact is not precise in areas south of Clinch River, but rock of this unit is less massive and breaks apart more readily than rock typical of the underlying Rockdell. The lower part of the unit contains interbedded argillaceous cobbly-weathering beds and massive coarse-grained limestone. Medium- to coarse-grained, blue to gray limestone with irregular shaly partings is dominant. Many beds contain brachiopods, gastropods, crinoid stems, corals, and other fossils, some of which are silicified. The upper part of the unit has chiefly thin-bedded limestone with shales and some massive limestone beds. Weathering produces abundant slabs and cobbles of fossiliferous limestone that cover the surface of the ground. In some areas, especially just north of U. S. Highway 58 and 23, the uppermost 75 feet or so weathers to yellow soft shale. The

thickness is about 420 feet at Manville (Geologic Section 10); to the north and south the unit appears to be no more than 300 to 350 feet thick.

Geologic Section 10. Along State Road 665, at Manville School. Strike E.-W., dip 30° S.

Bowen formation		Thickness Feet
Benbolt and Wardell limestones (421 feet)		
9	Limestone, blue and gray, nodular; much is coarse-grained	18
8	Limestone, coarse- to fine-grained, thin-bedded, and shale. Some massive limestone beds	87
7	Limestone, fine-grained to coarse-grained, massive	5
6	Limestone, blue, fine-grained and shaly. Some is cobbly-weathering. Limestone beds 1 to 4 inches thick separated by shaly or platy limestone beds	69
5	Limestone, blue to gray, medium-to fine-grained, nodular-weathering, fairly thick-bedded	42
4	Covered. Scattered platy limestone in soil	91
3	Limestone, gray, coarse-grained	25
2	Limestone, blue and gray, medium-grained, irregular shaly partings. Silicified fossil zones with abundant crinoid stems, brachiopods, corals, and other forms	34
1	Limestone, blue to gray, medium- to coarse-grained. Some shale partings. Abundant silicified fossils. Gradational contact	50
Rockdell limestone		

A distinctive and persistent fossiliferous zone at the base of the unit separates it from dark granular limestone or gray calcilutite of the Rye Cove limestone. This zone of dark-brown to gray limestone, from 1 to 10 feet thick, contains many silicified branching bryozoans up to 0.5 inch in diameter (Figure 8). Other commonly silicified fossils include corals, sponges, and straight cephalopods up to 1 inch in diameter and 4 inches in length. Groups of probable algae, with concentric structure 2 to 3 inches in diameter, are present. Conglomerate or sedimentary breccia composed of angular limestone fragments occurs at one locality. About 20 to 50 feet of fairly massive beds of calcilutite and medium- to coarse-grained brown, gray, and pinkish fossiliferous limestone are just above the basal bryozoan zone. In Rye Cove the unit is chiefly argillaceous, slabby- or cobbly-weathering, fossiliferous limestone with some beds of dark, coarse-grained, cherty limestone and dark-gray calcilutite.

A mappable zone of cherty limestone is present at the top of the unit in Rye Cove. The base of this zone is placed where chert is prominent in fairly massive brown or gray limestone. The middle part of the zone is dark-blue, fine-grained, thick-bedded limestone that develops

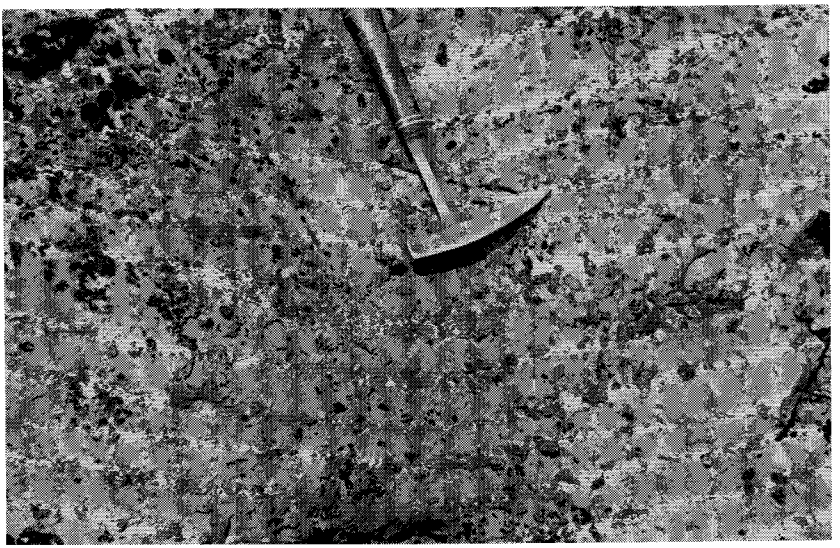

Figure 8. Bryozoan beds at base of Benbolt limestone just above Rye Cove limestone in Rye Cove.

a white, chalky weathered surface. The limestone has abundant small pieces of blocky black chert parallel to bedding and some nodular to irregular chert. Solution produces a soil filled with abundant angular black chert fragments, most of which are less than 2 inches in diameter. Near the upper contact, gradational with the Bowen, is about 10 feet of thick-bedded dove-gray calcilutite. The zone is approximately 30 to 60 feet thick.

Bowen Formation

The Bowen formation is exposed on the north slopes of Copper Creek Knobs and in Rye Cove approximately parallel with U. S. Highway 58 and 23. South of Manville School the lower part of the Bowen consists of blue and gray, chiefly fine-grained, shaly limestone that weathers into thin plates. Above is ribbony blue limestone with thin partings that are yellow and 2-inch thick blue-gray calcilutites and medium-grained limestone. In the upper half of the formation are interbedded red, green, and blue, chiefly fine-grained, shaly limestones. Exposures to the west are principally gray limestone with yellow-weathered surfaces; the red color commonly associated with the formation is absent. Maximum thickness is about 90 feet. The Bowen in the area to the south has a variable lithology of red, yellow, and gray

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limestone. Between Speers Ferry School and Ida Church steeply dipping beds on the north side of U. S. Highway 58 and 23 form prominent outcrops of red and yellow fossiliferous limestone and calcareous mudstone that contain mud cracks and ripple marks (Figure 9). The thickness is approximately 50 to 60 feet.

