Clarke County

Stratigraphy

The rocks of Clarke County are crystalline (schist or greenstone), and sedimentary, sandstone, shale, limestone, and dolomite. The rocks above the basal Cambian are divided into the following formations, with a total thickness of 11,150 feet as shown in the following generalized section:

	Feet
Martinsburg shale, basal	200 ±
Chambersburg limestone	200 ±
Athens	200 ±
Lenoir	50
Mosheim	50
Bellefonte	2250
Nittany	1200
Chepultepec	500
Conococheague	3000
Elbrook	2500
Rome	2500
Shady	1500
	150

Basal Cambrian quartzites, etc.

These formations are the units of mapping and are described in ascending order, or in the order of their deposition, beginning with the lowest and oldest.

Basal Cambrian quartzites (described by Mr. and Mrs. Stose). - The Antietam quartzite is abruptly succeeded by a thick mass of relatively pure carbonate

rock (the Tomstown dolomite which looks like limestone). This is the earliest or first formed rock of the kind in the Appalachian region and indicates possibly the most pronounced changes in the entire development of ~~the history~~ of the geology of the Appalachian region. This notable change was noted and commented on by Keith in the Roan Mountain folio of the U. S. Geological Survey.

Tomstown (Shady) dolomite. - The name Tomstown was given by Stose from Tomstown, a village in Franklin County, Pa. (Mercersburg-Chambersburg folio of the U. S. Geological Survey). Shady is an earlier name given by Keith for Shady, Johnson County, Tenn. (Cranberry folio of the U. S. Geological Survey). There are two names for the same formation.

The Tomstown is a pure carbonate rock. No interbedded layers of sandy or shaly material have been observed, but such are reported elsewhere. The pure rock is predominantly dolomite so far as shown by acid tests, but there are layers of limestone, as in Pennsylvania and at Austinville and elsewhere in southern Virginia, and in the type locality in Shady Valley of northern Tennessee. The formation is medium thick-bedded, in layers from a few inches to two feet or so thick. It is of bluish gray to light gray in color. Beds of rather coarsely crystalline (sacharoidal) dolomite occur, which are indistinguishable from similar rock in the formation all along its outcrop south into Johnson County, Tenn. Such rock is

highly characteristic and proves beyond question that the formation is the same from Pennsylvania to Tennessee. Except for the long salient on a subordinate anticline pitching to the north and extending to north of Route 7 between Webbtown and Riverside school, the outcrop of the Tomstown follows closely the course of the Shenandoah River across the County and north into Pennsylvania, crossing the Potomac River about one mile west of Harpers Ferry. As a matter of fact, there is a strong suggestion that during many ages of erosion the river has adjusted itself to the belt of domomite which is more easily eroded than the rocks on either side of that belt.

Some of the best exposures of the Tomstown in Clarke County are at the following localities: In the north bluff of the Shanandoah River about one mile southwest of Shephard Ford; in the salient north of Route 7 between Webbtown and Riverside school, and on the southeast slope of the river about 1,000 feet east of Good Spring five miles east of the railroad station at Berryville. This last is a large and striking exposure in an open field.

The thickness of the Shady is estimated to be 1,200 to 1,500 feet. Exact measurement is impossible.

No fossils have been found in the Tomstown in Clarke County. Salterella pulchella Billings is plentiful in the uppermost beds exposed in the east face of

the quarry in the Tomstown at Millville, 11 miles northeast of Clarke County. At Austinville and vicinity, Wythe County, a number of species occur in the Shady dolomite, including Archeocyathus, Kutorgina cingulata?, Nisusia festinata?, Olenellus sp., and a considerable assemblage of other genera and species of trilobites. The first three fossils named above occur on the southeast coast of Labrador just north of the Straits of Belle Isle, and at this locality Salterella pulchella also occurs. All of these fossils are of Lower Cambrian age and prove that the Tomstown-Shady is of the same age.

Waynesboro formation.

The Tomstown is succeeded by the Waynesboro formation named by Stose (1919) from Waynesboro, Franklin County, Pa. (See Mercersburg-Chambersburg folio.) Southward, the Waynesboro is found to be continuous first with the Watauga formation of Tennessee and farther south with the Rome formation named from Rome, Ga. Thus, there are three names for the same formation in common use. Confusion could be avoided by adopting a single name which, on the ground of priority, should be Rome, a name proposed by C. W. Hayes in 1891 (Geol. Soc. America Bull., vol. 2, pp. 143-146).

The Rome is a heterogenous formation throughout its extent, and the same is true for the Waynesboro in Clarke County. There is much argillaceous limestone or dolomite which commonly weathers to a yellowish ochreous rock through loss of its calcareous (limy) content, a process known as decalcification. There are thick beds, apparently dolomite, that break down on weathering to gray, shelly fragments. There are beds of apparently pure limestone. Thin layers of sandstone and of shale were noted in a few places but are probably in small amounts. The most distinctive rock is a red rock that may be best perhaps called a red mudrock. The color is not strictly red but a deep reddish brown, which is about the color of all the red formations in the Appalachian Valley, such as the Moccasin, Juniata, and Hampshire ("Catskill") formations. No such rock occurs in any other formation in Clarke County except a small amount in the basal quartzites on the northwest slope of the ~~northwest slope~~ of the Blue Ridge exposed in the road just south of Duke Hollow, north of Ashby Gap, ~~and~~ There is no possibility of confusing the latter with the red of the Waynesboro. The red beds of the Waynesboro are of no great thickness and seem to be scattered throughout the full thickness of the formation where they are interbedded with yellow weathering ochreous rock as shown in the following section. Owing to their predominant clayey composition these red and yellowish rocks are called shale for the purposes of description.

Section at Marvin Chapel, 3 miles east-northeast of the railroad station at Berryville.

	Feet
Shale, yellowish ocherous	25
Shale, red	15
Shale, yellowish	35
Shale, red	35
Shale, yellowish	10
Shale, red	15
Shale, yellowish	10

This section is probably a representative example of the manner of occurrence and relative thicknesses of the red beds of the Waynesboro. In Virginia at Roanoke and south into Alabama, while the red beds are similarly associated with the other types of rock, they are much thicker, constitute a larger proportion of the whole, and are much better exposed. Their occurrence in Clarke County, however, is sufficient to prove the equivalence of the Waynesboro with the Rome. The Waynesboro crops out across the county roughly parallel to the Shenandoah River in a belt varying from three-fourths of a mile to more than one mile in width, with zigzag boundaries due to the overlapping minor folds that cross the outcrop in a slightly northwest direction. The greatest width of the belt is nearly two miles just south of the West Virginia state line; the least width is just north of the Warren County line.

The most exposures of the Waynesboro are in the broad area north of Route 7 including the red beds at Marvin Chapel. Other exposures of the red beds are both east and west of Wycliffe church; along the winding farm road one-half mile north of Riverside Run; along Dog Run and in the triangular area south of the river west of Shepperd Ford; on the brow of the bluff ½ mile east of Milldale, Warren County, and in a ravine just west of the river and just south of Milldale Run in Warren County. Just east of the mouth of Milldale Run a massive bed of limestone or dolomite, probably argillaceous, nearly vertical and about 100 feet thick, crosses the river both above and below the mouth of the Run and makes strong riffles. The argillaceous, shelly dolomite is fairly well displayed along the farm road on Milldale Run and the north bluff of the Run within one-half mile southeast of Milldale. Beds of pure limestone are exposed along Dog Run and in the salient of Waynesboro tonear the north bank of the river.

