A

RECONNAISSANCE OF THE GEOLOGY OF CRAIG COUNTY, VIRGINIA

by

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1935

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INTRODUCTION

The field work upon which this preliminary report is based was undertaken during the summer of 1928, when about eight weeks were spent in a detailed reconnaissance of the surface geology of the county. During two previous summers, and in subsequent field seasons, the author was engaged in field work for the Virginia Geological Survey in adjacent counties.[2] The present paper describes the results of an independent survey, and is a summary statement of the geology of Craig County.

2. The results of this field work have been described and are in process of publication by the Virginia Geological Survey. A description of the general geology of the Roanoke area has already been published as Bulletin 34 (1932) of that Survey. Other bulletins describing the geology and mineral resources of the Eagle Rock and Natural Bridge Special quadrangles are prepared.

1. Published with the permission of the State Geologist of Virginia.

Craig County lies along the central portion of the western boundary of Virginia (see figure 1), and is bounded by Giles, Montgomery, Roanoke, Botetourt, and Alleghany counties, Virginia, and by Monroe County, West Virginia. Nearly all of the boundaries are mountain ridges. The county is about 30 miles long in a northeasterly direction, and its width averages about 12 miles in a northwesterly direction. Except for the small area which lies north of Potts Mountain, the county is roughly rectangular. Its total area is 373 square miles, and the center of the county is located at about $37^{0}30'$ North Latitude, and $87^{0}10'$ West Longitude.

The area is sparsely settled, and transportation facilities are poor. Two branch railroads terminate in the county. The Potts Creek Branch of the Norfolk and Western Railway crosses the northwesternmost extension of the county in Potts Creek Valley, with Paint Bank as its local terminus. The Craig Creek Branch of the Chesapeake and Ohio Railway extends along Craig Creek Valley to connect Eagle Rock, Botetourt County, with Newcastle, the seat of Craig County. The railroads are separated from each other by the mass of Potts Mountain, and no other rail transportation is readily accessible. An improved highway (Virginia State Highway No. 311) enters the county from Salem, Roanoke County, and passes north through Newcastle and Paint Bank to Sweet Springs, West Virginia. From Newcastle, there are county roads lead-

ing to Fincastle across Caldwell and Price mountains; to Eagle Rock along Craig Creek Valley; to Craig Healing Springs; and to Newport along the valley of Sinking Creek. Few of the country roads have been improved, and many are in poor condition during rainy weather. A county road traverses Potts Creek Valley, from Covington, Alleghany County, to Paint Bank. The proposed "Virginia Blue Grass Trail" is planned so as to follow Craig and Sinking Creek valleys through the area, and if improved, will do much toward developing the county.

Newcastle, seat of Craig County, is a small village of a few hundred people which has not increased appreciably in population for many years. Paint Bank, the only other village in the county, is a small settlement in Potts Valley thriving largely because of the railway. Craig Healing Springs, located about 12 miles west of Newcastle, are locally famous as a health and pleasure resort, and attract many visitors from nearby regions. Virginia Mineral Springs, located 4 miles northeast of Newcastle, have also received attention as a local health resort.

The county is largely forested, for agriculture is difficult in much of the area. The fertile limestone valley of Sinking Creek is extensively cultivated, and pasturage is fine along its length. The Devonian shale valleys of Potts, Johns, and Craig creeks are poor, their soil being sterile

and unproductive. Elsewhere, the county is mountainous.

PHYSIOGRAPHY

Craig County lies entirely within the area of the Appalachian Valley and Ridge physiographic province, which is sometimes known as the Alleghany Mountain Province (see figure 1.). The region consists of (1) linear, parallel mountains developed upon a series of folded, resistant sandstones, and (2) parallel, intermontane valleys developed chiefly upon weak shales and limestones (see figure 2). The resulting drainage has a trellis pattern, and in the local area the major streams are Potts, Johns, and Craig creeks, tributaries of James River, and Sinking Creek, tributary to New River. The mountains are maturely dissected, and for the most part are in a second cycle of development, having been etched by differential erosion from a former extensive peneplaned surface. The long, parallel ridges rise from 1,000 to 2,000 feet above the adjacent valleys, with a few scattered points reaching higher elevations. The highest elevation in the county is Arnold Knob of Potts Mountain, which reaches a height of 3,929 feet above sea-level. The lowest point is along Craig Creek where it leaves the county, its elevation being about 1,200 feet above sea-level. The maximum relief, therefore, is about 2,730 feet.