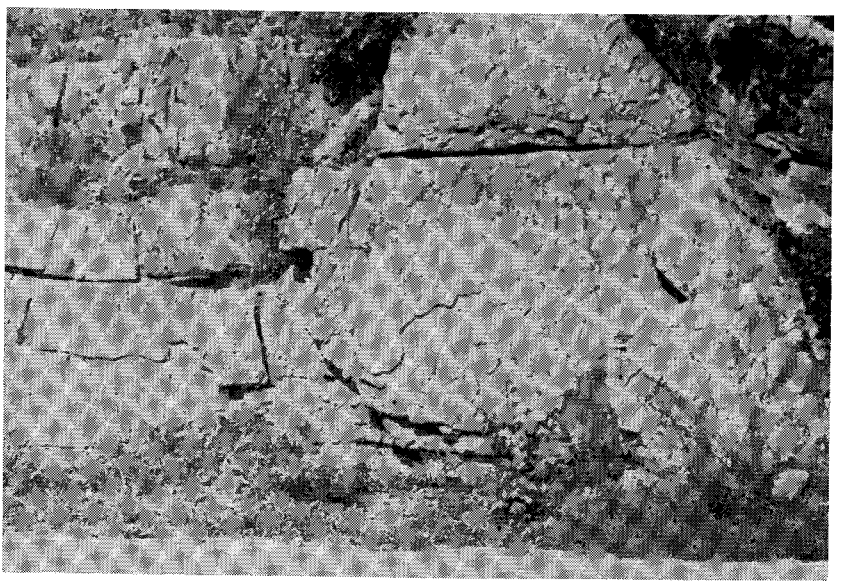

Figure 9. Mud cracks in steeply inclined beds of the Bowen formation along U. S. Highway 58 and 23.

In Rye Cove the conspicuous varicolored mud-cracked and ripple-marked limestones and calcareous mudstones are separated by about 10 to 15 feet of gray calcilutite. Some black chert is present, and behind Rye Cove School a 3-inch thick conglomerate is near the top of the formation. Many areas underlain by Bowen are covered by limestone slabs that are commonly piled into cairns or pillars by the farmers. The thickness is difficult to determine accurately because of gradational contacts and low dips, but it is approximately 60 to 80 feet.

Witten Limestone

The distribution of the Witten limestone is approximately the same as that of the Bowen. Beds of fine-grained to dense thin-bedded gray limestone and thick-bedded calcilutites characterize the Witten.

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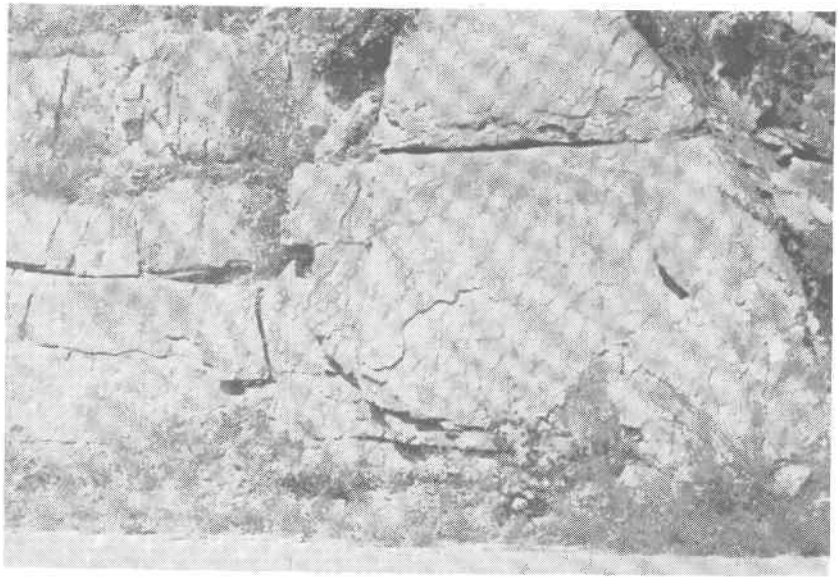

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Witten Limestone

The distribution of the Witten limestone is approximately the same as that of the Bowen. Beds of fine-grained to dense thin-bedded gray limestone and thick-bedded calcilutites characterize the Witten.

Fossiliferous layers contain fragments of crinoid stems, brachiopods, gastropods, bryozoans, and other types. Gastropods, approximately 1 inch in diameter, and *Camarocladia* occur in profusion. The Witten, about 175 to 225 feet thick, has gradational contacts with underlying and overlying varicolored formations.

Moccasin Formation

The Moccasin formation crops out on the north slopes of a series of foothills north of Clinch Mountain. The formation forms the footwall of the Copper Creek fault from the east edge of the quadrangle to near Bethel Church. In Rye Cove the Moccasin is exposed on the west and south slopes of Cedar Ridge; east of Cedar Ridge the formation is in fault contact with the Rome formation along the Clinchport fault.

The dominant lithology of the Moccasin in this area is mudstone. When fresh, the mudstone was probably an argillaceous limestone (Butts, 1940, p. 182). In the foothills north of Clinch Mountain, the Moccasin may readily be divided into a lower red limestone member, a middle limestone member, and an upper red mudstone member. The lower member, about 27 feet thick, consists of thin-bedded yellow and red limestone, shaly limestone, mudstone, and some blue limestone. The middle member, about 62 feet thick, is chiefly thin-bedded, blue-weathering, dove-gray, fine-grained to dense limestone. The upper member, about 429 feet thick, contains red, yellow and gray mudstone, calcareous mudstone, and limestone. Mud cracks and ripple marks are common in the red-colored beds.

The basal contact with the Witten limestone is gradational through several feet of yellowish limestone, and the contact is placed below the lowermost bed of red mudstone. The upper contact is placed above the red-colored beds and below the yellowish shale of the Martinsburg or the highly fossiliferous limestone of the Trenton. The presence of *Camarocladia* in the lower part of the Moccasin was noted by Harris and Miller (1958) and by the writer in gray limestone near the bottom of the formation in Rye Cove. Some blue or gray limestone layers contain abundant fossil fragments. Throughout the quadrangle its thickness probably varies from about 500 feet to 600 feet. Near Clinch Mountain tunnel the Moccasin attains a thickness of about 565 feet (Geologic Section 11).

Geologic Section 11. Just east of the north end of Clinch Mountain tunnel. Strike N. 70° E., dip 55° SE.

