STATE OF VIRGINIA
CONSERVATION AND DEVELOPMENT COMMISSION
VIRGINIA GEOLOGICAL SURVEY
Wilbur A. Nelson, *State Geologist*

BULLETIN 28

Fensters in the Cumberland Overthrust Block in Southwestern Virginia

By Charles Butts

Prepared In Co-operation with the United States Geological Survey

University, Virginia
1927

THE MICHIE COMPANY, PRINTERS
CHARLOTTESVILLE, VA.

STATE CONSERVATION AND DEVELOPMENT COMMISSION

WILLIAM E. CARSON, *Chairman,* Riverton.

COLEMAN WORTHAM, *Vice-Chairman,* Richmond.

E. GRIFFITH DODSON, Norfolk.

THOMAS L. FARRAR, Charlottesville.

JUNIUS P. FISHBURN, Roanoke.

LEE LONG, Dante.

RUFUS G. ROBERTS, Culpeper.

ELMER O. FIPPIN, *Executive Secretary and Treasurer.*

LETTER OF TRANSMITTAL

COMMONWEALTH OF VIRGINIA
Virginia Geological Survey
University of Virginia

Charlottesville, Va., August 6, 1927.

To the State Conservation and Development Commission:

Gentleman:

I have the honor to transmit and to recommend for publication as Bulletin 28 of the Virginia Geological Survey Series of reports a manuscript and illustrations of a report on *Fensters in the Cumberland Overthrust Block in Southwestern Virginia,* by Charles Butts.

The general purpose of this bulletin is to show that there are places in southwestern Virginia underlain by iron ore of Silurian age which may be of commercial value, and to show in detail the structural conditions existing in this section of the State.

This is the second of a series of reports which will be prepared by Mr. Butts in connection with the detailed mapping of the stratigraphy of the Valley of southwestern Virginia which he is engaged in at the present time, under a cooperative agreement between the State and Federal surveys.

Respectfully submitted,

WILBUR A. NELSON,
State Geologist.

Approved for publication:

State Conservation and Development Commission,
Richmond, Virginia, September 27, 1927.
E. O. FLIPPIN, *Executive Secretary.*

CONTENTS

PAGE

Introduction 1

Distribution and occurrence of the fensters 1

Partial record of well in fenster southeast of Rose Hill, Virginia. 3

Stratigraphy 6

Stratigraphic succession in Lee County, Virginia, and the Middlesboro basin, Kentucky 6

Interpretation of facts relative to Cumberland block 8

Nature and causes of the Cumberland block 9

Oil 10

Iron ore 11

Conclusions 12

ILLUSTRATIONS

PAGE

Plate 1. A, Upper Cambrian limestone in upper part of the Nolichucky shale thrust northwestward over the Clinton formation; B, Upper Cambrian limestone immediately to left of locality shown in A, looking northwest 2

2. A, Map of the Cumberland overthrust block in southwestern Virginia, southeastern Kentucky, and Northern Tennessee; B, Profile section through Fourmile Creek fenster 4-5

FENSTERS IN THE CUMBERLAND OVERTHRUST BLOCK IN SOUTHWESTERN VIRGINIA

By Charles Butts

Prepared in Cooperation with the United States Geological Survey

INTRODUCTION

The existence of a fenster 2 miles southeast of Rose Hill, Lee County, Va., was discovered by the writer in 1923 in connection with an examination occasioned by the occurrence of petroleum, as hereinafter more fully explained, and a brief description was published in a press bulletin of the United States Geological Survey issued in July of that year.

"Fenster" is a German word meaning window. As a geologic term it may be defined as an opening—for example, in the bottom of a valley—worn by erosion through an overthrust mass of strata and revealing the younger strata beneath the overthrust rocks, as shown in the profile section on Plate 2, B. The interest and importance of fensters lie in the fact that they afford certain proof of the overthrusting.

DISTRIBUTION AND OCCURRENCE OF THE FENSTERS

In the prosecution of a survey for a new geologic map of Virginia, in the summer of 1926, three other fensters were discovered within a distance of 4 miles along the strike southwest of the one found in 1923, as shown in the sketch map accompanying this paper (Plate 2, A). The region is very crudely represented on the reconnaissance topographic map of the Jonesville quadrangle. Briefly stated, these fensters disclose the Clinton or formations immediately underlying the Clinton beneath Upper Cambrian limestone or the next overlying Copper Ridge ("Middle Ozarkian") dolomite, which has been thrust horizontally westward over the younger Silurian and Ordovician rocks. These relations are absolutely clear and unmistakable.