Probably the best and most nearly continuous exposure of the Waynesboro in this general region, but of only the upper half, is on Route 9 in West Virginia southeast of Charlestown, between Mechanicstown and Bloomery. As with the other formations of the county the thickness of the Waynesboro cannot be accurately measured. There is a maximum limit, however, of about 3,500 feet. This estimate is based upon the least

width of the outcrop of the Waynesboro, which is along the river three-fourths of a mile north of the Warren County line where the width is 3,500 feet. If the rocks were uniformly vertical in this space, the thickness could be 3,500 feet, but no greater. Observations indicate an average dip of 40 degrees, which would make the thickness for that width of outcrop 2,500 feet, and that is taken as the probable thickness of the Waynesboro.

No fossils have been found in the Waynesboro in Clarke County, but Olenellus occurs near Indian Rock, six miles southeast of Natural Bridge in an ocherous bed associated with red shale. The same fossil occurs in the same association, and partly in ocherous rock, south into northern Georgia and northern Alabama, where the containing beds are in the Rome formation in its type region. Olenellus is universally recognized as a Lower Cambrian fossil, from which it follows that the Waynesboro, which is proved by continuity of outcrop, to be the equivalent of the Rome, is also of Lower Cambrian age.

Elbrook limestone

The Elbrook was named by Stose for Elbrook, Franklin County, Pa.

The Elbrook is predominantly limestone, little or no dolomite having been noted. It is usually compact in texture, bluish, and in layers varying from a few inches to a foot or two in thickness. A few layers weather to a dun color. A few layers of dolomite and compact, pearl-gray limestone were noted. Many layers contain argillaceous matter in sheets parallel with the bedding, which, owing to a slight difference in color brought out by weathering, give such layers a banded appearance similar to that of the equivalent Rutledge and Maryville limestones of southwestern Virginia and northern Tennessee. On extreme weathering the argillaceous layers tend to break down into ocherous looking slabs and debris that cannot be distinguished with certainty from similar material from the Waynesboro formation. This character persists in the Elbrook throughout the Valley in Virginia generally, and is particularly well displayed in road cuts on Route 11, two miles or so south of Buffalo Creek, Rockbridge County, and about one-half a mile east of Shawville, Montgomery County. The color banding usually is not conspicuous and requires close inspection to detect. It seems to show the bedding and indicate the true dip of the strata where that is obscured by shearing involved in their folding.

Conococheague limestone

The Conococheague was so named by Stose (Mercersburg-Chambersburg folio) for the creek of that name in Franklin County, Pennsylvania, on which the formation is well exposed at Scotland, a few miles northeast of Chambersburg.

As in its type locality in Pennsylvania, the Conococheague in Clarke County is mostly a banded limestone, medium thick-bedded, and of blue color. A few layers of dolomite occur, but limestone probably makes 90 percent of the formation. The banded structure is caused by thin layers of argillaceous material within thicker layers of limestone which, because of greater resistance to erosion, tend to stand out in relief on weathered surfaces like ribbing or fluting. (See Virginia Geol. Survey Bull. 52, pl. 20, fig. B.) No such strong fluting has been observed in Clarke County, however, as occurs elsewhere in Virginia or as shown in the photograph of plate 20.

The most distinctive character of the Conococheague, however, is beds of sandstone distributed through its full thickness. Much of the sandstone is composed of well-rounded grains of quartz embedded in a limy matrix, which, in some places, is dissolved out, leaving a porous, coarse-grained, friable sandstone, or, the matrix may be silicified and still include quartz grains, making a sandy chert. A specimen collected one mile north of Winchester from an even-

bedded layer $1\frac{1}{2}$ inches thick, is a compact mass of perfectly rounded quartz grains, one-half mm. in diameter, cemented by interstitial silica. Where freshly exposed, as in a new road cut, these sandstones can be recognized only by close inspection, owing to their similarity in appearance to the enclosing limestone.

The beds of sandstone are of variable thickness and extent. Some can be traced only one-half mile or so along their outcrop; others for several miles. Being more resistant than the enclosing limestone, the sandstones tend to make low ridges along which boulders and pieces of sandstone are scattered on the surface and give evidence of the presence and extent of the sandstone bed. The sandstone beds are generally thin, some only a few inches thick. Most observations are of layers one, two, or three feet thick. Two and one-half miles north of Berryville a bed 20 feet thick crosses the road at the west end of Stringtown, and at Dr. Miller's farm about one mile northwest of Gaylord, an equal thickness occurs. A typical example is on a knoll in a field 2 miles southeast of White Post at a right-angle in the road following down Long Run to the river.

Section 2 miles southeast of White Post.

	Feet	Inches
Limestone		
Sandstone		6
Interval	40	
Sandstone		2
Interval	90	
Sandstone	1	
Interval	50	
Sandstone		6
Interval, not measured		
Limestone		

This section was obtained on a low but prominent knoll, and it is very probable that more sandstone is present in the unexposed intervals.

The outcrop of a number of the sandstones is shown on the map by lines of black dots. This mapping is based upon exposures of the sandstone in places in road cuts, on rare exposures in the fields between the roads, but mostly upon tracing of sandstone debris along the lines of outcrop, commonly on the low ridges mentioned above.

The Conococheague crops out in a belt about two miles wide extending diagonally across the county. Boyce is near the northwest boundary and Millwood is about one-half mile west of the southeast boundary. Berryville is situated near the Middle of the belt.

Some of the best displays of the Conococheague are just northwest of Route 340, 1½ miles north of Berryville, where there is a continuous exposure 2,000 feet across on the slope just northwest of the road; in the open fields between the race track at Audley and Route 340; on Route 340 one mile southwest of Gaylord; on Route 340 for a mile northeast of Boyce; and on Borden Marsh Creek for three-fourths of a mile southeast of Stone Bridge. Here are a few layers of dolomite. Here also, in the field south of the road, 3,000 feet southeast of Stone Bridge, is a good exhibit of the banded limestone.

Good exposures of the sandstone in the Conococheague are as follows:- On the cross-road 1,000 feet northeast of the County House 2½ miles north of Berryville; at Dr. Miller's near the state line one mile northwest of Gaylord; on Route 50 about one-fourth mile east of the Fair Grounds, and nearly one mile west of Berryville; a number of exposures of beds 1-3 feet thick, on the roads between Boyce and Old Chapel; around the salient and reentrant north of Fauntleroys Run 2-3 miles east of White Post and at Stone Bridge near the Warren County line.

Good displays of the sandstone with siliceous matrix are to be seen on the east-west road one mile nearly north of Old Chapel, on the east-west road one mile west of Lewisville, and 1-3/10 miles north of that point in West Virginia on the crest of a low ridge.

Since sandstone is either very rare in or entirely absent from any other limestone formation in the Appalachian Valley, except to some extent in the Waynesboro formation, which is otherwise distinguishable, its universal and common presence in the Conococheague all the way from central Pennsylvania to Greenville, Tennessee, at least, serves as an infallible guide to the identification of the Conococheague throughout that extensive area.

The thickness of the Conococheague cannot be even approximately determined in Clarke County. A seemingly reasonable determination in Frederick County is 2,500 feet. The minimum width of outcrop at the south boundary of the county is 7,000 feet, and the dip is generally steep, varying from 20 degrees to vertical, but there are some reversals. It can be said that the thickness is less than 7,000 feet but may be greater than the thickness of 2,500 feet in Frederick County.

No fossils have been found in the Conococheague in Clarke County, and only a few have been found anywhere in it. A trilobite, Saukia stosei, occurs at the type locality of the formation at Scotland, Pa., and Tellerina wardi; another trilobite has been found at two places in Frederick County and about one mile north of Natural Bridge, Rockbridge County. Both fossils are regarded as of Upper

Cambrian age and indicate that the Conococheague may correspond to the Trempealeau, and possibly other divisions of the Upper Cambrian of Wisconsin. The Clarke County belt is known through actual tracing to be continuous in outcrop northeastward to Scotland, Pennsylvania, the type locality of the Conococheague, and thus is demonstrated to be the same formation as the typical Conococheague.

