GEOLOGY OF THE KENT WINDOW AREA
WYTHE COUNTY, VIRGINIA

by

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Illustrations

Geology of the Kent Window Area
Wythe County, Virginia

Introduction and Acknowledgements

The purpose of this report is to summarize and interpret the evidence pertaining to the structural geology of the Kent Window area, which is located along U. S. Highway 11, between Max Meadows and Fort Chiswell on the east, and Wytheville on the west (Fig. 1).

The window is situated in the Appalachian Valley within the broad strike belt of Cambro-Ordovician shales, dolomites, and limestones, between Lick Mountain on the south and Cove and Brushy mountains on the north. The area is drained by Reed Creek, which enters from the west and leaves at the east just south of Max Meadows, and Cove Creek, which enters from the north and empties into Reed Creek in the middle of the area. Except for the Pendleton Construction Company's crushed stone quarry in the southeastern corner of the window just south of Highway 11, which quarries the Conococheague formation for use as road metal, the economic activities of the area are confined to cattle-grazing, dairying, and chicken raising.

The window was discovered by Butts (Butts, 1932; 1933, 1940). He (Butts, 1940) described it as follows:

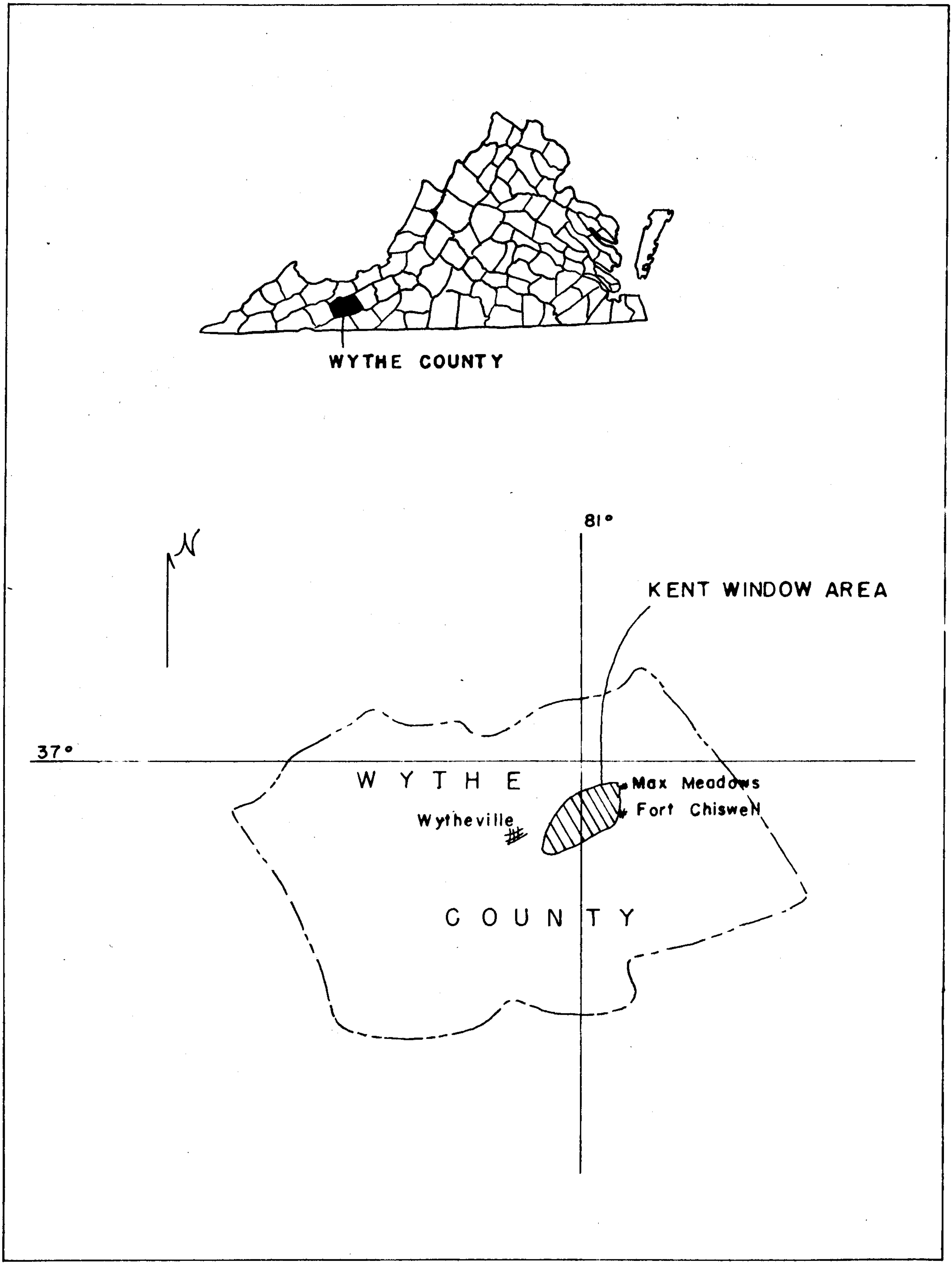


FIGURE I. Index maps of Virginia and Wythe County showing the location of Wythe County and the Kent Window area.