The existence of this thrust block had been previously noted by Wentworth [1] who described its extent and relations.

The Clinton formation in the fenster about 2 miles southeast of Rose Hill occupies an area of perhaps a quarter of a square mile at the head of the western of two southward-flowing branches of Martin

1. Wentworth, C. K., Russell Fork fault of southwest Virginia: Jour. Geolgy, vol. 29, pp. 351-369, 1921.

Creek, shown on the Jonesville topographic map. Here the Clinton formation crops out in the bottom of the valley and extends 100 feet or so up on the sides of the valley toward the head of the stream, dipping below the stream to the southeast so that the longest diagonal, that along the stream, is about half a mile in length. The greatest breadth seems to be somewhat less than half a mile. The spurs and ridges that partly inclose the head of the valley and reach a height of 200 to 300 feet above stream level are occupied, above the level of the Clinton, by Upper Cambrian limestone overlain by the Copper Ridge dolomite.

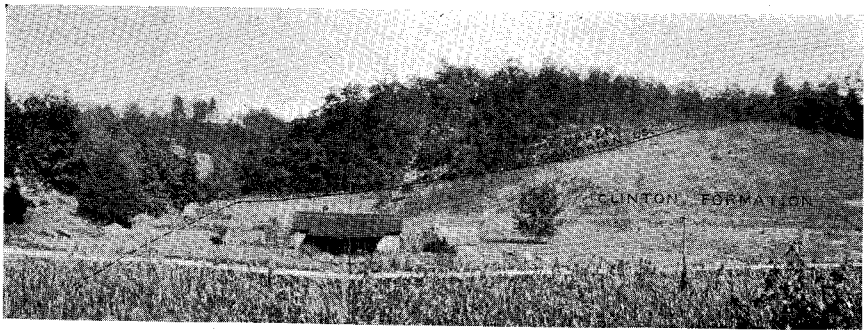
The next fenster, about 1½ miles to the southwest, is on Martin Creek. Here the Clinton is exposed beneath Upper Cambrian limestone for a quarter of a mile or so along the creek. Still farther southwest, apparently about 1½ miles, is another fenster exposing an area of Clinton of undetermined size. Here the Clinton iron ore has been mined. About a mile farther southwest, on the head of Fourmile Creek, 4 miles south-southwest of Rose Hill and 2 miles southeast of Ewing, is the largest of the four fensters. Here the Clinton and immediately underlying formations of Richmond and Lorraine ages are exposed for about 1¼ miles along the road directly across the strike. These formations are exposed in the lower parts of the ravines on both sides of the road but do not extend to the tops of the intervening spurs, which are capped by the limestone or dolomite of the overthrust mass. The general situation is shown in the photograph reproduced in Plate 1, A, and in the profile section on Plate 2, B, which passes through this fenster.

In all the fensters the youngest rocks recognized below the thrust plane are of Clinton age. The post-Clinton rocks that once also spread over the region were shoved westward in the upper part of the overthrust mass. The Clinton age of the rocks that crop out in the fenster is shown by such fossils as *Anoplotheca hemispherica, Schuchertella subplana, Calymene niagarensis,* and *Zygobolba decora.*

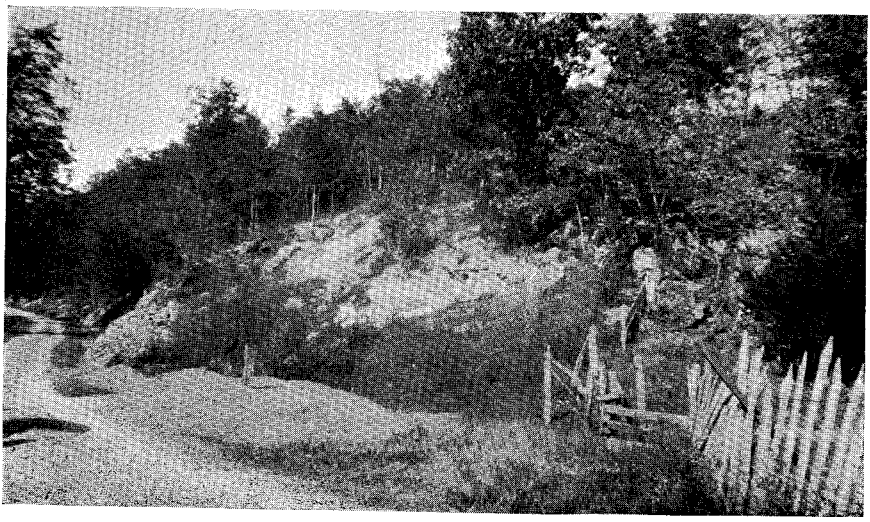
At an undetermined distance below the Clinton, in argillaceous and more or less rubbly limestone, *Amplexopora angulata* (identified by Ulrich) is abundant and associated with *Hebertella sinuata* and *Zygospira kentuckyensis.* The *Amplexopora* is an Upper Ordovician fossil of Maysville age, and the others occur both in the Maysville and in the overlying beds of Richmond age in the Cincinnati region.