Ordovician System

Chepultepec limestone

This formation was named for the village of Chepultepec in Murfrees Valley, Ala., 30 miles northeast of Birmingham. (Ulrich, E. O., Bull. Geol. Soc. America, vol. 22, pp. 549, 638-640, 1911.) It crops out just west of the village and came to attention because of the fossils that are rather plentiful there.

In Clarke County, the Chepultepec is all limestone. It contains no, or very little, dolomite and on solution with acid yields but little dark, insoluble matter. It is blue-gray and medium thick-bedded, roughly in layers one foot thick, with a few thicker or massive beds. It can be distinguished from the Conococheague by its overlying position and by the absence of sandstone and strong lamination. As shown on the geologic map, beds of sandstone occur in places close below the Chepultepec. Lithologically, it is not distinguishable from the overlying Nittany division of the Beekmantown, except possibly through the presence of more dolomite in the latter.

The Chepultepec crops out in a narrow band across the county, passing just east of White Post and Boyce, and a mile west of Berryville, where the Fair Grounds seem to be located upon it.

The best exposures are between Rockland and Success, Warren County, just east of the railroad for one-half mile north of Sugar Hill, just east of Boyce, and one mile south of Horsepen Spring. The thickness of the Chepultepec cannot be exactly determined. The outcrop is about 1,000 feet wide and the dip prevailingly steep to the southeast, but there are so many deviations from regularity, with a good many reversals, that a true average dip cannot be certainly postulated. If the average dip is 40 degrees, the thickness would be 600 feet. Allowing for uncertainties, a thickness of 500 feet seems a reasonable estimate.

Fossils are very scarce in the Chepultepec of Clarke County. A good collection of Finkelnburgia cf. F. bellatula was made 1,000 feet southeast of Success, Warren County, and probably the same species about 1½ miles a little west of south of White Post. A specimen of a characteristic, curved cephalopod, possibly a Dakeoceras, was noted in the same bed near Sugar Hill, one-half mile southwest of the last mentioned locality, and another specimen of the same was seen a few hundred feet east of Boyce. Curved cephalopods of the type seen here are widely distributed at this horizon, being found also in the Gasconade limestone of Missouri, the equivalent of the Chepultepec. The same is

true of the Finkelnburgia which occurs also at Newton, New Jersey, in the upper part of the Kittatiny limestone, which is therefore believed to occupy a horizon equivalent to that of the Chepultepec and the Gasconade. The curved cephalopods are quite plentiful in a massive bed at Funkstown, Pa., a few miles south of Hagerstown. This bed is in the same belt of outcrop which is continuous from Clarke County to Funkstown. The Chepultepec is thus a body of limestone laid down on the same sea bottom contemporaneously with the deposition of the Gasconade of Missouri and with that of the upper part of the Kittatiny limestone of New Jersey.

Beekmantown limestone

Nittany division

The Beekmantown limestone was named for the village of Beekmantown, west of Lake Champlain, Clinton County, N. Y. It is a subdivision of the Calciferous sandstone of early New York geologists. The Nittany division was named from Nittany Valley, Center County, Pa.

In Clarke County, the Nittany is a mixture of limestone and dolomite, the limestone greatly predominating. It follows, apparently by gradual transition, the Chepultepec limestone, with no, or but little, change in lithology, and thus with no perceptible lithologic upper boundary. It is, however, a definite body of strata limited below by the Chepultepec and above by beds bearing Ceratopea, which is everywhere a recognized post-Nittany fossil. Near Waterloo, midway between Boyce and White Post, Ceratopea occur (see map) and fix a maximum possible northwestern limit of the Nittany at that point. The top of the Nittany is accordingly placed just southeast of Waterloo. The width of the outcrop down to the Chepultepec at that point is about 1,700 feet and that is assumed to be the width of the outcrop of the Nittany across the country.

Mosheim limestone

The Mosheim limestone was named for the village of Mosheim on the Southern Railway 7 miles northwest of Greenville, Tenn. (Ulrich, E. O., Geol. Soc. America Bil., vol. 22, 1911). In Clarke County, as nearly everywhere in northern Virginia, it succeeds the Bellefonte member of the Beekmantown with a hiatus between caused by the absence of the uppermost beds of the Beekmantown--the Odenville limestone of Alabama--and of the Murfreesboro limestone. (See Virginia Geol. Survey Bull. 52, pt. 2, pls. 25 B and C.)

The distinctive characters of the Mosheim are a compact texture, glassy fracture, and dove color. This type of limestone has been named vaughanite (Kindle, E. M., Pan-Amer. Geologist, vol. 39, p. 370, 1923). This limestone persists at the same horizon from Alabama to West Virginia. It is usually rather thick-bedded, and the thick layers projecting above the surface of the ground and well-weathered can everywhere be recognized by their blue-gray color and boss-like contours. A chip from such a boss reveals the characters described above.

The glassy texture is also revealed at once by breaking. The Mosheim is a very pure limestone, probably will average at least 95% calcium carbonate. It is extensively quarried and burned for lime, as at Stevens City and Strasburg,

Frederick and Shenandoah Counties, but it is not utilized in Clarke County and probably cannot be on any large scale, because it is there relatively thin and also because of unfavorable quarrying conditions.

The Mosheim is present in Clarke County only in the narrow belt of complexly folded and faulted rock next east of Opequon Creek and Wrights Run, and in the narrow synclinal outliers east of the folded belt. Small exposures of characteristic appearances are common in the folded belt, but specific localities cannot readily be described. The outcrops can usually be followed for considerable distances by solid ledges or by lines of detached exposures of the characteristic blue-gray limestone. It can be seen on several low knolls crossed by the roads within the square mile next east of Glendale school and along Route 3 for 3 miles southwest of Double Tollgate. The best places to see the Mosheim and its relation to the Beekmantown and Lenoir is on the road on Tumbling Run 1½ miles southwest of Strasburg, Shenandoah County and One-half mile east of Fishers Hill.

The Mosheim is probably nowhere as much as 50 feet thick in Clarke County. It is 50 feet thick on Tumbling Run as described above and reaches a thickness of about 100 feet in the quarry district north of Strasburg, Shenandoah County, and at Martinsburg, West Virginia. (See Geology of Frederick County, Virginia Geol. Survey Bull.).

No fossils have been noted in the Mosheim of Clarke County, but at some places in the Appalachian Valley, as a Mosheim, Tenn., the formation is notable for its large gastropods, particularly species of Lophospira. Some of these are illustrated in Special Report 14 of the Alabama Geological Survey, pl. 19, figs. 19-27; Virginia Geol. Survey Bull. 52, pt. 2, pl. 77, figs. 14, [illegible] 26, 29, 30. The identification of the Mosheim in Clarke County, however, rests not upon its fossils but upon its lithology and stratigraphic relations which are constant and observable all down the Valley to Mosheim and in Cahaba Valley at Odenville, Ala.

Lenoir limestone.

The Mosheim limestone is everywhere succeeded, with no known interruption of deposition, by the Lenoir limestone, so named for Lenoir City, Tenn., 40 miles southwest of Knoxville.