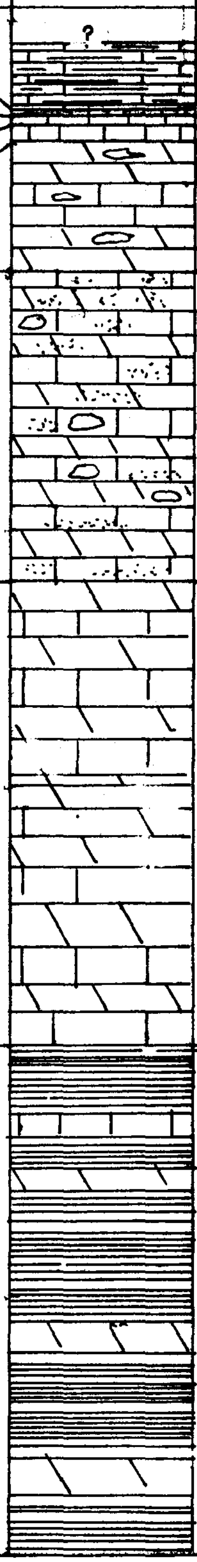
"Another example is the fenster between Wytheville and Max Meadows, Wythe County, where the younger rocks are completely surrounded by the much older Rome formation which was thrust over them along the Pulaski fault and subsequently eroded from the small area of the fenster."

The structural relations among the Upper Cambrian and Lower Ordovician rocks exposed within the window are somewhat complex and a detailed outcrop investigation was carried out by the writer during the summer of 1958 and the first weeks of the spring of 1959.

The writer wishes to acknowledge the much appreciated encouragement, advice, and assistance in the field rendered by Dr. Byron N. Cooper, who suggested the thesis topic. Field assistance rendered by Professor C. G. Tillman and advice and helpful comments on the thesis by Professors W. D. Lowry, R. V. Dietrich, J. A. Redden, and C. E. Sears, Jr. are also greatly appreciated.

Summary of the Stratigraphic Units Exposed in the Kent Window Area

General statement.--The formations mapped in the Kent Window area range in age from Lower Cambrian to Middle Ordovician and attain an aggregate thickness of nearly 5,500 feet. The Lower Cambrian and part of the Middle Cambrian rocks are marine shales and impure limestones and dolomites. Above



SYSTEM	FORMATION	THICKNESS (feet)	CHARACTER OF THE ROCKS
ORDOVICIAN	Liberty Hall		Black, shaly limestone
	Fetzer	5	Thin, irregular beds of coarse-grained calcarenite
	Lenoir	25	Medium bedded calcarenite
	Mosheim	50	Dove-gray calcilutite with calcite "eyes"
	Rocks of Beekmantown age	500	Light-gray dolomite and gray calcilutite. Massive chert.
CAMBRIAN	Conococheague	1200	Laminated and straticulate limestones and dolomites. Local lenticular sandstones. Oolitic limestone and chert. Calcilutites.
	Elbrook	1800	Laminated and straticulate limestones and dolomites.
	Rome	2000	Red, green, yellow shales and siltstones. Intercalated impure limestones and dolomites.

FIGURE 2. Columnar section showing rocks exposed in the Kent Window area.

these shales the rest of the section is composed entirely of marine limestones and dolomites.

Rome formation.--The Rome formation, named from Rome, Floyd County, Georgia (Hayes, 1891), occupies most of the mapped area southeast of the window. It is exposed in a bluff along the Norfolk and Western railroad tracks three miles east of Wytheville. This exposure is pictured by Butts (1940, page 48, Plate 15-A). The Rome typically contains a number of different lithologies: (1) red finely laminated sericitic and chloritic sandy shales; (2) green sericitic muscovite-bearing shales; (3) ocherous yellow muscovite- and quartz-bearing shale; (4) buff siltstones; and (5) silty ferruginous thin-bedded limestones and dolomites. The shales are the predominant lithologic constituent.

These shales yield almost no soil, and the surface underlain by them is characteristically littered by red and green chips of weathered, leached shale. They are intricately folded and measurements of thickness are not possible. B. N. Cooper (1939) estimates the thickness of the Rome in the Draper Mountain area to be about 2,000 feet. The Rome formation supports low strike ridges north of U. S. Highway 11 west of Fort Chiswell which can be readily recognized on air photographs.

Elbrook formation.--The Elbrook formation, named from Elbrook, Franklin County, Pennsylvania, (Stose, 1906), is present in the area northwest of the window and is the youngest rock mapped outside of the window. It consists of a variety of limestones and dolomites, including thin-bedded, straticulate and laminated impure dolomites and limestones, minor intercalations of thick-bedded calcilutite beds about five feet thick, and a few crumpled clay-shale partings.