The crests of the higher ridges in the northern and

western portions of the county show distinct traces of an old erosion level at elevations about 3,500 feet above sea-level. These level areas are remnants of a former widespread peneplane which has been called the Pearis peneplane in Giles County [1] to the southwest, and

1. Hubbard, G. D., and Croneis, C. G.; Notes on the Geology of Giles County, Virginia; Denison Univ. Bull., Vol. 20, 1924, p. 312.

the Summit peneplane [2] in Roanoke County to the south. It is

2. Stose, G. W., and others; Manganese deposits of the west foot of the Blue Ridge, Virginia; Virginia Geol. Surv. Bull. 17, 1919, pp. 34-40. Woodward, H. P.; Geology and mineral resources of the Roanoke area, Virginia; Virginia Geol. Surv. Bull. 34, 1932, pp. 16-17.

likely that such remnants are the most ancient physiographic features of the area, and that they have been preserved chiefly because they were located upon belts of especially durable rocks distant from the headwaters of the major streams.

There is good evidence of a somewhat younger erosion surface at present elevations of about 3,000 feet. This level is reached by the summits of Brushy and North Mountains, and represents the remains of the "Cretaceous" or Upland peneplane of the Appalachian Mountain Province.

It has been referred to as the Spruce Run peneplane [1]

1. Hubbard, G. D., and Croneis, C. G.; op. cit., p. 313

in Giles County. The Upland peneplane is widely represented throughout the Appalachian Mountains, indicating a conspicuous erosional stage (the Kittatiny level) produced in eastern North America near the close of the Mesozoic Era.

Levels on the floors of the various valleys are prominent at several elevations, chiefly at the 2,200-foot level in Sinking Creek Valley, and elsewhere at levels between 1,700 and 2,000 feet above sealevel. They represent the Valley-floor (or Harrisburg) peneplane, [2] which was developed

2. Stove, G. D., and others; op. cit., p. 34-40; Woodward, H. P.; op. cit., p. 20-23.

subsequent to the Upland cycle along the major streams that were entrenched below the Upland level. The lowest valley levels are those along the streams which are tributary to James River, whereas the valley peneplane along Sinking Creek is at the higher elevation of New River drainage. The present distribution of the Valley-floor (Pearisburg [3])

3. Hubbard, G. D., and Croneis, C. G.; op. cit., p. 313.

peneplane is greater than that of the Upland level, although originally the latter must have extended across the entire county. Present drainage is entrenched at depths amounting to as much as 300 feet below the Valley-floor level.

Among the minor physiographic features of Craig County should be mentioned the fine series of partially entrenched meanders of Craig Creek, the gorge of Johns Creek through

Peters Hill, the beautiful Buttermilk Falls of Meadow Creek southwest of Newcastle, and several windgaps across the ridges. There is considerable evidence of underground drainage in Sinking Creek Valley, as suggested by the name of the creek, and by the numerous sink-holes and springs in the in the valley. Sinking Creek and Back valleys are fine examples of breached anticlinal valleys, and Seven Mile Mountain is a typical anticlinal mountain. Potts, Craig, Barbour, and Johns Creek valleys are representative of synclinal valleys, and Broad Run Mountain is a synclinal mountain.

STRATIGRAPHY

The rocks of Craig County are entirely sedimentary and range from Ozarkian to early Mississippian in age. All of the exposed bed-rock belongs to the Paleozoic System, and the local columnar section, together with analogous sections in adjacent counties, is shown in figure 3. The accompanying geologic map (figure 4) shows their areal distribution within the county.

NOT AVAILABLE

It is convenient to arrange the local formations into groups, for purposes of description, the oldest of which may be called "Cambro-Ordovician". This group contains several calcareous units whose exact correlations have only recently been established and which formerly were assigned in part to the Cambrian and in part to the Ordovician. At present, these formations are grouped with the Ozarkian and Canadian systems which have been erected between the Cambrian and Ordovicial systems (restricted) of earlier usage. However, until a reluctance to accept the proposed divisions of the geologic column is overcome, the term "Cambro-Ordovician" remains a convenient, but not precise, name for the rocks in question.

"Cambro-Ordovician"

The Copper Ridge dolomite which is the oldest bed-rock

Table of Bedrock Formations in Craig and adjoining Counties.