		Thickness Feet
Martinsburg formation		
Moccasin formation (563 feet)		
Upper member (429 feet)		
7	Mudstone, red, calcareous, thin-bedded. Mud cracks and ripple marks present. Some thin blue limestone and yellow calcareous mudstone	243
6	Limestone, gray, dense, thin-bedded, blue-weathering. Lenticular, bedded black chert. Some impure, yellow, shaly zones	14
5	Mudstone, yellow	7
4	Limestone, gray, dense, thin-bedded, blue-weathering. Some yellow, shaly limestone	20
3	Mudstone, red and yellow, with some thin limestone beds	145
Middle member (70 feet)		
2	Limestone, gray, fine to dense, thin-bedded, blue-weathering. Some dove-gray calcilutite. A few thin shaly beds	62
Lower member (31 feet)		
1	Limestone and mudstone, yellow, red, and blue. Mostly thin-bedded, some mud cracks	27
Witten limestone		

Trenton Limestone

The Trenton limestone is exposed in a small area near the northeast end of Cedar Ridge in Rye Cove. The Trenton is a fossiliferous gray limestone with thin shaly partings. Generally, the formation is thin-bedded, and weathering produces a soil covered with platy or slabby limestone. Fossils are particularly abundant in the lower half of the Trenton, and some beds consist entirely of fossil fragments, especially brachiopods. Bryozoans are the most noticeable fossils in the upper half of the formation. Other forms, including gastropods and corals, are present at various horizons. The lower contact with the red-colored beds of the Moccasin is fairly sharp; the upper contact with the Reedsville shale is gradational. The formation is estimated to be between 300 and 600 feet thick.

Reedsville Shale

The Reedsville shale has an area of outcrop of about 0.2 square mile on the east slope of Cedar Ridge and along the axis of the Rye Cove syncline. In part the Reedsville consists of poorly exposed shale, siltstone, and gray fine-grained limestone. Brown-weathering shale is the dominant rock type; partly calcareous, dark-gray, brown and greenish siltstone and fossiliferous limestone are present locally. The thickness of the formation could not be determined since only the lower part is present.

Martinsburg Formation

The Martinsburg formation occurs along the north slope of Clinch Mountain. It is poorly exposed but appears to be dominantly brown-weathering shale with some green siltstone. Fossiliferous gray limestones occur in the lower half of the formation. The lower contact is placed above the red-colored beds of the Moccasin, and the upper contact is below the red shales and siltstones of the Sequatchie formation. The Martinsburg has an estimated thickness of between 850 and 1250 feet.

Sequatchie Formation

The Sequatchie formation crops out along the upper part of the north slope and some of the peaks of Clinch Mountain. The formation is composed of shale and sandstone. Most of the exposed rock crumbles into small chips and blocks. The formation is partly calcareous and sparsely fossiliferous. The contact between the Sequatchie and Martinsburg formations is covered on the north slope of Clinch Mountain. The upper contact with the Tuscarora is gradational through 10 feet or more of iron oxide-stained sandstone. The formation is between 300 and 325 feet thick.

SILURIAN SYSTEM

Tuscarora and Clinton Formations, undivided

The Tuscarora and Clinton formations are exposed along the crest and south slope of Clinch Mountain. These formations could not be separated and were mapped as a single unit. The lower part of the unit is chiefly white sandstone and quartz-pebble conglomerate with siliceous cement. Conglomerate is most abundant near the base, but thin conglomerate lenses and isolated pebbles are scattered throughout. Individual pebbles vary from rounded to subangular and range up to about 0.75 inch in diameter, but most are less than 0.5 inch. Cross-bedding is common, but no graded bedding was observed. Bands of hematite, in layers about 2 inches thick, were seen in the upper Tuscarora or lower Clinton west of Clinch Mountain tunnel.

The upper part of the unit is chiefly white to red sandstone with quartz cement. Shaly partings are fairly common. Judging from float, the hematite content increases appreciably toward the east.

Clinton fossils were reported a few miles to the southwest of the Clinchport quadrangle along Clinch Mountain by Harris and Miller (1958). The thickness of the unit is estimated to be between 450 and 500 feet thick.

DEVONIAN SYSTEM

Devonian, undivided

Devonian shales, siltstones, and sandstones that occur in the area of the Clinchport quadrangle include materials equivalent to the Brallier shale which are on the south slope of Clinch Mountain and in Poor Valley and materials listed as sandstones and shales (Harris and Miller, 1958) in the northwest corner of the quadrangle. The rock exposed at the south approach to the Clinch Mountain tunnel (Figure 10) has folded and contorted green to gray shale, siltstone, and fine-grained sandstone. Sandstone float covers the contact between the Clinton formation and the overlying Devonian rock.

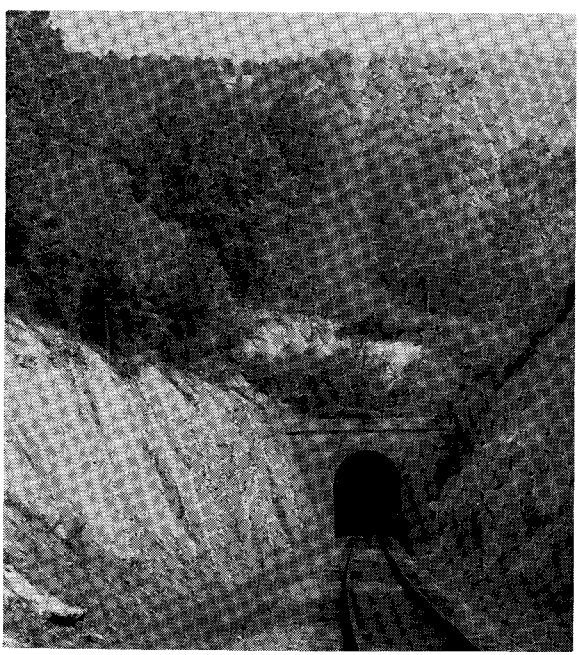

Figure 10. Shales and siltstones of Devonian age in railway cut at south approach to Clinch Mountain tunnel.

Poorly exposed shales and thinly laminated siltstones that are chiefly dark gray to black are largely covered with alluvium in the northwest corner of the quadrangle. The shales and siltstones are in fault contact with the Maryville limestone adjacent to the Hunter Valley fault, and the Greenbriar limestone adjacent to a fault on the northwest (Harris and Miller, 1958).