The most characteristic types of rock in this formation are the straticulate dolomites and limestones in which alternating strata from one to three inches thick consist of medium-grained limestone and calcareous dolomite. Upon weathering, these strata show up prominently as alternating stripes of blue-gray limestone and buff dolomite.

Laminated, silty, light-gray dolomite, which appears medium-bedded on fresh outcrop, also constitutes a prominent part of the formation. It weathers to platy and shaly chips which occasionally can be found littering the surface, and rarely crops out. Laminated limestone, composed of alternating laminae, one-eighth of an inch thick, of dark gray limestone and lighter-gray dolomitic limestone, constitute a minor part of the formation. One of the best sections of the Elbrook is exposed along U. S. Highway 21 in the south environs of Wytheville, where the thickness approximates 1800 feet.

Conococheague formation.--The Conococheague formation, named from Conococheague Creek, Scotland, Franklin County, Pennsylvania (Stose, 1908), is the oldest stratigraphic unit mapped within the window. It is exposed along Reed Creek on the northwest border of the window, along U. S. Highway 11 in the core of the small anticline in the southwest corner of the window, and as a fault sliver overlying the Liberty Hall along the southeast margin of the window.

The formation is composed of laminated and straticulate limestones and silty dolomites resembling those of the Elbrook formation. Edgewise conglomerate is present in some of the limestones and is apparent only on weathered surfaces. The limestone fragments in the conglomerate range in size from one-eighth of an inch to three inches in the greatest dimension and are elongate and tabular in shape.

One major lithologic characteristic which distinguishes the Conococheague is the presence of lenticular concentrations of rounded, frosted sand grains which occur in various parts of the formation. These grains may be so abundant in some beds as to constitute a carbonate-cemented sandstone lense, which upon weathering crops out as a low ridge. These sandy beds are light-gray on fresh surfaces and weather either to a slightly darker-gray or to a reddish-brown, depending on the amount of silt present in the matrix.

Another characteristic lithology which distinguishes the Conococheague is the presence of oolitic limestone and black and white oolitic chert. The oolites are about one-sixteenth of an inch in diameter and are enclosed in a matrix of dolomitic limestone.

The upper 300 to 500 feet of the formation is marked by the presenee of thick beds of light-gray calcilutite alternating with beds of laminated silty dolomite characteristic of the lower part of the formation. Sandy lenses may appear here as well as below, but are not usually as common.

The bottom of the formation is not recognized within the area. It is estimated that about 1,200 feet of beds belonging to the Conococheague are exposed in the Kent Window.

Dolomites and limestones of Beekmantown age.--Dolomites and limestones of Beekmantown age are exposed in the northwest-central and south-central portions of the window, and are divided into three mappable units.

The lowest unit, referred to subsequently as the lower dolomite member of the Beekmantown, is 100 to 250 feet thick and is principally light-gray to dark-gray, laminated to medium-bedded, silty, siliceous dolomite with thin intercalations of white chert near the top of the unit.

The next unit, referred to subsequently as the limestone member of the Beekmantown, is about 100 feet thick and is composed of thick to thin beds of dove-gray calcilutite, similar to the calcilutite beds of the upper part of the Conococheague, with minor intercalations of light-gray fine-grained and very coarse-grained saccharoidal dolomite. The persistence of calcilutite beds with less dolomite and the presence of the saccharoidal dolomite serves to distinguish this unit from the calcilutes of the upper part of the Conococheague. Edgewise conglomerates similar to those in the Conococheague straticulate limestones are locally abundant. This unit is equivalent to the Oglesby marble of the Draper Mountain area (B. N. Cooper, 1939), and bears the familiar Lecanospira gastropods.

The upper unit, subsequently referred to as the upper dolomite member of the Beekmantown, is 75 to 150 feet thick and is composed of dense, siliceous, medium-bedded to laminated medium to fine grained, greenish-gray dolomite.

Light-colored chert is characteristic of these Beekmantown rocks and can be found in any of the units. Lenticular beds of chert up to five feet thick can be traced along the strike for hundreds of feet before they lense out.

Mosheim limestone.--Although it is generally recognized that the Mosheim is the lower member of the Lenoir formation, it is a distinct mappable unit in this area. Therefore, for strictly practical reasons, it is treated essentially as a formation in this report. The Lenoir and Fetzer limestones are restricted to those beds overlying the Mosheim limestone.

The Mosheim limestone, named from Mosheim, Greene County, Tennessee (Ulrich, 1911), crops out in the northwest-central part of the window along the slopes of a tributary to Reed Creek, and just north of Highway 11, above the Beekmantown rocks in the south-central portion of the window. It is a medium-bedded dark dove-gray calcilutite, 50 to 75 feet thick which resembles in some respects the lighter-gray calcilutites of Beekmantown age. Its major distinguishing feature is the "calcite eyes", one-eighth to one-fourth of an inch in diameter which, on weathered surfaces, appear as small projections. At the base, the Mosheim generally contains a few small chert nodules and sometimes a thin bed of dolomite.