List of Formations		Craig	Roanoke	Botetourt	Giles	Monroe
Devonian	Catskill	500'?	0	500'?	3,000	0
	Chemung	1500'	1000-2500	2950'		1500
	Brallier	2500	2000-3000	3000		2450
	"Romney"	600	600	1000	500	635
	Oriskany	0?	50-60'	2-12	100'	210
	Helderberg	200'		250	100'	
Silurian	Tonoloway	200'	0	135-300		
	Wills Creek	50'				
	Keefer	200	400'	160-375	290-400	460
	Cacapon	150		110-250		
	Clinch	270	10-100	50-290	125-300	110
Ordovician	Juniata	300-0	0	0-300	321.	330
	Martinsville	1400	1350	1200	1200-1500	1350
	Moccasin	50-200	150-300	20-0	300-500	396
	Athens	0-600	0-950	1000-0	0.	0
	Whitesburg					
	Holston	0?	325	0-40	800	690
	Lenoir	50-200'		125-250		
	Mosheim	0-30		0-20		
	Sw Stones River	0-300	0	0-320		
Canadian – Ozarkian	Nittany	900-1200	800	250-1200	690-5000	2400
	Chepultepec	0-50	1200-1600	500		
	Copper Ridge	2000		2400		

Figure 3

formation exposed in Craig County, is a miscellaneous aggregate of calcareous beds containing pure limestones, dolomites, and slabby shales. It reaches a thickness of at least 2,000 feet, and is locally exposed only in Sinking Creek Valley. It may be distinguished from the overlying Chepultepec limestone by its different fossil content, and from the Nittany dolomite by the lack of chert on its outcrop and by the presence at various horizons of sandy lenses that are totally absent in the Nittany dolomite. In adjacent regions, the Copper Ridge dolomite rests upon the Elbrook limestone of Upper Cambrian age (restricted), but its base is not exposed in the local region. The Copper Ridge dolomite appears to be the exact equivalent of the Conocheague limestone of northern Virginia, and both are assigned to the Ozarkian System. By some authors they are known as uppermost Cambrian.

A thin representative of the Chepultepec dolomite of Upper Ozarkian age occurs in Sinking Creek Valley where its outcrop bounds that of the Copper Ridge dolomite except for a short distance west of Simmonsville where both formations are partially cut out by the Saltville fault. The Chepultepec is a succession of medium-bedded pure limestones containing fossil cephalopods that indicate an Ozarkian age later than that of the Copper Ridge. Its thickness is probably less than 50 feet, and the rock is not essentially different in appearance or behavior from the beds above and below.

The Nittany dolomite is a heavy-bedded calcareous formation whose total thickness is between 900 and 1,200 feet. It is well developed along the margins of Sinking Creek Valley, and exposures are abundant in the area near Looney. It also occurs in Miller Cove, and near the county-line in Clover Hollow and Back Valley. The formation is conspicuous for the heavy chert which develops on favored parts of its outcrop, and it can often be recognized by this characteristic alone. Gastropod fossils, which are sparingly found in the cherty fragments, indicate a Beekmantown, or Canadian, age. It is possible that the local outcrops include dolomitic beds of Upper Canadian age that are equivalent to the Bellefonte limestone of Pennsylvania, but which are too thin to be mapped separately.

Lower Ordovician

Several units belonging to the Stones River group of the Chazyan series are known in this general region. The lowest is a dark-blue cherty limestone of lower Stones River age. This unit is well displayed in Rich Patch Valley, 7 miles northeast of Craig County, where its maximum thickness reaches 300 feet. It is also present along the same strike in Sinking Creek Valley. The Lower Stones River limestone rests upon the Nittany dolomite and is overlain by the Mosheim limestone which is likewise of Stones River age.

The Mosheim limestone is represented by a few feet of dove-colored limestones that are well exposed in Miller Cove. This formation is sparingly fossiliferous and where pure is of possible importance as a source of lime or cement rock. It is largely composed of fine-grained, sub-crystalline vaughanite, which is sufficiently distinctive as to identify the formation.

The Lenoir limestone, reaching a thickness of about 200 feet, is abundantly exposed at several localities in Craig County. Fine ledges of dark knobby Lenoir limestone occur at the northeastern end of Sinking Creek Valley near Meadow Brook. The rock is thin-bedded, knotty, and contains an abundance of typical Lower Ordovician fossils, including brachiopods and trilobites.

In Miller Cove, the Lenoir limestone is overlain by a few feet of dark, coarse-grained, fossiliferous limestone, which probably represents the Whitesburg limestone that is occasionally associated with the basal Athens shale. In Botetourt and adjacent counties, the Lenoir is overlain by the pure Holston limestone, but the latter is not known in the local area.

In Craig County, the black Athens shale occurs only in Miller Cove where it consists of a series of dark, chocolate-colored calcareous shales that reach a total thickness of about 500 feet. The shales contain many species of grapto-

lites, which serve to identify the formation, and to indicate its correlation with the Normanskill shale of New York State.