Upon the slopes and crests of the ridges and spurs surrounding the fenster, directly above the rocks of Clinton, Richmond, and Lorraine ages, Upper Cambrian trilobites occur in the limestone, and Cryptozoa of Copper Ridge type are mingled with chert from the dolomite immediately overlying the Cambrian limestone.

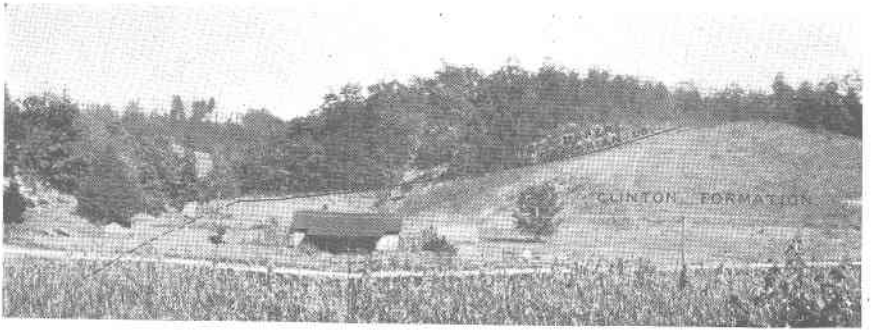
The fensters occur on the axis of a broad arch on which the opposing dips in the overthrust rocks on each side of the axis are about 15°, as shown in the structure section (Plate 2, B). In the northeastern fen-



A Upper Cambrian limestone in the upper part of the Nolichucky shale thrust northwestward over the Clinton formation. Looking northeast. Line shows approximate trace of the fault plane. At the head of the ravine on the left of the middle, about half a mile from the road, the Clinton iron ore has been extensively mined from beneath the overthrust mass.



B Upper Cambrian limestone immediately to left of the locality shown in A, looking northwest. Cambrian trilobites occur in this limestone. Still farther northwest along the road the Copper Ridge dolomite ("Ozarkian" of Ulrich) overlying the Upper Cambrian, is exposed for 1000 feet or so along the road.



A Upper Cambrian limestone in the upper part of the Nolichucky shale thrust northwestward over the Clinton formation. Looking northeast. Line shows approximate trace of the fault plane. At the head of the ravine on the left of the middle, about half a mile from the road, the Clinton iron ore has been extensively mined from beneath the overthrust mass.

B Upper Cambrian limestone immediately to left of the locality shown in A, looking northwest. Cambrian trilobites occur in this limestone. Still farther northwest along the road the Copper Ridge dolomite ("Ozarkian" of Ulrich) overlying the Upper Cambrian, is exposed for 1000 feet or so along the road.

ster the Clinton beds seem to lie upon the axis of the arch and to partake of the structure of the overthrust mass.