In contrast with the Mosheim, the Lenoir is a very dark, nearly black, finely crystalline limestone. The differences in color and texture of the two limestones is plainly evident upon the most superficial examination. Another distinctive characteristic of the Lenoir is the presence of nodules and plates of black chert, or flint, as many people would call it, distributed through the

full thickness of the formation. These cherts break down on weathering into small cuboidal blocks, which are in places thickly strewed over the surface of the ground above the limestone and, by their presence, the position of the limestone below the surface can be traced for long distances.

The Lenoir, being in immediate contact with the Moshein, has the same distribution in outcrop inthe complexly folded belt one mile or so east of Opequon Creek.

The best exposures of the limestone and best displays of the residual chert are inthe relatively large areas of the Lenoir at the north and south ends of the Wadesville anticline, the former being one-half mile north of Wadesville, the latter being just north of Marsh Run, one-half mile southeast of Glendale school. One of the best displays of the chert is on the first road to the north from Route 340, one-fourth of a mile east of Opequon Creek. The chert is especially abundant on the top of the low ridge in the field east of the road. A few fossils, crinoid stems, a ramose bryozoon, and Strophomena occur in the chert here. The best place to see the Lenoir is on Tumbling Run 1½ miles southwest of Strasburg, Shenandoah County. Here the Lenoir, with its black chert nodules, and the Moshim are both fully exposed.

The thickness of the Lenoir in Clarke County has not been exactly measured, but it is evidently thin, probably not more than 50 feet. It is substantially 100 feet thick on Tumbling Run mentioned above.

A few fossils occur in the Lenoir, both in the limestone and in the residual chert. Several specimens of a Strophomena cf. S. tennesseensis Willard, a ramose bryozoon suggesting Stenopora or Dekayella, a crinoid, unknown to Kirk, with a characteristic stem that Kirk thinks is the same as in the Lenoir limestone on Yellow Branch, Lee County, Va.

The Lenoir persists as proven by tracing in the same stratigraphic relations south through Virginia, where, at Marion, Washington County, it contains numbers of specimens of Maclurites magnus Lesueur. The Maclurites occurs in the Lenoir at Lenoir City, Tenn., the limestone having been formerly known as the Maclurea limestone, and the identification of the Lenoir at Marion rests upon the presence of Maclurites there. It is not known how far north from Marion it occurs. A small specimen thought to be such was seen in the Lenoir one mile east of Edinburg, Shenandoah County, but no specimens have been seen in Clarke County, so the identification of the Lenoir here rests upon its continuity as proven by tracing northward from Marion, where also the Lenoir is immediately underlain by a good thickness of typical Mosheim and immediately overlain by Athens, as it is in Clarke County, as will be next shown.

Athens limestone

The Athens was named from Athens, McMinn County, Tenn. In Clarke County, as for miles farther south, the Athens is limestone in which occur some thin beds of sandy, limy rock which weathers to a ~~rusty~~ friable, fine-grained sandstone. A characteristic feature is interbedded layers with sufficient clayey content so that they weather to a gray color. These gray layers are in places interbedded with layers of black limestone, both black and gray layers being only two to four inches thick. They are interbedded in regular succession and give the impression of rythmical deposition. This feature is exhibited in places where the outcrop of the vertical layers has been swept clear of soil. An illustration is given in Virginia Geol. Survey Bull. 52, pt. 1, pl. 32A. Except for these sandy and banded layers the Athens is a dark to black, mainly compact, commonly conchoidal limestone with an occasional layer of fragmental limestone full of fragments of fossils. Just west of Route 3 south of Double Tollgate the Athens contains a considerable thickness of dark, gray weathering, shelly limestone. The Athens crops out in the folded belt east of Opequon Creek from Warren County north to West Virginia in the vicinity of Wadesville; also in the narrow synclinal outlier east of the main belt, between Route 50 and Route 340.

Good exposures of the Athens are in the bluff opposite the highway bridge just north of Riverton and along Route 3 just north of Crooked Creek in the same locality, ~~in~~ Warren County; along Route 3, on both sides, beginning one-half mile north of Nineveh going north; on the east bluff of Opequon Creek, one-half mile south of Route 50; probably in the cut just east of the inclined bridge over Opequon Creek on Route 340; on the east slope of a knoll just north of the road next north of Marsh Run, 0.8 of a mile east of Glendale school; and on both sides of Route 274, 1500 ft. 2,000 feet east of Opequon Creek. At this last locality, in an open field a few hundred feet north of the road, the edges of vertical, even, thin-bdded, gray and black layers, already mentioned, are beautifully displayed on a weathered rock surface. The fossiliferous, sandy bed, also mentioned above, is shown in a field ~~500~~ 1000 feet west of Route 3 opposite the intersection of the Warren and Frederick County lines, and also in an open field a few hundred feet northeast of Double Tollgate. ~~What is thought to be~~ the same sandy bed also appears on the knoll 0.8 of a mile nearly east of Glendale school, where it expresses itself ~~as a~~ slight ridges spread over with sandy chips. A sandy layer with fossils, especially Resserella (Dalmanella) is exposed in the midst of limestone about 1,500 feet south of Route 274 about ~~3,500 feet east of~~ the point where Route 274 crosses Opequon Creek.

Owing to uncertainty about limits and to apparently irregular structure, and to lack of any fully exposed sections, it is not possible to determine the thickness of the Athens or to make a fairly reliable estimate. Judging from the variable apparent width of outcrop and probably irregular dip at various places, the thickness is estimated at 300 to 600 feet. The Athens in Clarke County and near Front Royal and Riverton, Warren County, has yielded a considerable number of fossils including Cryptograptus trico~~nus~~, Didymograptus sagitticaulis, Diplograptus foliacus, Dicellograptus sextans, Climacograptus, Echinosphaerites, Rhinidictya, several sp., Diplotrypa?, Strictoporella?, Resserella (Dalmanella), common in sandy beds, Paterula, ~~Christiania~~, ~~Scenidioides~~, Sowerbyella, ~~Petrocrania~~, Robergia major, Ampyxina scarabeus, Dionide holdeni, Arthrorachus elsoethi, Cybele, Tretaspis reticulate, Bronteopsis gregaria, Encrinurus? Ceraurinus?, and Eridoconcha, locally abundant.

It is plain that this is a distinctly Athens fauna, especially characterized by the graptolites and the trilobites. It shows the persistence of the Athens across the County and probably into West Virginia, where, ~~as at Strasburg~~, Shenandoah County, it ~~was~~ included with the overlying Nidulites-bearing ~~limestone~~ in the Chambersburg limestone. (See description of Frederick County.)

Chambersburg limestone

The Chambersburg limestone was named for Chambersburg Pa

Stose G.W. Mercersburg - Chambersburg folio

In Clarke County the Chambersburg limestone, so far as the evidence of Nidulites goes, is present only in a narrow area in the northwest corner of the county, just east of Opequon Creek. Nidulites was also observed about one-half mile north of Route 340 and a short distance north of the north end of the narrow synclinal strip of Martinsburg shale which crosses Route 340 on a narrow ridge 2,600 feet east of Opequon Creek. South of this place no Nidulites have been observed east of the Massanutten syncline, ~~broadly~~ roughly speaking north of the Lee highway west of Luray. In northwest Clarke County, the Chambersburg and Athens are in sequence, as they are south of Mount Jackson in Shenandoah County, (see Frederick Co., p. .), and are so much alike in lithologic character, being dark, fossiliferous, fragmental limestones, that it has not been possible to locate a boundary between them, except possibly for a distance of three or four miles north of Dry Marsh Run and at a distance in general three-fourths of a mile east of Opequon Creek. Along this line, a thin sandstone, laminated, and composed of very fine grains of quartz crops out. Except for its apparently finer grains and more even lamination, this sandstone corresponds in general character and stratigraphic position with the Tumbling Run sandstone. (See Frederick Co., p. .) As stated (loc. cit.) the Tumbling Run sandstone approximately marks the base of the Chambersburg limestone in Frederick and

Shenandoah Counties. If it is the same as the Tumbling Run, as thought probable, it is the only discovered marker between the Athens and Chambersburg in the County. Its approximate outcrop is shown on the geologic map by a stippled line. An exactly similar sandstone crops out in three bands in the distance of 260 feet across the strike, in a field just north of Route 660, one mile due east of Greendale school. These three outcrops are believed to be of the same bed repeated by folding as shown by figure . Just below the sandstone at this place Dionide holdeni was collected, showing that the limestone below the sandstone is Athens.