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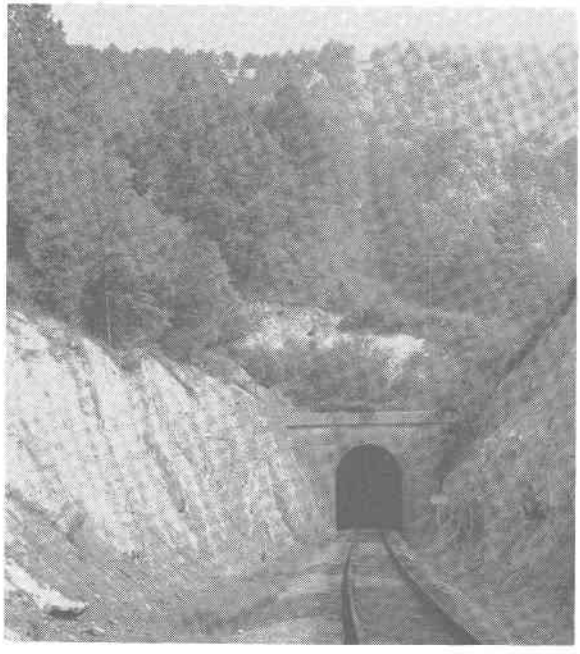

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STRUCTURAL GEOLOGY

Principal structures in the quadrangle are southeastward-dipping reverse faults and southeastward- or southward-dipping formations. To facilitate discussion, the following divisions are recognized from southeast to northwest: Clinch Mountain, Copper Creek area, Copper Creek fault, Clinchport area, Clinchport fault, Rye Cove area, and Hunter Valley fault (Plate 1).

CLINCH MOUNTAIN

Beds in Clinch Mountain strike northeastward and eastward in the southwest corner of the quadrangle and strike northwestward in the middle and southeastern parts. Structure is most clearly discernible in the massive sandstones of the Tuscarora and Clinton formations. The sandstones have undulatory surfaces, and commonly the dip ranges from 30° to 65° S. within short distances. In a number of places the combined effects of undulations and erosion have caused the formations to crop out entirely on the south side of the mountain. At the approach to Clinch Mountain tunnel shale and thin sandstone beds are tightly folded. Axial planes of small folds and associated drag folds dip steeply in a southerly direction (Figure 11).

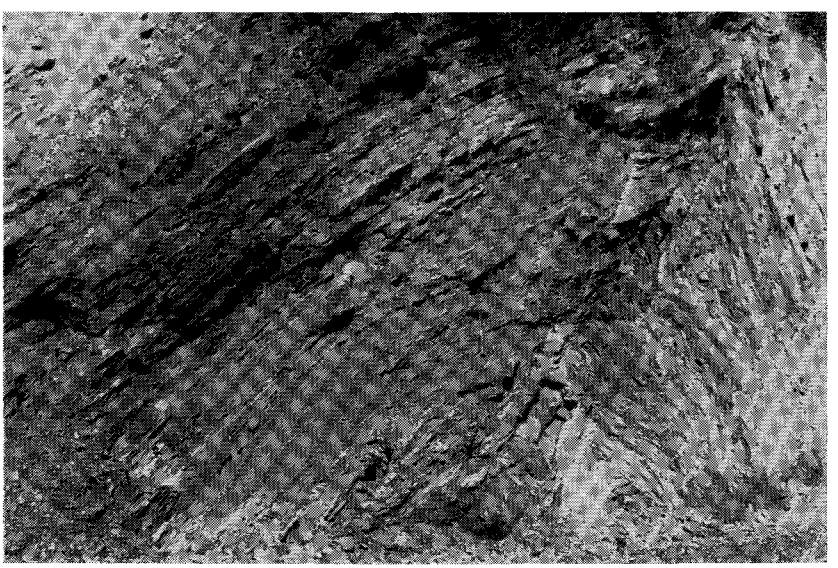

Figure 11. Fold in shale and siltstone on west wall of railway cut at south approach to Clinch Mountain tunnel.

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COPPER CREEK AREA

The width of the Copper Creek area increases gradually from about 1.5 miles in the west to 2.5 miles in the east. A change in strike, from northeast to east and southeast, of the formations in Moccasin Ridge occurs near Speers Ferry. There is some distortion of the rocks at Speers Ferry and a few small dislocations. The formations that are inclined in a southerly direction dip more steeply in the west than in the east.

The Bellamy fault, with an easterly to southeasterly trend, was mapped for 4 miles east of Spivey Ford. To the west the fault continues into the Rome formation, but could be traced no further. It may connect with or intersect the Copper Creek fault near Bethel Church. Rome beds are on the south side of the fault from near Spivey Ford to Williams Cemetery at which place the Rutledge is present to the east edge of the quadrangle. About 1 mile west of Williams Cemetery the fault splits; the Rome is thrust over Maryville and Maryville over Nolichucky. At the east border of the quadrangle, stratigraphic displacement on the south branch of the fault is decreased. Between Spivey Ford and Spivey Mill narrow, in part discontinuous, strata of Rutledge, Rogersville, and Maryville are present north of the fault. South of Spivey Mill a structurally complex area is cut by a group of faults of relatively short horizontal extent. Along some of the faults movement has been chiefly vertical; along others horizontal movement was probably dominant. The steep dip of the high-angle Bellamy fault, between 50° and 75° S. or SW., is indicated by the dip of beds adjacent to the fault and by exposures of the fault in northward-trending valleys. Topographically a relatively straight fault trace is indicative of a high-angle fault. The fault, probably related to the Copper Creek fault, was mapped as a high-angle reverse fault (Figure 12). Maximum stratigraphic displacement is probably about 2000 feet.

COPPER CREEK FAULT

The main trace of the Copper Creek fault is exposed high on the northwest slopes of the Copper Creek Knobs, but in several valleys the fault trace is south of the Knobs. East of Manville School the fault is south of the tops of the Knobs. Sandstones, siltstones, limestones, and dolomites of the Rome formation are on the south side of the fault. The Moccasin formation occurs on the north side, from the east edge of the quadrangle to southeast of Bethel Church where

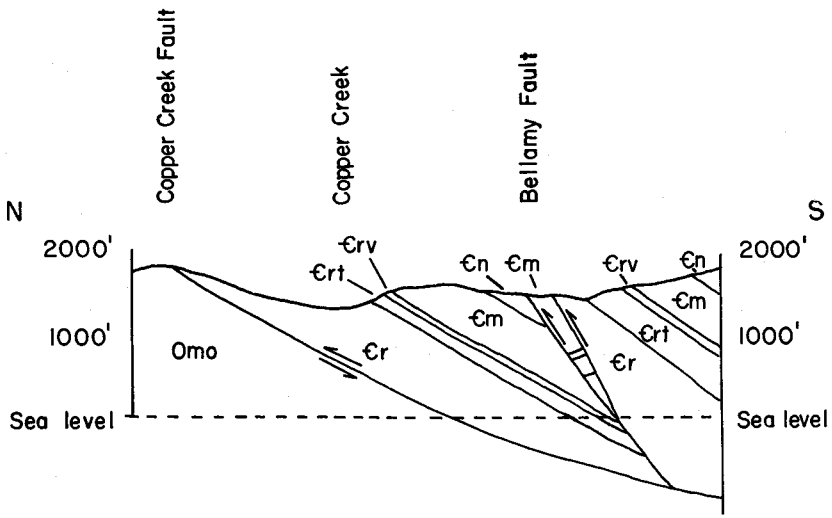

Figure 12. Diagrammatic cross section showing structural relations of Bellamy and Copper Creek faults.

there is an offset in the main fault. Stratigraphic displacement along Copper Creek fault is approximately 6000 feet.