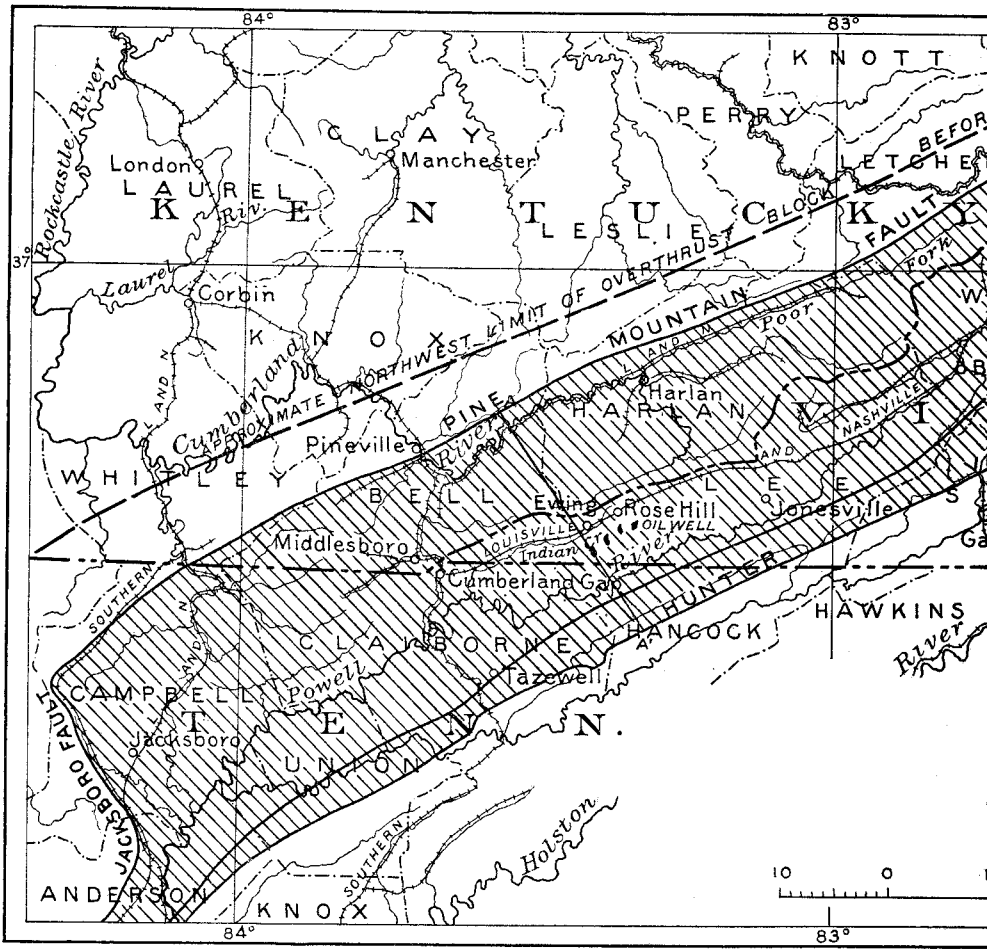
A well drilled for oil in the northeasternmost fenster to the depth of 1,400 feet penetrated the beds shown in the following section, made up from drillings beginning at the depth of 325 feet:

Partial record of well in fenster southeast of Rose Hill, Va.

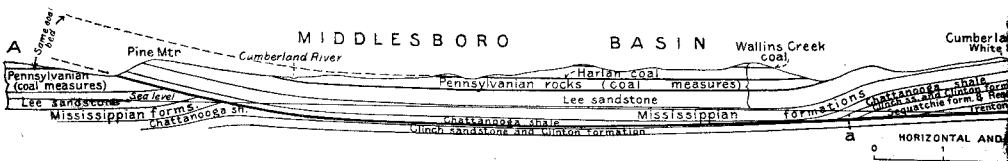
		Thickness (feet)	Depth (feet)
14.	Sandstone, very fine-grained quartz sand (Clinch?)	9	325-334
13.	Limestone, dark, fine grained	91	334-425
12.	Shale, red (Sequatchie)	90	425-515
11.	Limestone, dark, fine grained	65	515-580
10.	Shale, light pink	45	580-625
9.	Limestone, dark; drillings mostly small chips	255	625-880
8.	Limestone, dark; some large chips; *Zygospira* and Bryozoa (record incomplete)		880
7.	Blank	139	880-1019
6.	Limestone like No. 9	209	1019-1228
5.	Sandstone, very fine quartz sand, chert, orthoclase, and diopside; shows of oil (record incomplete)	(?)	1228
4.	Limestone like No. 9	97	1228-1325
3.	Limestone, light gray; small chips	15	1325-1340
2.	Limestone, drab and light gray	50	1340-1390
1.	Limestone, dark; large chips; fragments of fine-lined brachiopods	(?)	1400

The main significance of this log is that it shows a normal downward sequence for the region in the beds below the Clinton formation and Clinch sandstone. The red shale and pink shale (Nos. 10 and 12) are in the Sequatchie formation of Richmond age, which throughout southwestern Virginia underlies the Clinch sandstone; the dark-gray limestone with *Zygospira* and other brachiopods below No. 10 is of Maysville, Eden, and Trenton ages. The same sequence in outcrop is traversed in going along the railroad from Cumberland Gap to Harrogate, Tenn., just south of the State line, or in going southeast for a mile or two from Cumberland Mountain anywhere between Cumberland Gap and Pennington Gap. The Cambrian limestone and Copper Ridge dolomite that overlie through overthrusting the strata penetrated in the well would have been penetrated in normal sequence if the well had been drilled to a depth of 5,000 feet or thereabouts.