The Athens does not occur in either Sinking Creek or Back valleys, both of which were beyond the area of Athens sedimentation.

Middle Ordovician

The Middle Ordovician begins with the Black River group, of which the Moccasin formation is the earliest representative in Craig County. A good exposure of the Moccasin may be examined near Newport, about 3 miles southwest of the county-line, in Giles County. The formation consists of a series of red and purplish shales which are separated by several sandy zones from blue limestone at the base, the total thickness being about 200 feet. The formation changes considerably in character along its strike and is wholly absent at the northeastern end of Sinking Creek Valley, disappearing on both sides of the valley near Sinking Creek P. O. A thin bed of bentonite was observed in this formation in Miller Cove not far south of Giles County.[1]

1. Woodward, H. P., Geology and Mineral resources of the Roanoke area, Virginia; Virginia Geol. Surv. Bull. 34, 1932, p. 51-52.

The Martinsburg shale which overlies the Moccasin formation contains both Middle and Upper Ordovician members. Its lowest portion is a mass of gray and brown calcareous shale and sandy limestone of Trenton age. The unit is well

exposed along the inner slopes of the ridges bounding Back and Sinking Creek valleys, where the Trenton outcrop produces gentle slopes that have been cultivated well toward the summits of the nearby ridges. The total thickness of this part of the Martinsburg shale is about 500 feet.

Upper Ordovician

The middle and upper portions of the Martinsburg shale total about 1,000 feet in thickness; they belong to the Upper Ordovician, and respectively represent Eden and Maysville horizons. These units are very similar to the Trenton division but become more and more arenaceous toward the top of the formation. They are exposed in the same areas as the Trenton division and immediately underlie the Juniata shale and basal Silurian sandstones. Their slopes are commonly cleared and are either farmed or utilized for pasturage.

Beds equivalent to the Juniata formation are known above the Martinsburg in four of the adjacent counties, but are not present in Roanoke County to the southeast. The Juniata (erroneously called the Bays, or Red Medina, sandstone) consists of red and gray sandstones and shales which have a total thickness of 300 feet. They occur above the Orthorhynchula zone of the upper Martinsburg, and below the heavy sandstones of the Clinch.

Lower Silurian

The rocks of the Lower Silurian are largely arenaceous,

consisting of sandstones, fine conglomerates, and sandy shales. The lowest member is the resistant Clinch sandstone which is about 170 feet thick. The Clinch is so highly lithified that its various members approach the character and appearance of quartzites. It upholds the crests of Johns Creek, Sinking Creek, and Potts mountains, and also occurs on Peters, Cove, and Bald mountains. It is largely unfossiliferous, and its Lower Silurian age is determined by its stratigraphic position.

The Cacapon formation which overlies the Clinch, consists of deep-red sandstones with grayish-green, interbedded shales; it reaches a total thickness of about 150 feet. The formation is readily recognized by the red sandstone float which covers the slopes below its outcrop near the crest of the Clinch mountains. Fossils of Clinton age are known from the shaly beds in the upper portion of this formation.

The Keefer sandstone, which has a thickness of about 200 feet, directly overlies the Cacapon and is very similar in general character to the Clinch sandstone of lowermost Silurian age.

Ledges of the Keefer formation, however, are less highly lithified than are those of the Clinch, and the rock is essentially a pinkish-gray sandstone. In its effect upon the topography, it is scarcely less important than the Clinch sandstone, and the three Lower Silurian formations combine to produce the rugged and picturesque ridges of the county.

Upper Silurian

Rocks of Upper Silurian age belong to the Cayugan series and include the Wills Creek sandstone and the thin-bedded Tonoloway limestone. The former is a gray-green friable sandstone which carries abundant ostracode fossils and which is well exposed along Grannys Run near Craig Healing Springs. The Tonoloway limestone is a thin-bedded, slabby, dark limestone that attains a thickness of nearly 200 feet in the narrow gorge of Johns Creek through Peters Hill, 2 miles northwest of Newcastle. The Tonoloway limestone is either much thinner and entirely concealed, or wholly absent near Craig Healing Springs, where the Lower Devonian limestones closely overlie the Wills Creek sandstone.

Neither of the Upper Silurian formations are well exposed in Craig County, and their local presence might be un-

suspected save for the two localities mentioned above. The outcrops of the Upper Silurian rocks are grouped with those of the Cacapon and Keefer sandstones and represented with a single symbol on the accompanying geologic map.

Lower Devonian

The Helderberg group of the Lower Devonian is well exposed in Craig County where it contains ferruginous sandstones and sandy limestones that form a conspicuous belt immediately below the Devonian black shales on the outer flanks of the local anticlines. A wide area of Helderberg outcrop extends from Peters Hill northeastward to Rich Patch Mountain in Alleghany County, and other areas occur on both slopes of Potts and Seven Mile mountains.