Lenoir and Fetzer limestones.--The Lenoir limestone, named from Lenoir City, Loudon County, Tennessee (Safford and Killebrew, 1876), and the Fetzer limestone, named from Fetzer Creek, Benton Quadrangle, Polk County Tennessee (G. A. Cooper, 1956), are exposed in the northwest-central portion of the window. Their combined thickness is only 30 feet and they were mapped as one unit. The unit consists of distinct medium beds of black, fine-grained calcarenite at the bottom, which becomes progressively thinner, more irregularly bedded, and coarser grained upward. The top few feet consist of thin beds of a very coarse-grained calcarenite, whose texture is that of an abraided shell sand.

Liberty Hall limestone.--The Liberty Hall limestone (H. D. Campbell, 1905) is the youngest rock mapped in the window and is exposed principally at the eastern end and in the northwest-central and south-central portions of the window. It is mainly a fine-grained, dense, black, shaly limestone and contains intercalations of black graptolitic shale, The beds have been so intricately folded that thickness measurements are not possible. It is equivalent to the graptolite-bearing Athens limestone of the Draper Mountain area, to which B. N. Cooper (1939) gives a thickness of 800 feet. Upon weathering, the Liberty Hall yields only a very thin soil, and where bedrock is close to the surface, the surface is littered with small, decalcified, siliceous chips.

Structural Geology

General statement.--The rocks within the window are surrounded by rocks belonging to what is generally referred to as the Pulaski thrust block. To the northwest of the window, rocks of the Elbrook formation are exposed in a broad southwest-trending syncline, the Pine Ridge syncline, which extends southwestward through Wytheville to within about ten miles of Marion, Virginia. To the southeast, intricately drag-folded rocks of the Rome formation occupy the remainder of the area mapped.

Within the window, the rocks have folded into an overturned, recumbent anticline, the major portion of which has been removed by thrusting and erosion which left part of the nose exposed along the northwestern edges of the window. In the southwestern corner of the window, a small anticline has been thrust obliquely over the larger recumbent anticline.

Pulaski fault zone.--The window is surrounded by a prominent fault zone which contains large blocks and masses of straticulate limestone such as is found in the Conococheague and Elbrook formations, large blocks of highly fractured dolomite, masses of crushed shale, and a carbonate-cemented breccia which contains angular fragments of various kinds of carbonate rock, principally laminated dolomite. This tectonic breccia zone has been recognized and described by M. R. Campbell (1925, pp. 17-10), Cooper (1939, pp. 59-63 and 1946, pp. 95-104), and Cooper and Haff (1940, pp. 945-974).

Some of the included blocks and masses of straticulate limestone attain huge proportions. Longitudinal dimensions of over 100 feet were observed in at least two places northwest of the window. That these masses are not in place is indicated by the presence of carbonate-cemented breccia surrounding either in direct contact with or near to these masses.

The width of outcrop of the brecciated zone is estimated to be close to a mile on the northwest side of the window, whereas on the southeast side, this zone of outcrop is but a few hundred feet wide. The fault zone is believed to be composed of elements obtained from the Elbrook and Rome formations. The rocks within the window on its southeast margin are overlain only by the Rome formation. Therefore, since the blocks and masses of limestone and dolomite within the fault zone are believed to be derived mainly from the Elbrook, there is a lot less material on the southeast side of the window from which to form breccia. This may explain why the fault zone is so much narrower on the southeast side of the window than it is on the northwest side.

On the northwest side of the window, the zone of brecciation grades northwestward into the limestones and dolomites of the Elbrook formation which dip generally to the northwest, away from the outcrop of the fault zone.