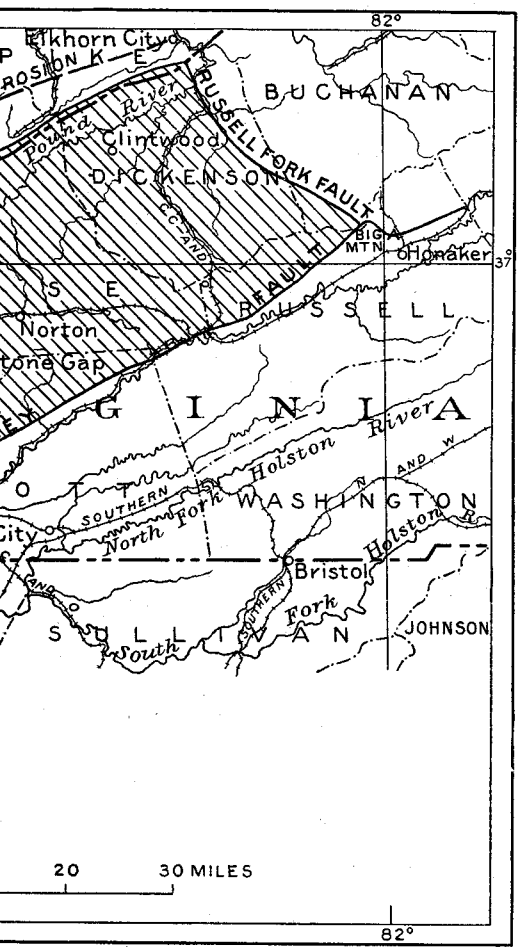
VIRGINIA GEOLOGICAL SURVEY



A

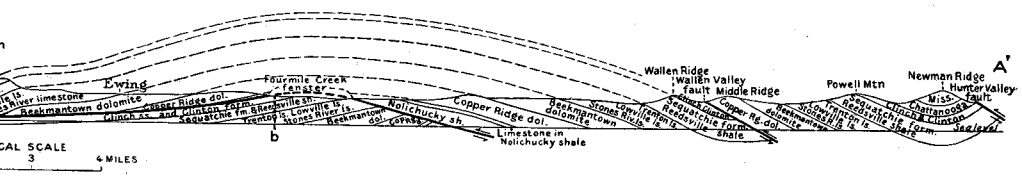


B



A. Map of the Cumberland overthrust block (shaded area) in southwestern Virginia, southeastern Kentucky, and Northern Tennessee. Based on a map by C. K. Wentworth (Jour. Geology, vol. 29, No. 4, May-June, 1921). The black spots south of Rose Hill represent fensters in the overthrust block.

B. Profile section along line A-A′ on map, through Fourmile Creek fenster, greatly enlarged. The part of the profile section covering the Middlesboro Basin, Kentucky, is practically copied from the geologic map of that area by G. H. Ashley and L. C. Glenn (U. S. Geol. Survey, Prof. Paper 49, pl. 40, 1906). The position of the fault plane beneath the Middlesboro Basin and the structural conditions of the strata adjacent thereto are hypothetical. The amount of movement is shown by the displacement of the broken edges of the Clinton formation, from "b" to "a."



In the northeasternmost fenster the strata pitch southwestward along the axis of the low fold, but somewhat northeast of the fenster the pitch must change to a northeast direction for the rocks exposed beneath the thrust plane in the fenster do not appear in the valley of Yellow Branch, about 1 mile still farther northeast, which is eroded to a level as low as the Clinton in the fenster, or perhaps even lower. At this locality a quaquaversal structure with low dips is indicated. In the southwesternmost fenster, on Fourmile Creek, the overridden formations dip 15° N. W. or are locally nearly flat as indicated by the ore strippings along the sides of the ravines.