The most conspicuous unit within the Helderberg group is the Clifton Forge sandstone, which is the local equivalent of the middle Keyser formation. This formation is an aggregate of true sandstones and highly arenaceous limestones; it is heavy-bedded and has a thickness of about 100 feet. Although it is somewhat less resistant than the Lower Silurian sandstones, its effects may be noticed upon the local topography where it produces fairly rugged and wooded country. No equivalents of the limestone facies of the Keyser formation were observed, although it is possible that they are also present, but obscured by debris from the sandy material

above and below them.

Along the Salem-Newcastle highway, about half a mile south of Newcastle, occur 50 feet of dark-blue, fossiliferous limestone of Becraft age[1].

1. Woodward, H. P.; op. cit., p. 59-61.

This limestone is highly fossiliferous and contains lenses of black chert scattered through the rock. In adjacent areas, the Becraft limestone is separated from the Clifton Forge sandstone by the Coeymans limestone and Healing Springs (New Scotland) sandstone, but the present reconnaissance did not disclose these units.

The Oriskany sandstone normally overlies the Helderberg group in west-central Virginia, where it is a coarse-grained friable sandstone of small and variable thickness. This formation underlies the Upper Devonian shales and is commonly associated with the brown ores of iron which bear its name. In examined exposures of Helderberg rock in Craig County, no equivalent of the Oriskany sandstone was observed, and it is not clear that the formation is present within the county.

Middle and Upper Devonian

The "Romney" shale is one of the conspicuous formations in Craig County, its outcrop surrounding the desolate valleys of Craig, Barbours, Johns, and Potts Creeks. This formation has a thickness of at least 600 feet, but as it is invariably

highly deformed, exact determinations of thickness are difficult to make. The formation consists of black fissile shales that weather readily to produce a soil filled with tiny shale splinters. This ground is unproductive and gives rise to large areas that have remained uncleared. At the very base of the "Romney" is a 20-foot zone of smooth, yellow shales which represent the equivalent of the Onondaga formation of New York State. Both the "Romney" and Onondaga shales are sparingly fossiliferous.

The West Virginia Geological Survey[1] reports the presence of Hamilton fossils from the "Romney" shale of Potts Creek Valley, but the present reconnaissance was unable to verify

1. Reger, D. B., and Price, P. H.; Mercer, Monroe, and Summers counties; West Virginia Geol. Surv., County Reports, 1926, p. 554.

this occurrence. It is thought, therefore, that the "Romney" includes thin equivalents of the Marcellus, Genesee, and Lower Portage horizons of the Devonian. It is the lithologic, but not the exact stratigraphic, equivalent of the typical Romney shale of northern West Virginia, and, for this reason, the name as applied in Craig County, is placed in quotes.

The Brallier shale, with a total thickness of at least 2,500 feet, occupies large areas of the local valleys. It is a thick mass of greenish-gray shales, interbedded with gray, flaggy sandstones partly of marine origin. A common characteristic of this formation is the occurrence of ripple

marks and minor sedimentation features that serve to distinguish it from other Devonian units. It grades without appreciable break into the "Romney" shale below and the Chemung formation above, the actual contacts as indicated on the geologic map being arbitrarily chosen. Its unproductive soil is largely responsible for the general lack of agriculture, and the unproductiveness of much of the county.

The Chemung formation consists of rather heavily bedded sandstones with thinner partings and shaly zones between the heavier sandy units. This formation is from 1,500 to 2,000 feet thick, and occurs along the southeastern edge of the county on Brushy and North mountains and on Broad Run Mountain. Several prominent zones of red shales occur within the Chemung formation on Price Mountain at the extreme eastern portion of the county. All of the local outcrops of the Chemung are south of Craig Creek, and the formation is responsible for the rugged mountain range that forms the southern boundary of the county. Fossils, especially of brachiopods and pelecypods, are common in the Chemung and indicate a late Devonian age.

A series of red shales and sandstones overlying the Chemung beds of Price Mountain has been tentatively assigned to the Catskill formation on the basis of its stratigraphic position, but in the absence of distinctive fossils, it is not possible to distinguish these shales from those which

are definitely associated with the Chemung.

Mississippian

A small outcrop of Price sandstone extends southwestward into Craig County along Price Mountain in the eastern portion of the county, and an extensive outcrop of this formation parallels the southeastern boundary of the county within one-half mile of the county-lime. In the latter outcrop on Brushy and North Mountains, the formation consists of a basal white conglomerate overlain by red and brown sandy shales and sandstones. The Price formation is of early Mississippian (Osagian) age and is sparingly fossiliferous.