Owing to this uncertaintiy in regard to a boundary, the Athens and Chambersburg are combined under a single pattern on the geologic map.

The Chambersburg in Clarke County is a dark to black subcrystalline to compact limestone, mostly in layers a few inches thick. The top 50 feet or so is thick-bedded to massive, with Nidulites common. Some layers break down on weathering into irregularly lenticular chunks so that the layers may look as if made up of such chunks overlapping each other. No beds made up of alternating black layers and of gray weathering layers as in the Athens have been observed.

There is a strip of Chambersburg next west of Opequon Creek, known by Nidulites, as far south as a point a few hundred feet south of the west end of

the farm road 3,000 feet N. 20° E. of Glendale school. East of this strip, Nidulites occurs just east of the small syncline of Martinsburg shale just north of Route 274, and also near the north end of the long narrow area of Martinsburg which corsses Route U.S. 340 on the ridge 2,500 feet east of the inclined bridge across Opequon Creek. Evidence for the Chambersburg, in Christiania trentonensis was also found just east of the road to Wadesville 2,000 feet north of Route 274.

This whole area in the northwest corner of the County is affected by folding, and these outlying occurrences of Chambersburg can be explained as remnants caught in the narrow synclinal folds. There are probably many such, but it is only in exceptional circumstances that evidence of their existence is discovered, owing to the nearly identical character of the Chambersburg and the Athens. It is assumed that the limestone between the Lenoir and Martinsburg in the synclinal outliers east of the main belt is Athens, but no positive evidence that that is so has been obtained.

The best exhibitions of the Chambersburg in the area are in the belt next east of Opequon Creek. There is a large exposure in the creek and on the bank at the Baltimore and Ohio Railroad bridge one mile southwest od Wadesville. Another good exposure is of about 50 feet of massive rock, 3,000 feet northeast

of Greendale school. This is at about the top of the Chambersburg and includes numbers of good specimens of Nidulites. Another good exposure with Nidulites is on the slope east of the small area of Martinsburg shale just north of Route 274, 1,000 feet east of Opequon Creek. Certain determination of thickness of the Chambersburg in Clarke County as described above is not possible, but at the point two miles northwest of Greendale school, already described, the rocks are nearly vertical and the width of outcrop and consequently the thickness of the beds referred to the Chambersburg is 500 feet, ~~which~~ This seems to be the best estimate of the thickness of the formation in this region that can be made.

The Chambersburg is plentifully fossiliferous, but the fossils are usually fragmentary and closely enclosed in the matrix and not available in condition for identification. Nidulites occurs commonly and serves for the identification of the formation, Christiania trentonensis was obtained by etching with acid but is rare. One of the most significant fossils is an orthoid provisionally referred by Cooper to Corineorthis (not to be published without approval). The importance of this form arises from its occurrence in the base of the Chambersburg in the section two miles southwest of Marion, Pa., (see folio cited) as recently discovered. Resserella (Dalmanella), Oxoplecia, Bryozoa, Receptaculites, and Streptelasma? also occur rare. The Corneorthis?, Christiania, and Nidulites are sufficient to prove the Chambersburg age of the limestone.

The Martinsburg was named from Martinsburg, W. Va. It is next in order above the Chambersburg limestone. The belt on which Martinsburg is located extends south through Clarke and Frederick Counties, and the area of the formation in Clarke County is on the eastern margin of the belt, immediately east of Opequon Creek and includes only the lowest few hundred feet of the formation.

The Martinsburg is a sub-fissile rock composed of clay, fine quartz, sand, and lime. Unweathered, fresh rock effervesces freely on treatment with acid. According to Keith (Harpers Ferry folio), the composition of the shale is about 80 percent clastic (earthy) material and 20 percent lime (calcium carbonate). Some of the material is black in the unweathered state, but on exposure to the weather the lime is leached out and the rock becomes yellowish or rusty gray and breaks down to thin chips and slivers.

Controlled by the meandering course of Opequon Creek, which forms the western boundary of Clarke County, the width of the Martinsburg area in the County varies greatly. Its greatest width, about a mile, is just north of the Senseny road. In places, as west of Lost Corner, the County does not extend into the Martinsburg area. Besides the marginal area, there are four outlying, narrow synclinal areas, or counting the small area just north of Route 274, 1¼

miles south of Wadesville, five areas east of the main area, as shown on the geologic map.

The best displays of the Martinsburg in the County are on Route 50 and on the Senseny road both just east of Opequon Creek. The Martinsburg is extensively exposed along all the roads crossing the great Massanutten synclinal belt between Opequon Creek and the Lee highway, and an adequate conception of the character and enormous mass of the formation can be had by crossing the belt along any of these roads.

The thickness of the Martinsburg in Clarke County cannot be determined with any accuracy, owing to the folded structure, as shown by the dip symbols on Route 50 and on the Senseny road. The thickness in the County can be reasonably estimated at more than a thousand feet, and the full thickness of the formation, as at the north end of Massanutten Mountain, where its upper limit is determined by the overlying Massanutten sandstone, may be as much as 4,000 feet.

No fossils have been found in the Martinsburg in the County except graptolites, which are represented by species of Diplograptus, probably D. amplexicaulis, which are common, Climacograptus sp., and Corynoides gracilis. All these forms occur in great numbers in the very base of the Martinsburg in

the Mercersburg-Chambersburg region of Pennsylvania and afford satisfactory evidence for the correlation of the containing beds in both regions. The age is generally accepted as Trenton. The occurrence of Cryptolithus tessellatus and Tetradella subquadrans, other Trenton fossils, in association with the graptolites in the Strasburg region, Shenandoah County, confirm the Trenton age of the lower part of this the typical Martinsburg; known to be such because of its continuity between Clarke County and Martinsburg, W. Va.

Pleistocene? and Recent deposits

The Martinsburg formation is the youngest and highest formation of thoroughly stratified rocks remaining in the County after ages of erosion in which all younger rocks which were once present have been removed.