STRATIGRAPHY

Although these fensters are interesting in themselves, their chief importance arises from what they reveal concerning the nature and extent of the overthrusting in this region. In order to understand these matters, it is necessary to know the stratigraphic succession in the region, which is given in the following section:

Stratigraphic Succession in Lee County, Va., and the Middlesboro Basin, Ky.

	Feet
Pennsylvanian (coal measures), including Lee sandstone at base (in the Middlesboro Basin, Ky.)	3,700
Mississippian:	
Pennington formation: Limestone, shale, and sandstone	150
Glen Dean limestone: Limestone and shale	270
Gasper and Ste. Genevieve limestones: Limestone, largely oolitic	175
Hiatus: rocks of St. Louis, Warsaw, and Keokuk ages absent, except a few feet of limestone of possible St. Louis age.	
Price (or New Providence) formation: Shale, some red, and sandstone	250
Devonian or Carboniferous:	
Chattanooga shale: Black shale	500
Silurian:	
Clinton and Clinch formations: Shale and sandstone with two iron-ore beds near middle, separated by 40 to 50 feet of red shale	500
Ordovician:	
Sequatchie formation:[2] Shale and limestone, in part red	400

2. The writer is disposed to accept Ulrich's assignment of the Sequatchie formation, of Richmond age, to the Silurian System.

Reedsville shale, of Lorraine (Maysville and Eden) age: Shale, calcareous sandstone, and limestone in thin layers.. 350

Trenton limestone, approximately equivalent to Hermitage and Cannon limestones: Limestone, generally thin bedded, coarsely crystalline 250

Lowville limestone, of Black River age: Medium, thick-bedded limestone, largely of compact texture; includes at top 100 feet or so of shaly beds, probably of post-Lowville Black River age 1,000

Stones River limestone: Thick-bedded compact and coarse grained crinoidal limestone 500

Beekmantown dolomite:[3] Dolomite, thick-bedded, gray, generally coarsely crystalline, some compact..... 1,200

Cambrian or Ordovician:[4]

Copper Ridge dolomite: Dolomite, coarsely and finely crystalline 1,200

Cambrian:

Nolichucky shale:

Limestone 150

Shale, not exposed to bottom 500

This entire sequence, dipping 5°-25° N. W. to the Cumberland escarpment, crops out in regular unbroken succession in the space between the fenster on Fourmile Creek and the middle of the Middlesboro Basin in eastern Kentucky. Still farther northwest the succession is repeated in descending order to the Chattanooga shale, which at the northwest base of Pine Mountain, bounding the Middlesboro Basin on the northwest, is faulted against coal-measure rocks well up in the Pottsville on the west of the outcrop of the fault. (See Plate 2, B.)

From the fact that there is no break in the stratigraphic succession of southwestern Virginia between the Fourmile fenster and the northwest base of Pine Mountain it seems certain that the thrust plane exposed in the fenster continues beneath the surface and crops out along the northwest base of Pine Mountain as shown in Plate 2, B. Southeastward from the fenster on Fourmile Creek the same sequence occurs unbroken up to the top of the Clinton formation on the southeast slope of Wallen Ridge and the northwest slope of Middle Ridge, where apparently the Copper Ridge dolomite is faulted against the Clinton along the Wallen Valley fault. Thence southeastward the sequence is again repeated up to the Mississippian limestone, of Chester age, on the crest of the synclinal Newman Ridge, southeast of which is the main boundary fault of the region, along which different Cambrian formations are faulted

3. "Canadian system", in part, of E. O. Ulrich.
4. "Ozarkian system", in part, of E. O. Ulrich.

against different younger formations up to the basal formation of the Pennsylvanian (Lee conglomerate). The boundary fault is the Hunter Valley fault, which appears to extend continuously from the vicinity of Jacksboro, Campbell County, Tenn., northeastward to and beyond Bluefield, W. Va. In the Jacksboro region, on the southwest, and in the vicinity of Honaker, on the northeast, the Hunter Valley and Pine Mountain faults are in effect intersected by cross faults, the Jacksboro fault and Russell Fork fault as named by Wentworth.[5]

INTERPRETATION OF FACTS RELATIVE TO CUMBERLAND BLOCK

The interpretation of the facts already set forth is that the entire block, named by Wentworth the Cumberland block, inclosed by the faults described, has been thrust as a whole northwestward on a nearly horizontal thrust plane. The amount of movement is measured by the distance between the broken edge of the Clinton formation in the Fourmile fenster, at "b" of the profile section, and the broken edge of the same formation in the overthrust mass where it meets the thrust plane at "a", beneath the Middlesboro Basin. The position of "a" depends on the depth of the overthrust fault at this point and is therefore indeterminate. As arbitrarily drawn on the section this distance is 7 miles. If the mass of rocks above the thrust plane be moved back to the southeast until "a" coincides with "b", the broken edges of the Clinton would match each other, layer for layer, as can be seen by comparison of the sections in the fensters with those on the outcrop of the Clinton on the ridge paralleling the Cumberland escarpment from Cumberland Gap to Big Stone Gap.