Quaternary Deposits

Minor accumulations of surficial sands, clays, and gravels occur in several parts of the county, but their distribution is not shown on the accompanying geologic map. Residual and transported soils of several types also occur, in many places masking the bed-rock exposures.

GEOLOGIC STRUCTURE

Folds

Craig County lies wholly within the belt of folded Appalachian Mountains, and its geologic structure is typical of that area (see figure 5).

The most striking geologic feature of the area is the long Sinking Creek anticline [1] which extends from the Giles county-line nearly to Newcastle. It is a single fold about 6 miles wide and over 22 miles long. The anticline has been breached by erosion along its central axis so as to develop a long, narrow, fertile lowland bounded by the two flanks of the fold. The structure ends abruptly near Newcastle where the anticline plunges sharply below the Devonian shales about a mile south of the village. Sinking Creek Mountain forms the southeastern rim of the fold, and Johns Creek Mountain forms its northwestern rim. These ridges are breached by no streams except at the extreme northeastern end of the fold where the two flanking ridges come together. At this point, Meadow Brook has cut a deep gorge through the broken and jointed nose of the anticline. The rocks forming the ridges which surround the central valley are Silurian quartzites, and they dip away from its axis at angles of about 40 degrees. The inner flanks of these ridges are smooth and even, having been developed upon the weak Martinsburg and Juniata formations. The outer slopes are more rocky, with Lower Silurian and Upper Devonian sandstones extending well down toward the Devonian black-shale valleys at

1. Campbell, M. R., and others; Valley coal fields of Virginia; Virginia Geol. Surv. Bull. 25, p. 274-275. Woodward, H. P.; op. cit.; p. 90, 100.

the foot of the mountains.

The central valley developed on this structure is known as Sinking Creek Valley, and is floored with the Copper Ridge and Nittany formations of "Cambro-Ordovician" age. Along its strike the valley floor is not truely level, but is undulating, and in certain sections is decidedly rolling. Toward the southwestern county-line, the anticline is somewhat less regular than in its northeastern portion Near the Giles county-line, a long spur of Johns Creek Mountain extends southward to separate Sinking Creek Valley from Clover Hollow. This dividing ridge is an unbreached remnant of the roof of the anticline which elsewhere has been removed by erosion.

A geologic structure of some interest is the irregular anticlinorium that extends southwestward from Alleghany and Botetourt counties to plunge below the Devonian shales at Peters Hill, 3 miles west of Newcastle. This structure lacks the regularity of many Appalachian folds, and its area is marked by a large outcrop of the Lower Devonian formations, in which occur inliers of both higher and lower formations. In reality this structure is the southwestward extension of the southern limb of Rich Patch anticline, which extends from Iron Gate on James River to Peters Hill. Several ridges occur within this anticlinorium including Bald, Nutters and the two Little Mountains. Each is formed by the crest of a

sharp anticline in which Clinch and Keefer sandstones cap the mountain summit. Peters Hill is a lesser summit, and does not carry Silurian sandstones. Northwest of Little Mountain is the synclinal valley of Mill Creek in which "Romney" shales may be found in a belt that extends northeastward to Roaring Run, in Botetourt County. About 3 miles due west of Newcastle, the end of the anticlinorium has been cut through by Johns Creek, so as to leave Peters Hill separated from the main mass of the range by a deep gorge. At this point, the anticlinal nature of the fold is clearly displayed in a prominent arch which reveals the entire Silurian sequence. A minor up-fold in this general structure has brought a narrow patch of Clinton sandstones to the surface at a point about 2 miles west of Barbours Creek Post Office.

The relation of this irregular anticlinorium to the extremely regular Sinking Creek anticline is not entirely clear, but the two are sufficiently different in nature to point toward a separate structure rather than a continuation of the same fold.

The three deep valleys of the county are all synclinal and are floored with the "Romney" and Brallier shales of Devonian age. These valleys are, from south to north, Craig Creek Valley, Barbours-Johns Creek Valley, and Potts Creek Valley. Each is a shallow syncline between the flanks of anticlinal structures, and the weak Devonian shales are tho-

roughly crumpled so as to produce wide areas of outcrop. As is typical of Devonian shale valleys throughout the Appalachians, the Craig County valleys are unfertile and poor.