Copper Creek fault has an undulating surface with dips ranging from about 0° to 50° S. or SE.; average dip is about 30°. Parallel dips in beds adjacent to the fault in both lower and upper blocks indicate that it is a bedding-plane, low-angle, reverse fault. Where shale of the Rome formation forms the sole of the allochthon, there are few signs of faulting other than stratigraphic displacement. This is well illustrated on a hilltop north of Spivey Ford where parallel beds of the Rome and Moccasin formations crop out within about 6 feet of each other and are only slightly broken and skewed. Carbonate beds adjacent to the fault are commonly brecciated and distorted, and zones of broken rock with calcite-filled fractures occur as much as several hundred feet from the main break. There are indications of cross folds with north or northwest strike in the allochthon, but these folds could not be traced across the fault and into the autochthonous block.

Southeast of Bethel Church the Copper Creek fault is steeply inclined to the south and offset by a transverse fault. West and northwest of Bethel Church are other transverse faults, some of which cause offsets in the main trace of the Copper Creek fault. These transverse

faults south of Clinchport have been mapped as strike-slip faults, but some vertical displacement is probable. The dip, where observable, is nearly vertical, and the direction of horizontal movement is commonly indicated by drag of adjacent formations. One fault is exposed in cross section just south of the Clinchport tunnel. An idea of approximate dip may be obtained from outcrops southeast of Gravelly Hill Church and just south of the former location of Bethel Church. Drag along the faults is best displayed in the Maryville limestone above Clinchport tunnel and southeast of Gravelly Hill Church.

All the transverse faults trend northwestward except one that strikes northeastward. Of those with northwesterly trend, the three longest are to the east and are right-hand faults. The easternmost fault, over 1 mile long, is bent near Bethel Church, and adjacent Ordovician formations are squeezed and faulted. The fault just west of Gravelly Hill Church is well exposed along a somewhat sinuous trace where southeastward, the Maryville limestone and Rome formation are adjacent. The next fault to the west which cuts through Clinchport tunnel is bounded by the Rome formation on its northeast side. Movement along the northeastward-trending fault, that truncates two of the other transverse faults, may have been mainly vertical. It is shown as strike slip, however, because some horizontal displacement has occurred and such movement best fits the local structural pattern.

Two northwestward-trending faults cut both the hanging wall and footwall of the Copper Creek fault north of Horton Cemetery. Along the east fault horizontal separation parallel to the fault trace, as measured at the base of the Blackford formation, is approximately 800 feet. These two faults differ from the other northwestward-trending faults in that they are left-hand, strike more nearly due north, are relatively short and straight, and truncated ends of formations on opposite sides of the faults can be easily matched.

The transverse faults probably were formed while movements along Copper Creek fault were taking place. The dip and apparent displacement along the Copper Creek fault are greater to the west of the transverse fault area than to the east. These faults south of Clinchport are due north of a prominent northward bend in Clinch Mountain and about 1 mile west of the mappable end of the Bellamy fault. East of these faults the surface traces of the Clinchport and Copper Creek faults diverge. The transverse faults probably represent local relief from concentration of forces that resulted from large-scale movements.

CLINCHPORT AREA

The general inclination of the Cambrian and Ordovician beds is toward the southeast at 25 degrees or more. Exceptions occur to the southwest in an area of structural complexity and toward the northeast where there is folding. A syncline southeast of Starnes Tunnel has caused preservation of a small outlier of Rogersville shale near the center of a wide outcrop of Rutledge limestone. Folding and faulting in an expanse of Rome formation in the northeastern part of the quadrangle cannot be accurately mapped because of a lack of recognizable stratigraphic horizons. The complex structure is well displayed in a road-cut on the southwest side of Starnes Bend in Clinch River.

CLINCHPORT FAULT AND RELATED STRUCTURES

The Clinchport fault extends northeastward from Clinchport to Rhoton Mill where it trends northward. On the southeast side of the fault is the Rome formation. Northeast of Rhoton Mill this formation has an outcrop width of about 1.5 miles as a result of internal folding and faulting. The Maryville limestone forms the footwall of the fault to about 0.75 mile southwest of Rhoton Mill. From there to Rhoton Mill, the Mascot formation is the footwall. North-northeast of Rhoton Mill the fault truncates the northeast end of the Rye Cove syncline, and a number of formations are adjacent to the fault. Stratigraphic displacement ranges from about 1500 feet, north of Clinchport to about 6500 feet, west of Hall Gap. Southwest of Rhoton Mill dip of the fault averages about 35°; north of Rhoton Mill dips of beds adjacent to the fault range from 20° to 80° SE. or E.

Beds on the southeast flank of the Rye Cove syncline are overturned and dip toward the southeast. South and east of Johnson Springs the beds have been broken by southeastward-dipping reverse faults that are related to the Clinchport fault. They are mainly bedding faults and become noticeable by progressive thinning and elimination of a formation. Their trend is approximately parallel to the Clinchport fault, which overrides them to the northeast. Northwest of the bedding thrusts is a low-angle thrust that extends from about 1 mile west of Johnson Springs to about 0.75 mile north of Rhoton Mill. Dolomite of the Mascot formation is present along most of the southeast side. Because of low-dipping undulatory beds and deelpy dissected topography, the surface trace of the fault is irregular. In the

vicinity of Rhoton Mill the Mascot formation was thrust over the complexly folded and faulted autochthonous block that is now revealed by erosion (Figure 13).

Figure 13. Fault in the autochthonous block of Clinchport fault about 0.5 mile north of Rhoton Mill. Rye Cove limestone thrust over limestone of Bowen formation.

About 0.75 mile north-northwest of Rhoton Mill two high-angle faults are shown separating the Bowen and Witten limestones. These faults are somewhat interpretive because the Bowen and Witten lithologies are similar. The structure is further complicated by westward-trending folds and cross folds and faults, many of which are too small and obscure to be accurately mapped.

Folding of the rocks after faulting is indicated by variable dips along some of the exposed faults and by a small klippe along the axis of a tight syncline about 1 mile west of Rhoton Mill. The Clinchport fault has overridden the genetically related faults, indicating that movement along the Clinchport fault occurred after formation of the subordinate faults to the northwest.