According to Wentworth,[6] the vertical displacement, upward on the west on the Russell Fork fault, is slight. There may have been a considerable horizontal movement, the fault being of the nature of a horizontal shear or "blatt". Wentworth estimates this movement at 2 miles. The movement on the Jacksboro fault, both vertical and horizontal, was much greater, the horizontal movement being estimated by Wentworth at 10 miles. The vertical displacement on the Jacksboro fault appears to be the result of a rotational movement of the Cumberland block pivoted or retarded at the northeast end and does not indicate a southwestward movement of the block. The amount of movement on a northwest line through Ewing, as determined by the construction of the accompanying section—namely, 7 miles—agrees very well with Wentworth's estimates for the movement on the Jacksboro and Russell Fork faults, the location of the writer's section northeast of the Jacksboro fault being about two-fifths of the distance between

5. Wentworth, C. K., op cit.
6. Idem, fig. 4.

the faults. This determination was made independently of Wentworth's, and the agreement was noticed only on rereading his description.

At present the thrust block is 127 miles long and 25 miles wide. Originally, before the erosion of its northwestern edge back to its present position, the average width of the block must have been at least 30 miles and the average thickness must have been about 2 miles. The volume of the mass was therefore 7,620 cubic miles.

The profile section accompanying this paper shows the thrust plane beneath the Middlesboro Basin as following the Chattanooga shale. It certainly cuts as deep as the Chattanooga, because the Chattanooga is brought up to the surface above it all along the northwest base of Pine Mountain. There is no evidence, however, that the thrust plane cuts into or below the Clinton formation, except toward the southwest end of Pine Mountain in Tennessee where, as mapped by Keith in the Briceville folio, the Clinton is brought up to the surface above the fault. The Clinton is not known to crop out along the northwest base of Pine Mountain in Kentucky northeast nor southwest of Pineville. Of course the location of the thrust plane either in the Chattanooga shale or at any other horizon is purely hypothetical, but that formation seems reasonably to offer a zone of weakness on which yielding and movement might easily have taken place. Then, too, the condition of the rocks near the fault plane is unknown, but it is probable that there is crumpling not indicated in the section.

NATURE AND CAUSES OF THE CUMBERLAND BLOCK

The phenomena described in this paper naturally raise the old question as to the nature and causes of the movements that have taken place. It is self-evident that the movement of the Cumberland block was in the main substantially horizontal and was caused by a push acting northwestward. It follows that the whole region southeast of the Cumberland block has also been pushed northwestward an equal or greater amount, for the force was transmitted to the Cumberland block through the rocks to the southeast, and also if there had not been extensive northwestward movement of the blocks to the southeast on the Wallen Creek and Hunter Valley faults there would have been left a great depression out of which the Cumberland block had come. Still farther southeast, behind all of this area, the Appalachian Mountains and Piedmont region must have moved northwestward a greater or less distance. It seems probable that intermittent and relatively slight movements were taking place on all the thrust planes, practically simultaneously, throughout a very long period of time. The only general cause that seems at all adequate to meet the facts appears to the writer to be shrinkage of the earth, with resultant horizontal

displacement of the exterior parts in order to fit themselves to their shrinking interior support. Such the writer believes to be the true cause of crustal thrusting, in spite of the speculative objections of physicists and mathematicians.

OIL

Oil has been found in the Clinton formation of the fenster 2 miles southeast of Rose Hill. An oil seepage in this area is reported to have been known for years, and it is affirmed by the owner of the land that several gallons of oil could, at times, be pumped from a dug well, where it had accumulated on top of the water. A well located on the Clinton formation near the seepage and near the dug well referred to was drilled in this fenster to the depth of 303 feet, and oil was reported in sandstone at four different horizons, from the depth of 71 feet to the bottom. On visiting the locality just after the completion of this well the writer saw a scum of oil on the water filling the hole and noted that the floor of the derrick was smeared with oil but could obtain no further knowledge through direct observation. Subsequently, another hole was drilled nearby to a depth of 1,400 feet, and the drillings from the depth of 325 feet were submitted to the writer for examination. (See log, p. 3.) None of them showed any trace of oil. If oil occurs in this well, it is in the upper 325 feet, of which a full suite of drillings was not furnished. A sample of the oil reported to have come from the first well, submitted to the United States Geological Survey for examination, proved to be a green oil, very similar to some of the high-grade oil from western Pennsylvania.