Minor structures rise from the floors of these valleys. These structures include Seven Mile and Broad Run mountains. The former appears as a regular, oval anticline in Johns Creek Valley between Johns Creek and Potts mountains. Clinton and Cayugan sandstones occur along its summit, and Craig Healing Springs are located along the axis of the structure at a point where Grannys Run cuts through the anticline. Broad Run Mountain is a synclinal hill underlain by Chemung sandstones that are infolded along the central axis of Craig Creek Valley, east of Newcastle. North and Brushy mountains along the southeastern edge of the county are synclinal structures of the same nature.

Potts Creek Valley is narrower than Johns and Craig Creek valleys, and its synclinal structure (the Waiteville syncline[1])

1. Reger, D. B., and Price, P. H.; Mercer, Monroe, and Summers counties, West Virginia; West Virginia Geol. Surv., County reports, 1926, p. 159.

is more tightly crushed. A narrow belt of "Romney" shale has been infolded on the northern slope of Potts Mountain southeast of the main mass of shales on the floor of Potts Valley. The southwestern continuation of Potts Valley is in Monroe County, West Virginia, and its structure has been described in a recent report of the West Virginia Geological

Survey. [1]

1. Reger, D. B., and Price, P. H.; Mercer, Monroe, and Summers counties, West Virginia; West Virginia Geol. Surv. County reports, 1926, p. 159.

Potts Mountain itself is a narrow anticline (the Crosier anticline[2]) which has been breached between Arnolds Knob

2. Reger, D. B., and Price, P. H.; op. cit., p. 160-161.

Hanging Rock to expose Ordovician limestones in the narrow Back Valley immediately northwest of the main ridge of the mountain. This small valley is analogous in structure and appearance to the larger Sinking Creek Valley; about 3 miles of its length lie within Craig County.

The southern end of an anticlinal tract [3] extends for

3. Woodward, H. P., Geology and Mineral resources of the Eagle Rock quadrangle, Virginia; Virginia Geol. Surv. Bull. (prepared).

about 2 miles into Craig County at the northernmost point of the county just south of Nichols Knob, where, for about one square mile, Martinsburg shale is exposed. In the south-central part of the county, Millers Cove, bounded by Brushy and Cove mountains, has been eroded on the northward plunging end of the Millers Cove[4] anticline; the cove itself is a

4. Woodward, H. P.; Geology and mineral resources of the Roanoke area, Virginia; Virginia Geol. Surv. Bull. 34, 1932, p. 77.

wide recess developed upon Athens and Nittany formations.

Faults

Several faults enter this county and all are overthrusts. The most prominent is the Saltville overthrust [1] which has been traced from southwestern Virginia into this area. The outcrop of this overthrust is exposed along the road leading north from Newport, about 3 miles southwest of Craig County. From this point, the fault may be traced in a northeasterly direction along the flank of the ridge which bounds Clover Hollow on the south. The fault truncates the mountain spur which separates Clover Hollow and Sinking Creek Valley, and parallels the main valley road to pass directly through Simmonsville. From this point northeastward, no surface trace is apparent, and the fault probably dies out near the axis of the anticline. On former geologic maps of Virginia,[2] the fault-line continued through the nose of Sinking Creek anticline into the shale valley east of Newcastle, but there is no field evidence to indicate that it can be traced more than 2 miles north of Simmonsville. Throughout its length in Craig county, the overthrust carries the Copper Ridge dolo-

1. Stevenson, J. J.; Faults of southwest Virginia; Amer. Jour. Sci., Vol. 33, 1887, p. 262-265.

2. Geologic map of Virginia; Virginia Geol. Surv., 1914, and 1928.

mite upon foot-wall formations which include all units from the Copper Ridge to the Clinch sandstone.

A similar overthrust, known as the Miller fault, [1] enters Craig County in Millers Cove, where it truncates the northern end of Cove Mountain and extends along the valley of Broad Run Creek between Caldwell and Price mountains into Botetourt County. This fault emerges beneath the Pulaski overthrust immediately south of the tri-county boundary between Montgomery, Roanoke, and Craig counties, and becomes lost in the Devonian shales of Patterson Creek northwest of Eagle Rock in Botetourt County.

1. Campbell, M. R., and others; op. cit., p. 44-45. Woodward, H. P.; op. cit., p. 89-90

The Pulaski overthrust [2] borders the southern flanks of Brush and North mountains, and, at McAfee Gap, is only a few rods south of the Craig county-line. At no point, however, does the fault actually occur within the limits of the county. The West Virginia Geological Survey reports a small overthrust (the Sugar Grove fault [3]) along the northern side of the anticlinal Back valley developed between Arnolds Knob and Hanging Rock, and has traced this fault to the border of

2. Campbell, M. R., and others; op. cit. p. 76-96. Woodward, H. P.; op. cit., p. 84-89.

3. Reger, D. B., and Price, P. H.; op. cit. p. 183.

Craig County. The writer has been unable to find any continuation of this structural break within Craig County. A minor fault [1] separates the southern end of North Mountain

1. Woodward, H. P.; op. cit., plate 1, geologic map of the Roanoke area.

from Cove Mountain, and parallels the road between these two ridges. It meets, or is cut off by, the Miller fault at a point about 2 miles north of Moomaw Post Office in Roanoke County.