RYE COVE AREA

The Rye Cove synclinal complex, referred to as a syncline for convenience, is bounded by the Clinchport fault on the south and east

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RYE COVE AREA

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and by the Hunter Valley fault on the northwest. The axis of the syncline trends northeastward from Glenita. Near Cartertown Church it has an easterly trend, and from there it trends northeastward along the southeast side of Cedar Ridge. On the northwest flank beds dip fairly regularly and gently, commonly less than 20° SE. Some folds, too small to warrant mapping, deform the Witten limestone and Moccasin formation on the northwest side of Cedar Ridge. Irregularities on the southeast flank of Rye Cove syncline, where beds are folded, faulted and overturned, are attributed largely to the same forces that formed the Clinchport fault.

West of Johnson Springs is an inlier where erosion has exposed rocks of the Blackford and Mascot formations. The westward-trending inlier, that is about 0.75 mile long and 0.25 mile wide, is surrounded by Rye Cove limestone. The feature is situated on the south flank of a small anticline. The area contains four small, high-angle faults of relatively little displacement. Where stratigraphic displacement is greatest, the Mascot formation is adjacent to the Rye Cove limestone.

HUNTER VALLEY FAULT

The trace of the Hunter Valley fault extends for about 0.75 mile across the northwest corner of the Clinchport quadrangle. The fault location and stratigraphic relations can be accurately determined about 400 feet west of the quadrangle, but within the quadrangle the fault is covered by stream deposits. Maryville limestone of the hanging wall forms a cliff along the southeast side of the fault; some Rogersville shale appears to be present in places at the base of the cliff.

Two small exposures of shales and siltstones of Devonian age are present in the extreme northwest corner of the quadrangle. These outcrops abut against a northeastward-trending fault that is at the northwest tip of the Clinchport quadrangle and not shown on the geologic map.

The dip of the Hunter Valley fault cannot be obtained from information available within the Clinchport quadrangle, but the Maryville limestone, adjacent to the fault, dips approximately 30° to 35° SE. To the west, in the Duffield quadrangle, the fault dips about 20° SE. (Harris and Miller, 1958). Stratigraphic displacement along the fault is more than 1 mile, and actual displacement, or net slip, along the fault surface may be several miles.

ECONOMIC GEOLOGY

LIMESTONE AND DOLOMITE

Middle Ordovician limestone, 94 to 98 percent calcium carbonate, is present north of U. S. Highway 58 and 23, parallel to tracks of the Southern Railway. There is an operating quarry in this limestone, and many acres of the potentially valuable limestone have been leased. Measured geologic sections and chemical analyses of the limestones are listed by Cooper (1945). Limestones of the same age crop out northeast and northwest of Manville School. The quality and quantity of limestone probably compare favorably to that being quarried, but it is less accessible to important transportation facilities. Limestone for local use can be readily obtained adjacent to State Road 665, about 0.75 mile north of Copper Creek. The best limestones in the Rye Cove area are the Rye Cove and Witten. Calcilutites in the Rye Cove are extensively exposed about 1 mile northwest of Rye Cove School, and the Witten crops out near the base of the northwest and south sides of Cedar Ridge. About 0.5 mile south of Hill Station, along State Road 665, are exposures of Rutledge and Maryville limestones. These limestones have abundant silty and clayey partings and are too low in calcium carbonate content to be of chemical grade. Quarries for crushed and broken stone and aggregate could be located where the limestones crop out along a paved road and are well above the water table.

Speers Ferry Quarry

The limestone quarry of the Penn-Dixie Cement Corporation at Speers Ferry was operated from 1910 to 1918, and re-opened in the 1950's (Figure 14). The quarry is in the Rockdell limestone, which strikes N. 65° E. and dips 65° SE. About 290 feet of chiefly gray to pinkish, medium- to coarse-grained limestone beds comprise the Rockdell here; a measured section and chemical analysis are listed by Cooper (1945, p. 227). Approximate dimensions of the quarry are: height, 200 feet; width (N-S), 300 feet; length (E-W), 1000 feet. The limestone is crushed at the quarry and shipped by rail to the company's plant at Kingsport, Tennessee.

Glenita Quarry

The Natural Tunnel Stone Company has operated a quarry at Glenita, on the northwest side of Stock Creek, since 1954. Quarrying at this locality began in the early 1900's, but operations have been intermittent. The quarry, chiefly in gently dipping dolomite of the

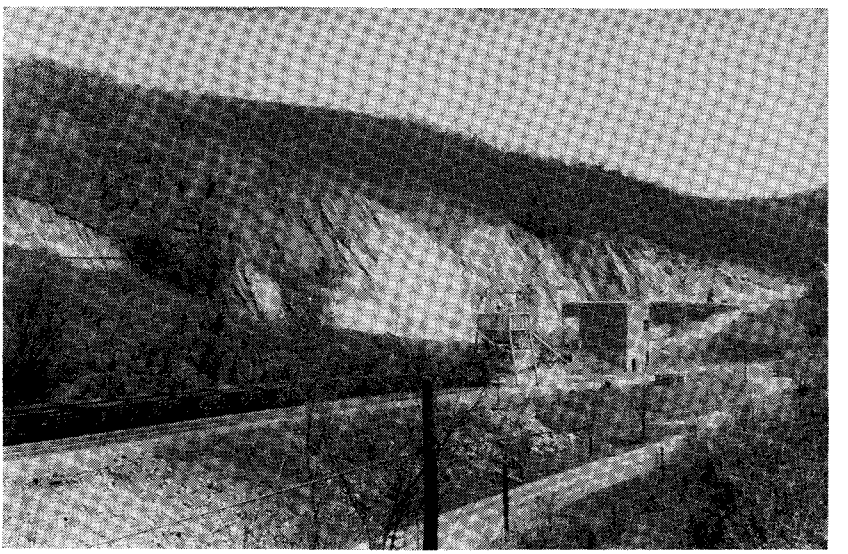
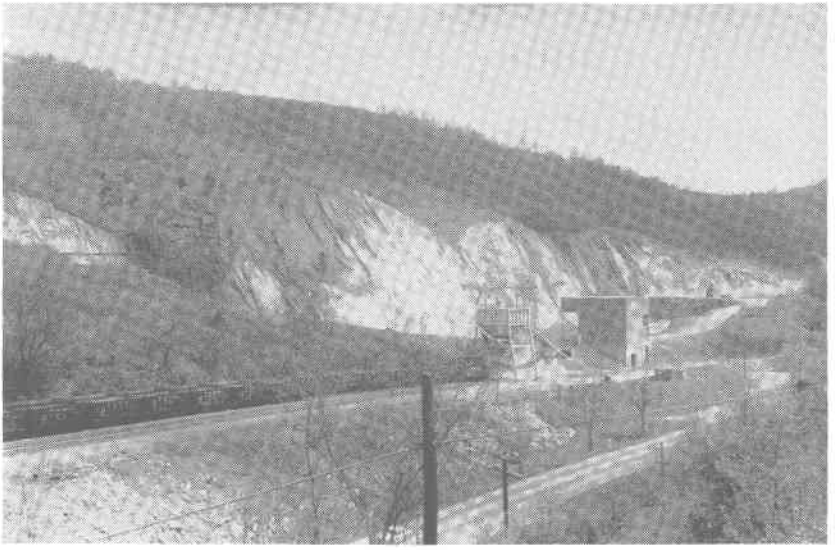


Figure 14. Limestone quarry of Penn-Dixie Cement Corporation at Speers Ferry.