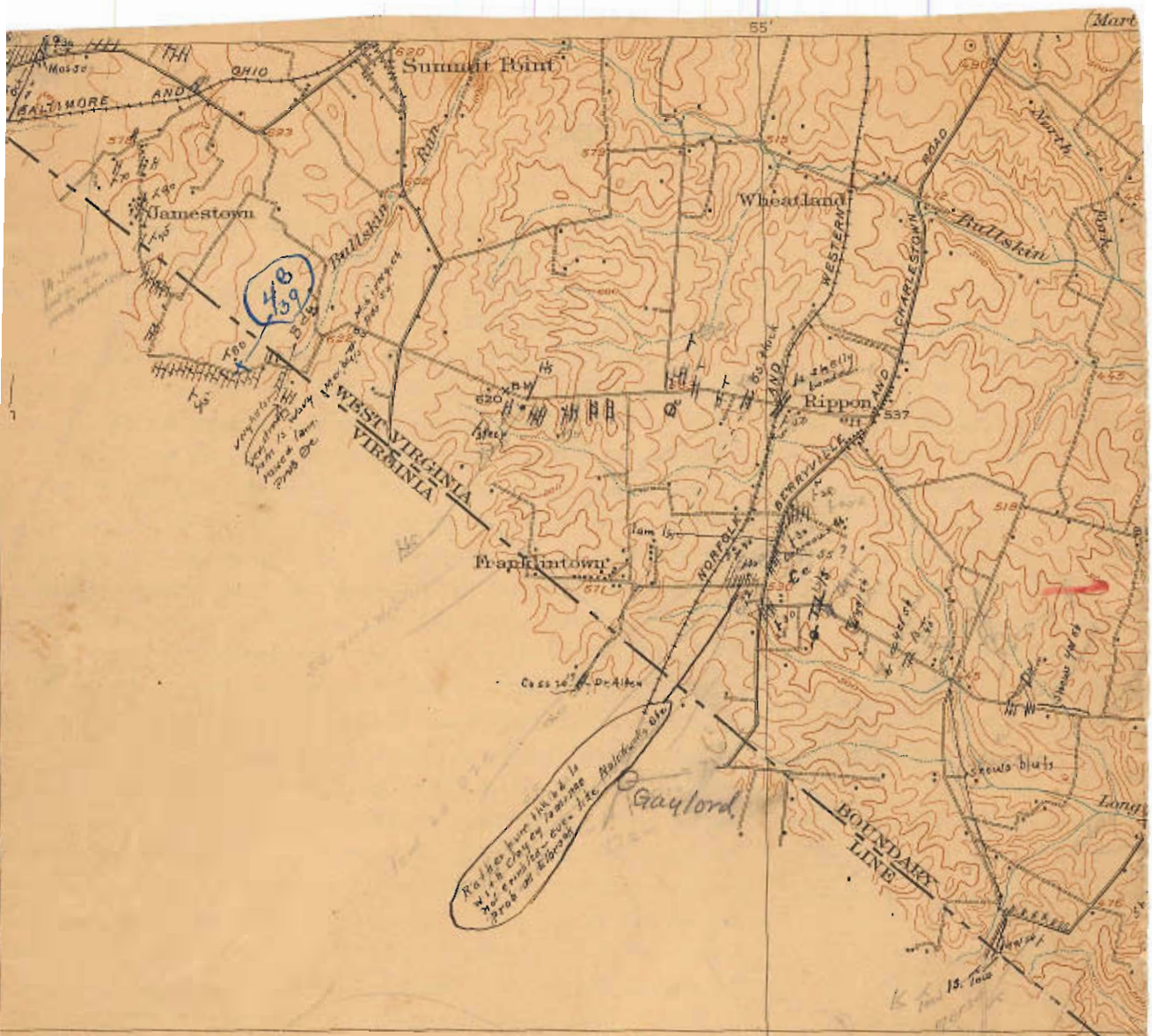
There are, however, water-rounded gravels widely spread on the uplands, especially near the Shenandoah River in Clarke County and near Cedar Creek in Shenandoah County. In Clarke County the gravel is abundant on the level upland immediately west of the river and south of Route 50, where it now lies in places as high as the 600-foot level and 180 feet above the Shenandoah River. In Shenandoah County gravel occurs at about the 800-foot level and 200 feet above Cedar Creek. These pebbles are of sandstone and quartzite, and their only source was the Tuscarora quartzite in Little North Mountain on the west and the Cambrian quartzite of the Blue Ridge on the east, where bed rock quartzite crops out on the surface. The pebbles were formed and transported to their present locations by running water, mainly by Cedar Creek on the west and the Shenandoah River. Of necessity those streams were flowing on the surfaces where the gravel was deposited. That means that since the time the gravel was deposited the streams have cut down their valley approximately 200 feet. The time involved in that last and most recent episode in the geologic history of the County may be left to the imagination of the reader to compute.

The question naturally arises whether the streams flowed at the upland level upon which the gravel now is present, or whether that surface was at some lower level and has been uplifted to its present level since the time the gravel was deposited. In either case it is evident that the streams have cut down their valleys by about 200 feet since the deposition of the gravel.

The only other deposits are the alluvium on the narrow river and creek flats rarely more than 500 feet wide. The deposits are of small thickness and have been made in relatively recent times when the streams have overflowed their banks. Notwithstanding their slight width and depth they must be of considerable age as compared with human history. It probably would be no exaggeration to guess that they existed in about their present state when America was discovered or even in the days of the Roman Empire.

Line of Section
WINCHESTER
Stephens City
Middletown
Strasburg
Cedarville
Nittany
Chepultepec
Conococheague
Elbrook
Rome
Shady
Chilhowee
Athens and Chambersburg
Scale 48,000
Polyconic projection 1927 North American datum
TRUE NORTH
MAGNETIC NORTH
No 210

Summit Point
North Fork
South Fork
Butts
1936-'40
Ripponn
Franklintown
Long Mars
Gaylord
Wickliff
Marvin Chapel
571
BERRYVILLE
Webbtown
C L A R
Castleman Ferry
FERRY
Lewis Run
500
1000
1500
2000
Ashby Gap



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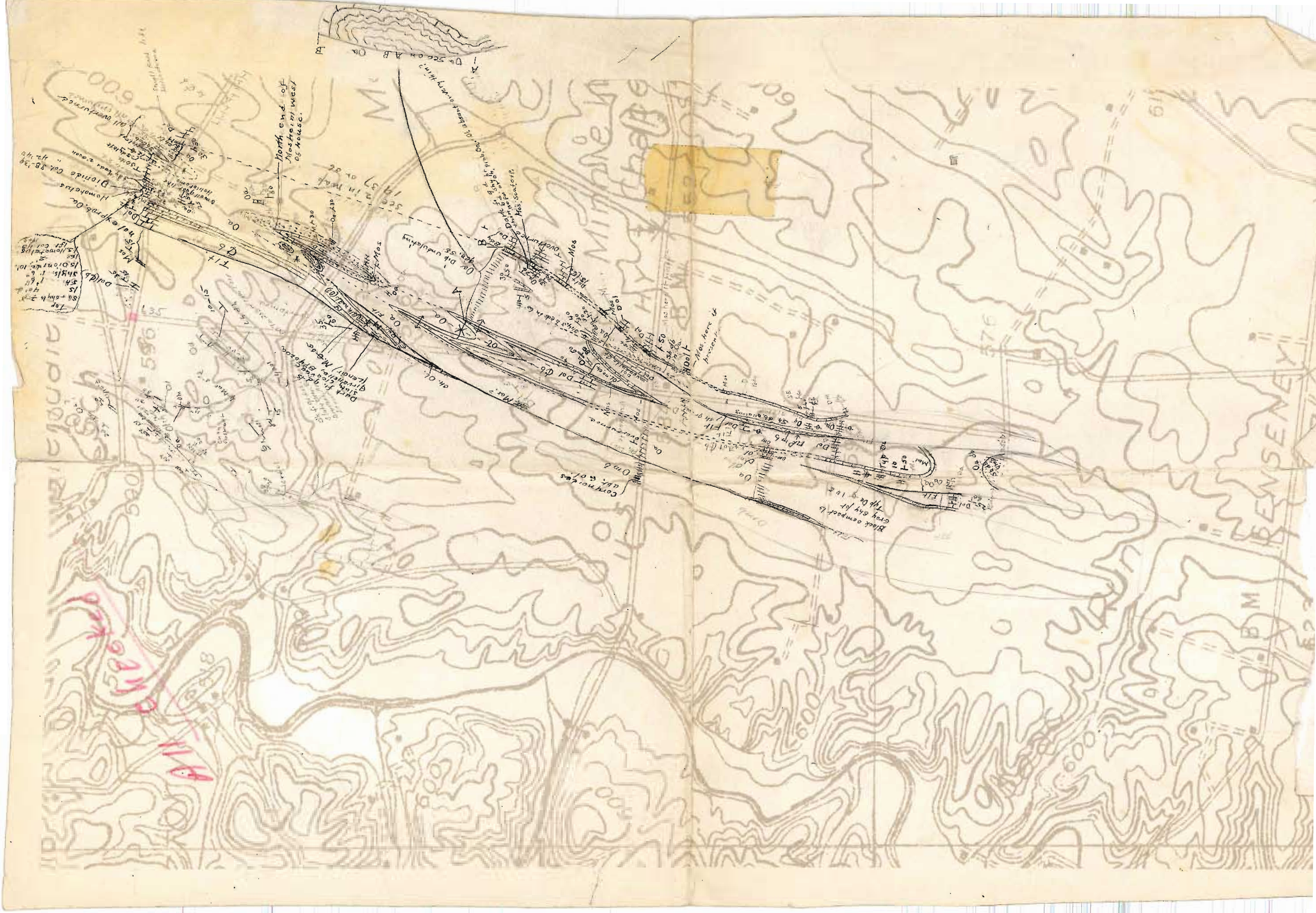
12 36 — 1919