Structure of rocks within the Kent Window.--Evidence gained mainly from seven pertinent localities (Plate 1) indicates that the strata within the window are inverted 180 degrees from their normal stratigraphic position. At locality 1, the upper dolomite member of the Beekmantown, the Mosheim limestone, the Lenoir and Fetzer limestones, and the Liberty Hall black shaly limestones are exposed in succession from north to south and dip to the north toward Reed Creek, with the younger units dipping under the older units. At locality 2, the Conococheague limestones and dolomites, the lower dolomite, the limestone, and the upper dolomite members of the Beekmantown are exposed in succession from north to south along a ravine tributary to Reed Creek. The beds dip steeply to the north toward Reed Creek. Up the ravine south of the last exposure of the upper dolomite member of the Beekmantown, Lenoir and Fetzer beds are exposed and dip steeply to the north, under the older beds. At locality 3, the upper dolomite member of the Beekmantown, the Mosheim limestone and the Lenoir and Fetzer limestones are exposed in a hillside and dip moderately to the northwest into the hillside. The contacts are well exposed and the older beds overlie the younger. In the same hillside, to the northwest of this exposure, the limestone member of the Beekmantown is exposed and dips to the northwest. At locality 4, the upper dolomite member of the Beekmantown, the Mosheim limestone and the Lenoir and Fetzer limestones are exposed on the west slopes bordering a tributary to Reed Creek, and dip to the west and northwest into the slope. The contacts are well exposed and the older rocks overlie the younger rocks. At locality 5, the upper dolomite member of the Beekmantown is exposed around the rims and dip from a cluster of sinks with the Mosheim limestone exposed down in the bottom of the sinks. The contact is well exposed and the beds are upside down. At locality 6, the Lenoir and Fetzer limestones and the Liberty Hall black shaly limestones are exposed along the steep southeast banks of a tributary to Reed Creek, and dip southeast into the creek bank. The Lenoir and Fetzer beds overlie the Liberty Hall in a depositional contact, so that the beds are upside down.

The observed relations necessitate the existence of a recumbent overturned structure within the window. At locality 7, the exposed sequence ranges from the Conococheague up to and including the Mosheim limestone. These beds are exposed from southwest to northeast along the slopes bordering Reed Creek on the southeast, and dip north-northwest toward Reed Creek so that the beds here are not overturned, but right-side-up. The limestone member of the Beekmantown can be traced from Reed Creek up the slope east-northeast to the top of the hill where it turns sharply to the south and can be followed southward toward locality 4 along the crest of the hill where it is overturned and dipping steeply west.

This limestone thus encloses, on the northwest, older rocks in a structure which is interpreted by the writer as the nose of an overturned anticline whose roots lie to the southeast of the window. Localities 1 to 6 therefore represent exposures of the overturned northwest limb of this anticline (Pl. 2).

Evolution of the geologic structures in the Kent Window area.--To the northeast, in the Draper Mountain area, B. N. Cooper (personal communication, 1959) says that the stratigraphy of the Middle Ordovician limestone sequence from the top of the rocks of Beekmantown age to the Athens (equivalent to the Liberty Hall in the window) is in all significant aspects the same as that of the Kent Window, although it is somewhat thicker. From this consideration, it seems unlikely that the rocks within the window were originally deposited very far from the present window area, since the stratigraphy of the Middle Ordovician limestones is generally known to undergo remarkable changes northwest to southeast across the structural trends of the Appalachian Valley. The writer, therefore, believes that the recumbent overturned anticline was folded essentially in place and was not detached from an originally more southeasterly position and transported to the northwest.

The proximity of the rocks of the thrust plate, with respect to horizontal distribution and elevation, to the exposed overturned northwest flank of the recumbent anticline within the window suggest that the overriding thrust sheet not only removed the rocks overlying the recumbent anticline, but at least part of the right-side-up southeast limb of the anticline itself as well.

Figure 3 illustrates the writer's concept of the several stages in the evolution of the Kent Window structure. A