Chepultepec formation, has approximate dimensions of: height, 250 feet, width, 400 feet; length, 600 feet. Faults are present in the lower part of the quarry face, especially near the center and west end. The quarried stone consists chiefly of gray, fine-grained dolomite with small amounts of dark-colored dolomite, breccia, and chert. Quartz is present as scattered grains in dolomite and as sandstone beds. A chemical analysis of rock from the quarry is listed by Cooper (1945, p. 250). The rock is crushed at the quarry and sold to various users, including the Virginia Department of Highways and the Southern Railway System.

CLAY AND SHALE

Readily accessible shale beds of the Rome, Rogersville, and Nolichucky crop out near Clinch River. Shale samples from these formations were collected and shipped to the U. S. Bureau of Mines at the Norris Metallurgy Research Laboratory, Norris, Tennessee for testing and evaluation. The Rogersville shale on the east side of State Road 665, about 700 feet south of its intersection with State Road 645 might be used in the production of lightweight aggregate. Shale from the Nolichucky formation might be utilized in the manufacture of low-grade common brick. This shale is located on the east side of State



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Road 665, about 0.9 mile southeast of the bridge across Clinch River at Hill Station. Another locality is about 0.1 mile southeast in a small roadside quarry.

SILICA SAND

The Tuscarora and Clinton formations, potential sources of silica sand, crop out along the crest and south side of Clinch Mountain. The sandstone is firmly cemented, but in highly weathered areas the rock can be separated into discrete grains fairly easily. The Tuscarora contains relatively pure sandstone, but that of the Clinton has some iron oxide. The generally inaccessible location of the Tuscarora makes production from it unlikely. About 0.3 mile west of Clinch Mountain tunnel there is an abandoned quarry in this sandstone just south of the mountain crest.

SPHALERITE

Rocks of the "Knox" group, the chief zinc-bearing formations in east Tennessee, are extensively exposed within the quadrangle. A few years ago, prospect pits were opened on the north side of Copper Creek about 1 mile west of Bellamy. Several shallow holes were blasted and dug in southward-dipping beds of the Rome formation about midway between the Copper Creek and Bellamy faults. The mineralized zone is a 5-foot, fractured, medium-coarse-grained, gray dolomite that is between shale, siltstone, and sandstone beds. Partly porous, gossan-like material composed of limonite and silicified dolomite fills fractures and projects on weathered surfaces. Light-brown sphalerite occurs as fissure filling and replacement material in fractured dolomite. White, crystalline dolomite, commonly associated with sphalerite mineralization, occurs as cavity fillings. The mineralized area is probably less than 200 feet in diameter; along strike the dolomite is fine grained and barren.

IRON-BEARING MINERALS

Atop a hill in the Rome formation, about 0.75 mile S. 20° W. of Johnson Springs, is a gossan-like outcrop of iron and quartz. X-ray analyses indicate that the chief minerals are goethite and hematite. The porous, partly banded masses are several feet in diameter, and small clear quartz crystals fill many cavities. The occurrence, about 400 feet south of the Clinchport fault, may have originated by replacement of shattered rock.

About 0.4 mile northeast of Alleys Chapel a large area on top of a hill in dolomite of the Mascot formation is stained red. Scattered,

irregularly shaped pieces of hematite, up to 1.5 inches in diameter, occur along probable bedding planes, and abundant hematite nodules are strewn over the surface.

Iron oxides, chiefly in the form of hematite, occur north of Marble Point Church in the disconformable contact zone between the Mascot and Blackford formations. Massive beds of hematite, some more than 1 foot thick, occur through a 40-foot zone. The very slightly calcareous beds dip approximately 30° S. and are overlain by gray calcarenite. Megascopically, the red-colored beds seem to consist chiefly of hematite with flattened clay pellets and angular chert and dolomite fragments. Chert fragments are generally less than 0.5 inch in diameter, but some are several inches in length. X-ray analysis indicates that the matrix contains a mixture of hematite and quartz.

The hematite beds crop out on the west side of a small stream that empties into Little Moccasin Creek at Marble Point Church, and they extend between 1000 feet and 3000 feet to the west. On the east side of the valley the hematite beds are absent.

GROUND WATER

Rye Cove

Much of Rye Cove is structurally and topographically low, and about 3500 feet of limestone and dolomite, with subordinate shale, overlie the relatively impervious Rome formation. Water from surrounding slopes drains toward the center of the synclinal structure; some sinks below the surface and flows along solution channels. Much of this water may have collected in the subsurface, trapped by inward-dipping beds; low-dipping faults on the southeast probably have no adverse effect on water storage. Surface streams, augmented by flow from springs, carry some water from the Rye Cove area to Clinch River. Water-filled sinkholes probably indicate local impervious conditions and do not represent the water table, as nearby sinks with lower bottom elevations are commonly dry. Cedar Ridge is well-drained by surface streams.

South of Rye Cove

South of Rye Cove all formations dip to the south or southeast except for locally disturbed areas. Much water may be carried far below the surface along bedding planes and solution openings in carbonate formations. Ground-water conditions east of Speers Ferry are illustrated by the water-filled abandoned quarry at Marcem, north of U. S. Highway 58 and 23 about 1.5 miles east of Marble Point Church.

Springs

Most springs in the area are of small yield and show marked seasonal variation. Some of the springs with fairly large flow never go dry and are little affected by changes in season; the most productive issue from cavities in limestone or dolomite. Several springs with copious flow are located in or near fault zones.

Wells

Successful location of wells in carbonate rocks is dependent upon the encounter of fracture zones or solution openings, and the quantity of water obtained is variable. Information from Tazewell and other counties indicates that significant solution channels occur within 200 feet of the surface; below this level solution openings become progressively smaller and fewer. Shales are commonly fractured, and yields up to 10 gallons per minute may be expected from wells approximately 50 feet in depth.