North end of Mos horn west of house.

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VIRGINIA GEOLOGICAL SURVEY
ARTHUR BEVAN, STATE GEOLOGIST

VIRGINIA-WEST VIRGINIA
WINCHESTER QUADRANGLE
15-MINUTE SERIES

SAVE

Place on this edge of patch

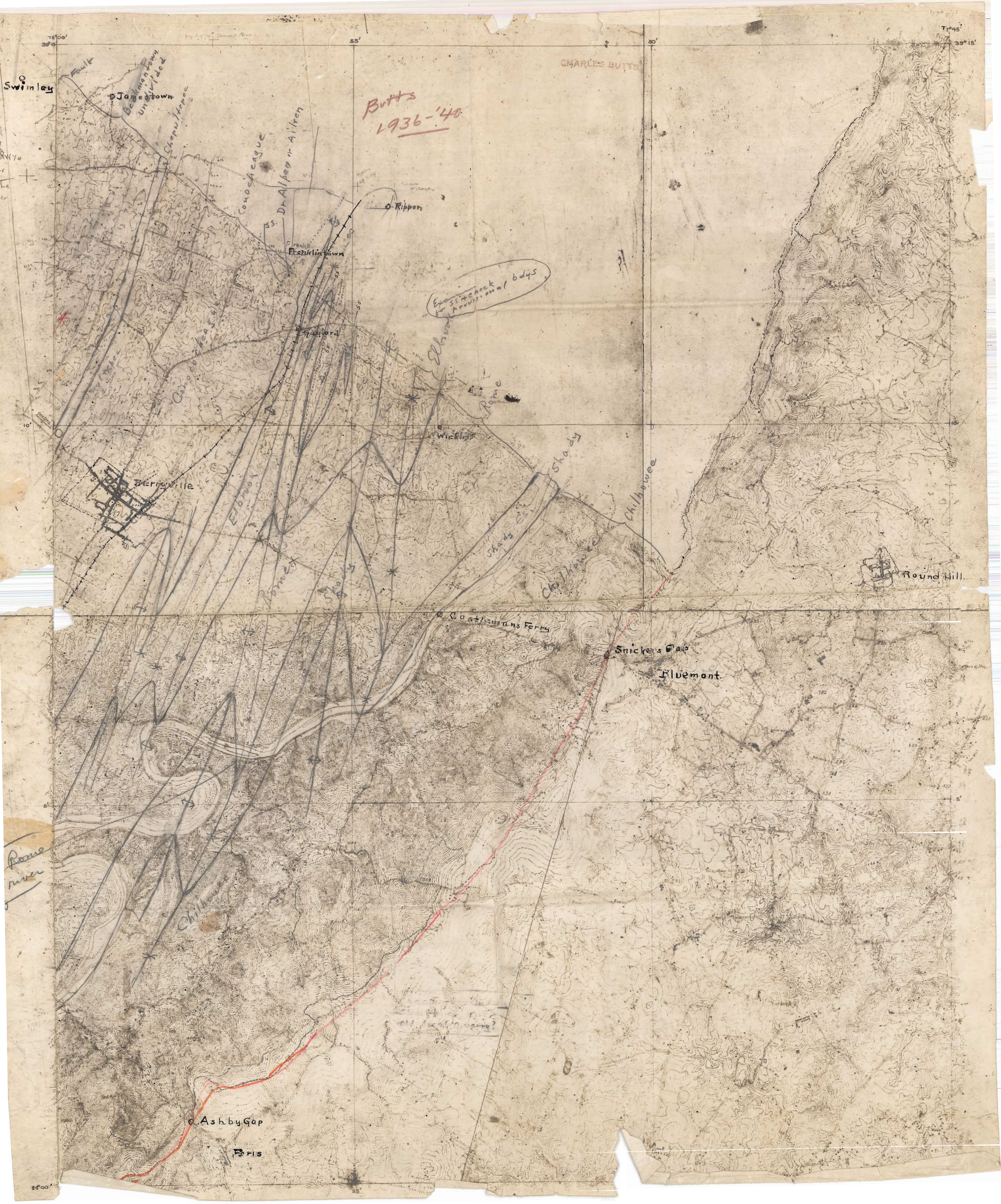
Place on this edge of patch

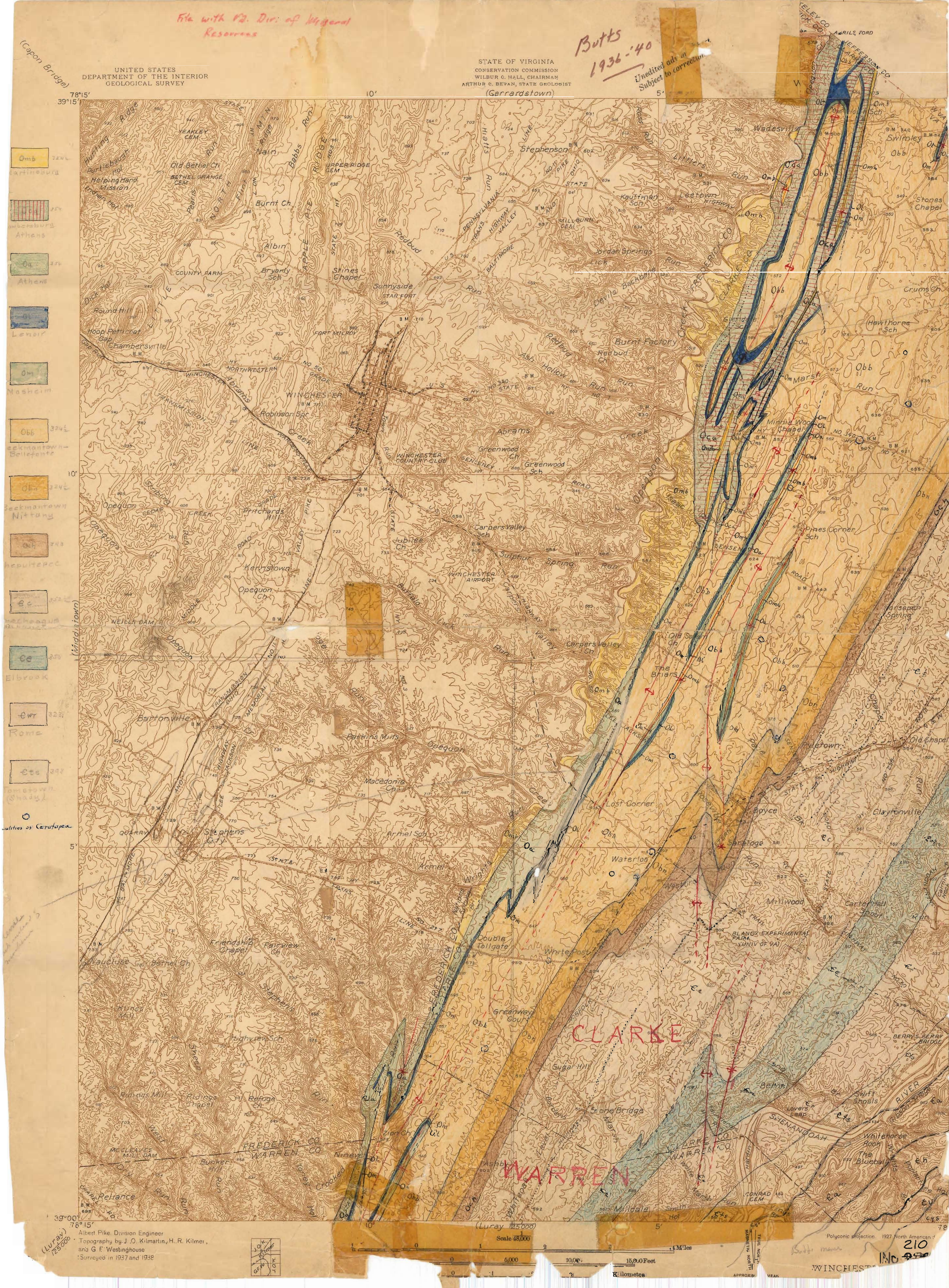
Bots 1936-40

211

210

No. 211 c.2


CHARLES BUTTS
Butts
1936-'40
Swimley
Fault
Jamestown
Beekmantown
Undivided
Chepultepec
Conococheague
Dr. Allen or Aitken
Rippon
Franklintown
Gaylord
Wickliffe
Berryville
Ebrey
Bonnet
Shady
Chilhowee
Castleman's Ferry
Snickers Gap
Bluemont
Round Hill
Ashby Gap
Paris
Rome
Rome river
Exp. for stitcheck provisional bdys
39°15'
78°00'
77°45'
55'
50'
10'
5'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Butts 1936-'40
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STATE OF VIRGINIA
CONSERVATION COMMISSION
WILBUR C. HALL, CHAIRMAN
ARTHUR C. BEVAN, STATE GEOLOGIST
(Capon Bridge)