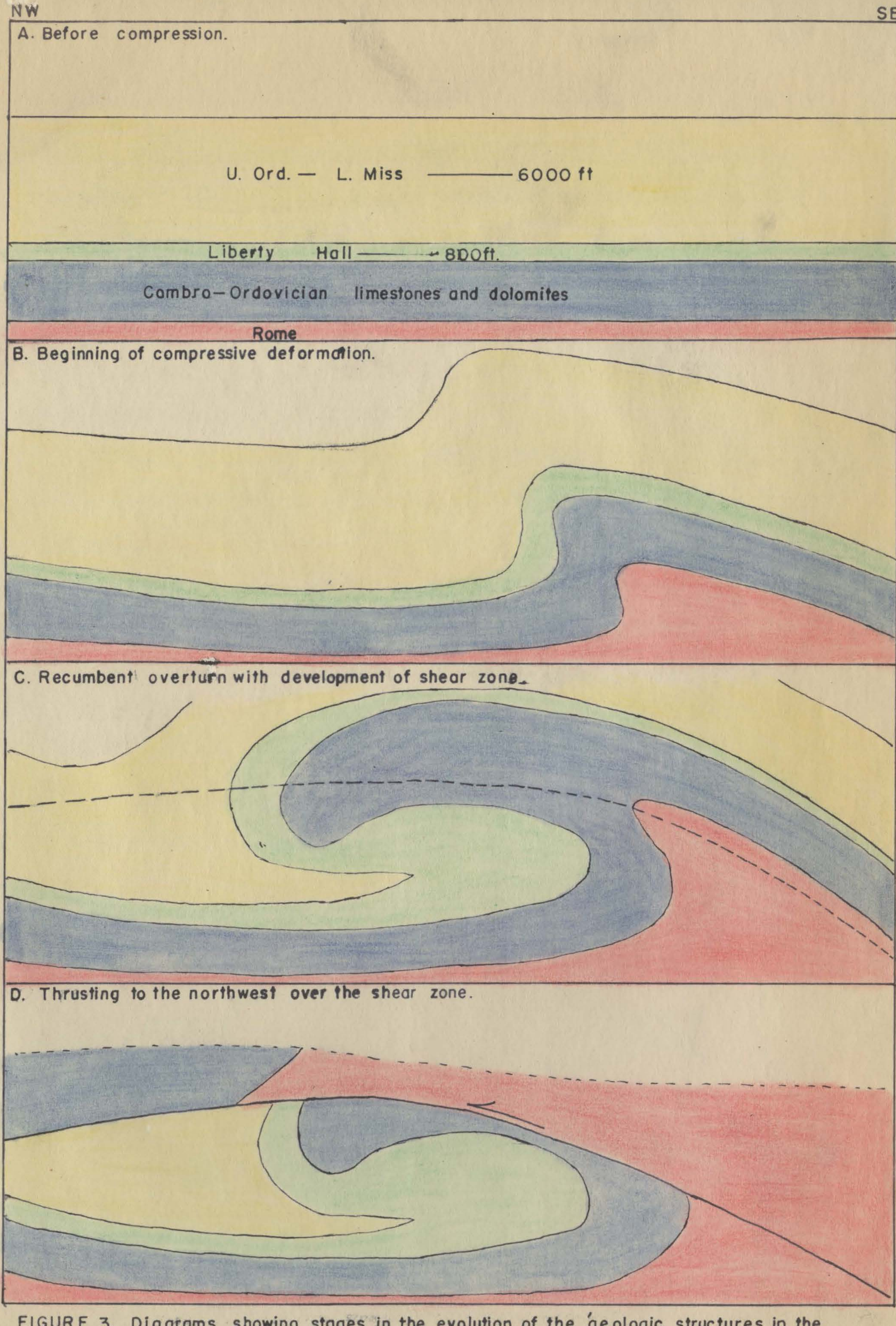


FIGURE 3. Diagrams showing stages in the evolution of the geologic structures in the Kent Window area.

section roughly 6,000 feet thick, including rocks at least as young as Early Mississippian was present above the Liberty Hall limestone prior to deformation (Fig. 3, A). This thickness was taken from the section reported in the Draper Mountain area (Cooper, 1939).

The beginning of compressive deformation resulted in the formation of an anticline (Fig. 3, B) oversteepened on its northwest flank to the point of recumbency (Fig. 3, C). A shear zone cutting through the axial portion of the structure developed as a consequence of continued compression. This zone of weakness became the surface over which the rocks of the Pulaski fault block were thrust to the northwest. This movement sheared off the top part of the recumbent anticline and brought the Rome formation of the overthrust block into contact with the rocks now exposed within the window (Fig. 3, D). The smaller anticline exposed in the southwestern corner of the window is apparently thrust in a general northerly direction, obliquely over the planed-off nose of the recumbent anticline. This event must have occurred after movement along the thrust surface had removed the upper part of the recumbent anticline.

The rocks exposed within the window are at approximately the same elevation as those of the surrounding Pulaski thrust block, indicating that the fault surface dips away from the window on all sides, as from an elliptical dome. The window is generally in line with a major fold of the Pulaski thrust surface which is outlined by the Draper Mountain breached window (Cooper, 1939). The elliptical outline of the Kent Window may be the result of a more gentle flexure of the fault surface in this area. Thus, although the attitude of the fault trace itself cannot be determined in the Kent Window area, the relations just described suggest that, in the gradual evolution of the structures in this area, the final phase of deformation probably was the warping of the Pulaski thrust surface.

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Abstract

The Kent Window is located along U. S. Highway 11 between Wytheville, Fort Chiswell, and Max Meadows. It is surrounded by the Elbrook formation to the northwest and the Rome formation to the southeast and southwest, which make up part of the Pulaski thrust block. The rocks exposed within the window are the Conococheague formation, limestones and dolomites of Beekmantown age, the Mosheim limestone, the Lenoir and Fetzer limestones and the Liberty Hall black shaly limestone.

The window is bounded by a prominent zone of tectonic breccia and brecciated limestones and dolomites nearly a mile wide on the northwest side but only a few hundred feet wide on the southeast side.

The rocks within the window have been folded into a recumbent overturned anticline whose roots lie to the southeast. In the southwest corner of the window, a small asymetric anticline is thrust northward obliquely over the nose of the recumbent anticline.

The evolution of this structure involves a single episode of compression. The Cambro-Ordovician rocks were folded into a recumbent overturned anticline. Subsequently, the top part of the anticline and the overlying rocks were thrust to the northwest. The final stages of compression resulted in the warping of the Pulaski fault surface.