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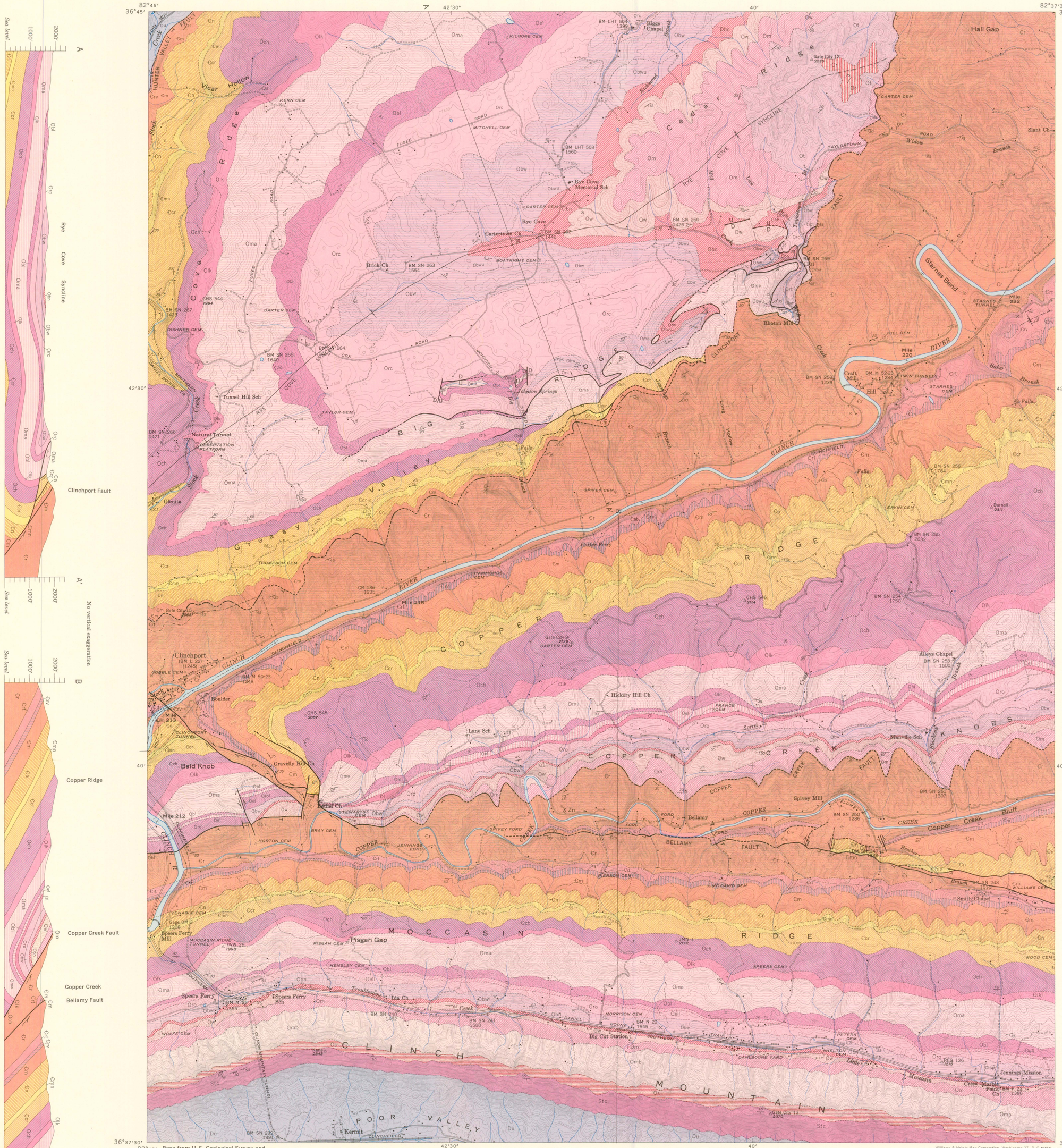
COMMONWEALTH OF VIRGINIA
DEPARTMENT OF CONSERVATION AND ECONOMIC DEVELOPMENT
DIVISION OF MINERAL RESOURCES
James L. Calver
Commissioner of Mineral Resources and State Geologist



Base from U.S. Geological Survey and Tennessee Valley Authority Clinchport Quadrangle, 7½ Minute Series.

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EXPLANATION

DEVONIAN — SILURIAN

- Du — Devonian undivided
- Stc — Tuscarora and Clinton formations

ORDOVICIAN

Upper Ordovician
- Os — Sequatchie formation
- Or — Reedsville shale, in Rye Cove

Middle Ordovician
- Omb — Martinsburg formation
- Ot — Trenton limestone, in Rye Cove
- Om — Moccasin formation
- Ow — Witten limestone
- Obn — Bowen formation
- Obwu / Obw — Benbolt and Wardell limestones, Obwu-upper member in Rye Cove only
- Oro — Rockdell limestone
- Orol — Lincolnshire and Rockdell limestones,
- Orc — Rye Cove limestone, in Rye Cove
- Ol — Lincolnshire limestone
- Oel — Elway and Lincolnshire limestones
- Oel — Elway limestone
- Obl — Blackford formation

Unconformity

Lower Ordovician
- Oma — Mascot formation
- Olk — Longview and Kingsport formations
- Och — Chepultepec formation

CAMBRIAN

Upper Cambrian
- Ꞓcr — Copper Ridge formation
- Ꞓmn — Maynardville formation
- Ꞓn — Nolichucky formation

Middle Cambrian
- Ꞓm — Maryville limestone
- Ꞓrv — Rogersville shale
- Ꞓrt — Rutledge limestone

Lower Cambrian
- Ꞓr — Rome formation

CONTACTS
exposed
approximate
covered

FAULTS
NORMAL AND REVERSE
U/D exposed
U/D approximate
U - upthrown side
D - downthrown side

THRUST
exposed
approximate
T overthrust side

TRANSVERSE
exposed
approximate
Arrow indicates relative movement

FOLDS
Anticline - trace of axial plane
Syncline - trace of axial plane

ATTITUDE OF ROCKS
Strike and dip of beds
Strike and dip of overturned beds
Strike of vertical beds
Horizontal beds

PROSPECT
X Zn Sphalerite mineralization

GEOLOGIC MAP AND STRUCTURE SECTIONS OF THE CLINCHPORT QUADRANGLE, VIRGINIA

Geology by W. B. Brent

SCALE 1:24000

1 ½ 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

Contour interval 20 feet
Datum is mean sea level

1963

1¼°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1949