The indecisive character of the knowledge of this occurrence of oil, which seems to be genuine, arouses a certain degree of curiosity as to whether oil in significant quantity may be trapped and sealed up in the sandstone beds of the Clinch or Clinton formations beneath the overthrust mass. The question arises whether a well drilled into the Clinton through the superincumbent Copper Ridge dolomite in the vicinity of the Rose Hill well might not have a chance of encountering oil in paying quantities. The Clinton should be reached anywhere within half a mile northwest of the line of fensters at a depth of a few hundred feet. Of course, it is impossible to determine details of structure in the Clinton where it is buried beneath the overthrust rocks. In general the strata beneath the thrust plane dip to the northwest, as shown in the accompanying section, but it is probable that there are minor anticlines superposed on the general structure that would favor the accumulation of oil and gas.

IRON ORE

The Clinton formation carries two beds of iron ore in the Fourmile fenster, 2 miles southeast of Ewing. The ore was formerly mined by the Union Iron & Steel Co. and hauled by tram road to a tipple 1 mile east of Ewing for shipment. The mines have been abandoned, and satisfactory information about the ore could not be obtained in the locality. According to reports by men who worked in the mines, there are two beds, apparently about 40 feet apart, associated with intervening reddish shale. The same relations can be seen in outcrop in the vicinity of Cumberland Gap. The upper bed is reported to reach a thickness of 18 inches but is generally thinner; the lower bed reaches a thickness of 30 inches and averages 18 inches. The mining was carried on in the head of a ravine extending half a mile northeast of the highway, 2 miles southeast of Ewing. (See Plate 1, A.) The outcrop ore has been dug out all around the heads of the ravine, and the diggings indicate that the ore bed is nearly horizontal in that area. However, considerable irregularity in the lay of the ore beds is plainly shown when a larger area is taken into view, as might be expected from the proximity of the beds to the thrust plane, where the underlying strata could not but be affected and more or less deformed by the movement of a great thickness of superincumbent strata above the thrust plane.

Ore has also been mined from a fenster in the next valley about 1 mile northeast of the Fourmile fenster, but no information was obtained concerning this operation.

The composition of the ore in the Fourmile fenster is shown by the following table, based on analyses of samples representing 26 carloads or ore. This information was furnished by the Union Iron & Steel Co.[7]

Composite analysis of Clinton ore from Fourmile fenster, 2 miles southeast of Ewing.

	Per cent
Metallic iron	34.09
Silica	6.58
Phosphorus	.58
Lime	7.72
Magnesia	3.95

This ore should be nearly if not quite self fluxing due to its relatively low silica and high lime and magnesia content. The metallic content is less than that of the Clinton ores of the Poor Valley Ridge, to the north-

7. Watson, T. L., Mineral resources of Virginia, p. 467, 1907.

west, but very nearly the same as that of the Clinton ores of the Birmingham District, Alabama.

CONCLUSIONS

The fensters described in this paper afford revelations, not only of extremely interesting crustal movements and ensuing anomalous structural relations, but also of possible economic deposits hitherto unsuspected. It is highly probable that considerable reserves of iron ore underlie a belt of limestone country 3 to 5 miles wide lying next southeast of Poor Valley Ridge for the entire distance from Pennington Gap to the State line. Also, the possibility of the occurrence of oil in significant quantities trapped in the less disturbed sandstones of the Clinton and Clinch formations beneath the thrust plane may reasonably be entertained—at least as an interesting speculation, if it does not seem sufficient to justify exploration.

Mention might also be made here of the extensive areas of the Price sandstone with minable coal beds exposed in fensters in overthrust blocks in Montgomery and other counties, as described by Campbell.[8] Such overthrusting is thus shown to be extensively developed in Virginia.

---

8. Campbell, M. R., The Valley coal fields of Virginia: Virginia Geol. Survey Bull. 25, 1925.