GEOLOGIC MAP AND STRUCTURE SECTIONS OF THE KENT WINDOW AREA, WYTHE COUNTY, VIRGINIA

EXPLANATION

ORDOVICIAN

Olh — Liberty Hall limestone

Ofl — Fetzer and Lenoir limestones

Om — Mosheim limestone

unconformity

Beekmantown group:

Obmu — Upper dolomite member

Obnm — Limestone member

Obml — Lower dolomite member

CAMBRIAN

€c — Conococheague formation

€el — Elbrook formation

€r — Rome formation

Contact, dashed where approximately located

Fault, dashed where approximately located

Approximate base of thrust block

Tectonic breccia

Approximate top of overridden block

Pulaski thrust

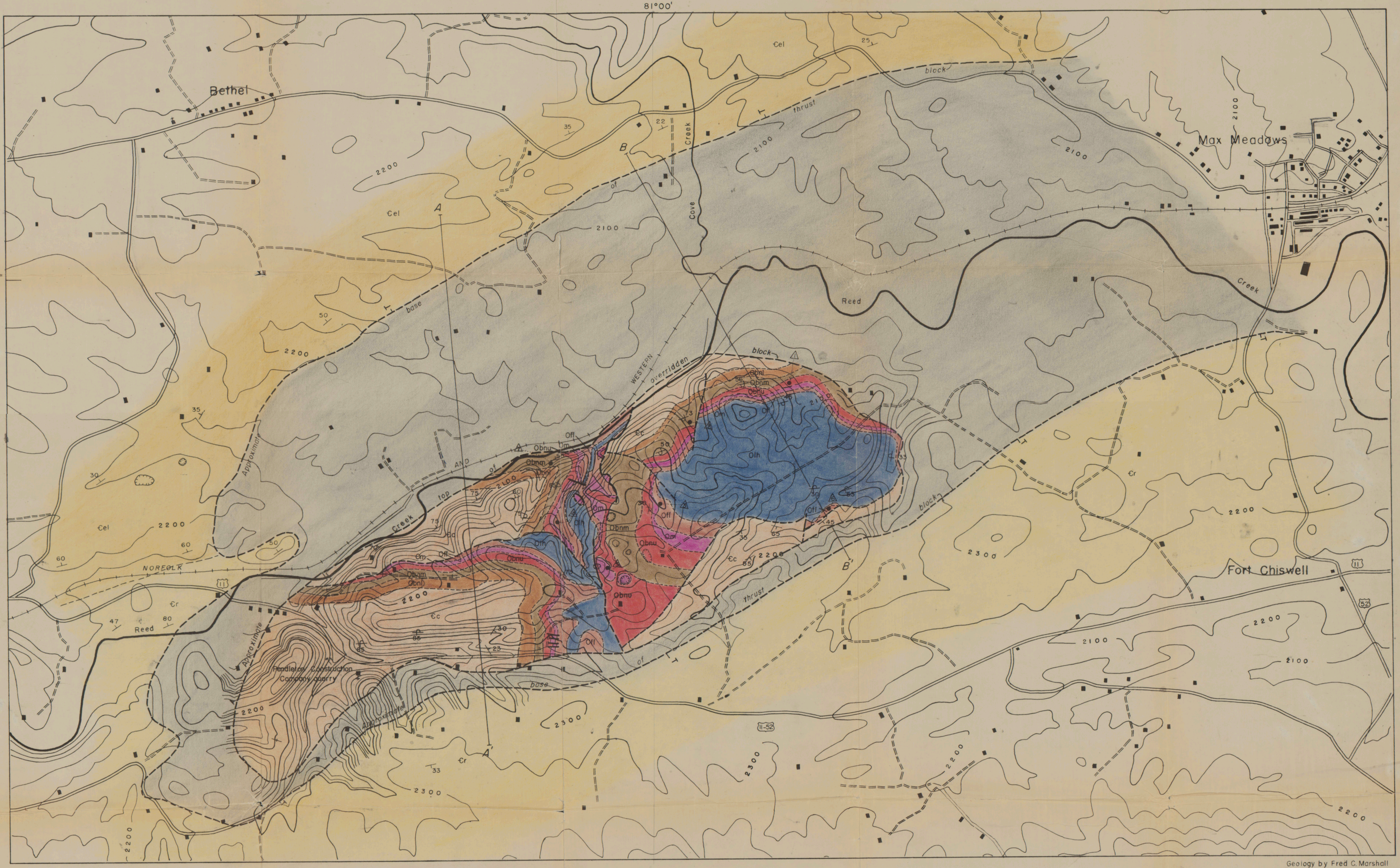
Strike and dip of beds

Strike and dip of overturned beds

Strike of vertical beds

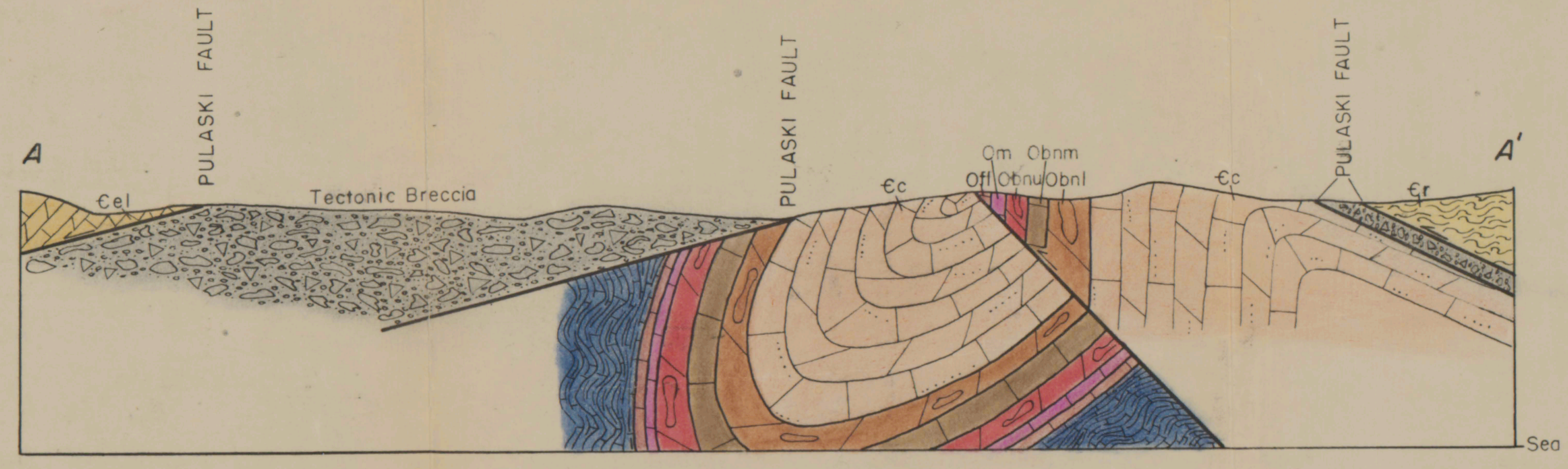
Quarry

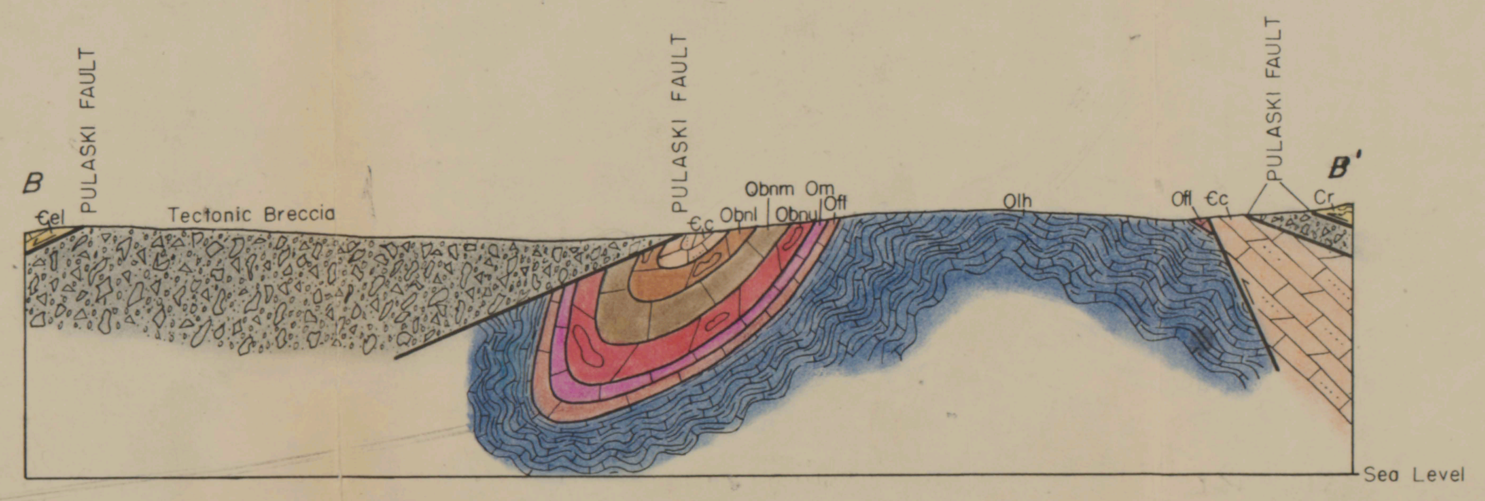
Locality cited in text, dot indicates locality



Base from maps of the U. S. Geological Survey Speedwell and Max Meadows quadrangles

Geology by Fred C. Marshall





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Scale

0 — 1 Mile

2000 1000 0 1000 2000 Feet

About 1:15,485

Contour interval 20 feet (inside window), 100 feet (outside window)