(Gerrardstown)
(Middletown)
(Luray 125000)
WINCHESTER
CLARKE
WARREN
FREDERICK CO
WARREN CO
SHENANDOAH RIVER
Albert Pike, Division Engineer
Topography by J. O. Kilmartin, H. R. Kilmer, and G. F. Westinghouse
Surveyed in 1937 and 1938
Scale 1/48,000
Polyconic projection. 1927 North American datum
210

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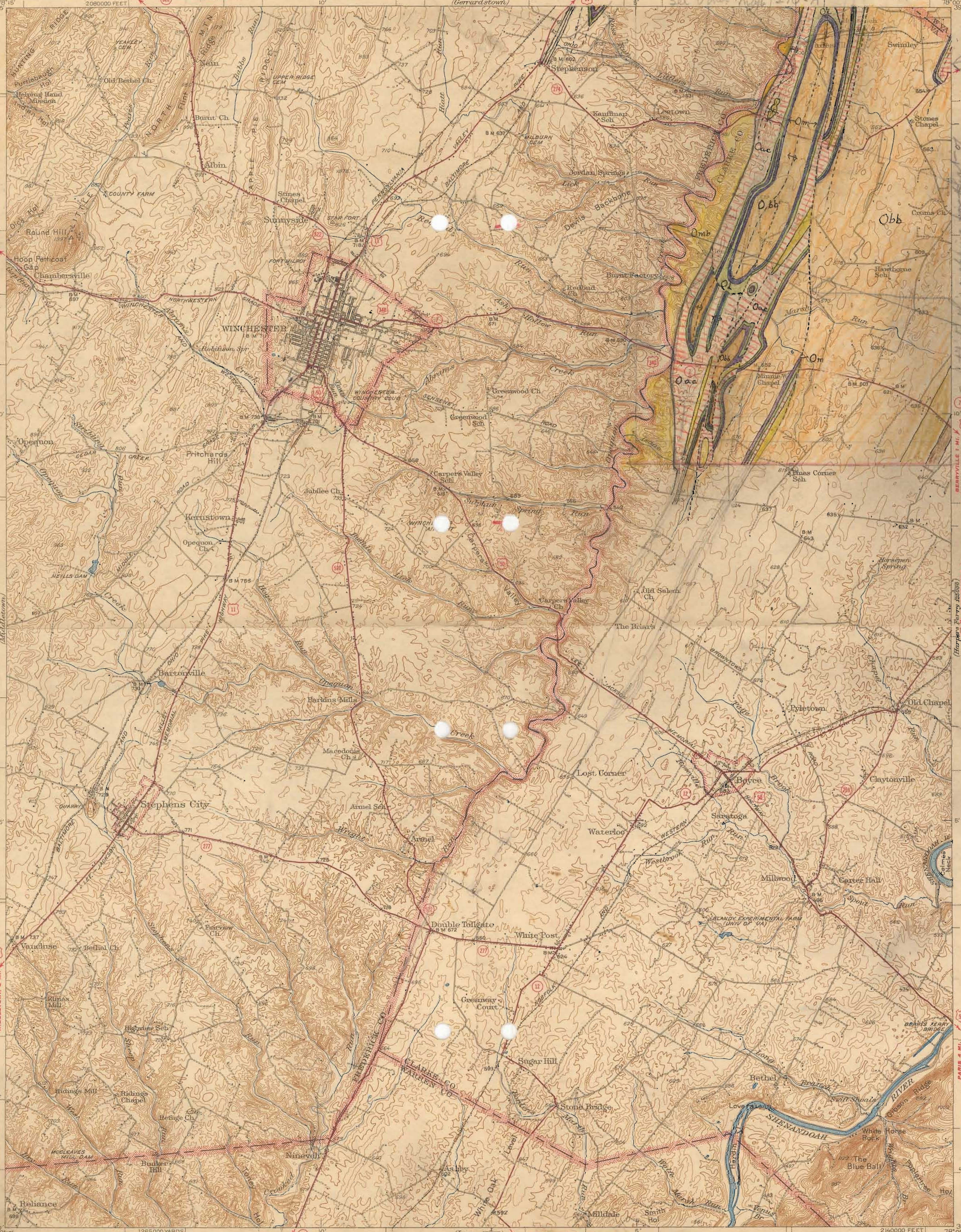
Butts 1936-40

VIRGINIA-WEST VIRGINIA
WINCHESTER QUADRANGLE
15-MINUTE SERIES



Topography by J. G. Kilmartin, R. R. Kilmer, and G. F. Westinghouse.
Surveyed in 1937 and 1938

Scale 62500
Contour interval 20 feet
Datum is mean sea level

Polyconic projection. 1927 North American datum
5000 yard grid based on U.S. zone system, B
10000 foot grid based on Virginia (North) rectangular coordinate system

ROUTES USUALLY TRAVELED
HARD IMPERVIOUS SURFACES
OTHER SURFACE IMPROVEMENTS
1942
U. S. ROUTE
STATE ROUTE

WINCHESTER, VA.-W.VA.
Edition of 1942

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