Summary

The various geologic structures of Craig County were formed during the eventful close of the Paleozoic Era, and represent the effects of the Appalachian Revolution. All available indications suggest that they were produced by compression acting from the southeast, and the general strike of all structures is normal, or at right angles, to this direction. In a larger sense, the folding and faulting were contemporaneous, although when the details are studied it appears that the production of the folds slightly preceded the displacement along the faults. There is no evidence of any bed-rock structure which was produced after the close of the Paleozoic Era.

ECONOMIC RESOURCES

The natural economic resources of Craig County are of limited nature and uncertain value. Iron and manganese have been the chief metallic materials obtained in the area, and these are not being actively produced at the present time. Small deposits of slate and ochre have also been prospected but have not proven of particular value. It is probable that cement rock and clay are available in workable quantities and of satisfactory grade, but no operations have been opened in these materials to date. The following brief outline of the mineral resources of the county shows the present state of mining and quarrying in the region.

Iron and Manganese

Irregular scattered deposits of iron and manganese ores are known to occur in west-central Virginia at about the horizon of the Oriskany sandstone; hence they have become known as "Oriskany ores". The deposits contain limonite, manganiferous limonite, and psilomelane, with occasional masses of other related oxides. The ores generally lie a short distance below the base of the Romney shale, and are found associated with the Oriskany sandstone, if present, or with other members of the Helderberg group. It is thought that the metallic materials were leached out of the overlying Devonian black shales and were concentrated by surface waters within the zone of weathering. The ores occur rather per-

sistantly at elevations between 1,600 and 2,000 feet above sealevel, and were probably formed during a period when local base-levels maintained the water-table at those elevations.

In adjacent regions, small amounts of bedded hematite are found in Clinton horizons and, near Iron Gate, Alleghany County, were once mined in a small way. No material of this nature was observed in Craig County, and there is no reason to expect its presence in the area. Iron and manganese ores have been also found in the residual clays of the Copper Ridge and Nittany dolomite near Simmonsville and Huffman in Sinking Creek Valley where their concentration appears to have been connected with the production of the Valley-floor peneplane.

Very little actual iron mining has been undertaken in the area. The most important producing mine is the Fenwick

1. Stose, G. W., and Miser, H. D.; Manganese deposits of western Virginia; Virginia Geol. Surv. Bull. 23, 1922, p. 112.

mine, located at the head of Mill Creek, 8 miles northeast of Newcastle along the southeastern slope of Bald Mountain. The mine consists of a shaft which was sunk in through the "Romney" shale into 50 feet of underlying sandstone and clay to an ore body that rests upon the Becraft limestone. There are several side drifts from which ore was obtained which is reported to carry 44.6 per cent. of metallic iron, and was

mined in 1900 and for several years afterward. It has not been operated, however, for over 25 years. The mine is adjacent to the extensive Oriskany mine in Botetourt County.

A number of small iron prospects were formerly opened in Potts Creek Valley near Paint Bank and were once considered to be of considerable economic importance. Included among them were the following: Given, Cornfield, Paint Bank, Haupt, Rowan, Loop, Valley Branch, and Humphreys prospects.[1]

1. Holt, H. A., and Snyder, A. C.; The iron ores of Potts Valley, Virginia; Lewisburg, Virginia, 1891, p. 1-38.

None of them was ever seriously operated and it is unlikely that they will ever be of economic importance.

The following table (figure 6) shows the reported compositions of iron and manganese ores from Craig County, but the accuracy of these analyses cannot be guaranteed, for many of them may represent selected specimens and not run-of-the-mine samplings.

A recent bulletin of the Virginia Geological Survey [2]

2 Stose, G. W., and Miser, H. D.; op. cit., p. 112-119.

describes the principal manganese workings in Craig County, and the present reconnaissance has added little to this description. A few mines were once operated in the county, and scattered additional prospects are reported. The Chevy Mine[3]

Analyses of Iron and Manganese Ores from Craig County, Virginia

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Metallic Fe	46.45	55.10	56.60	54.45	33.60	52.70	53.64	57.71	52.36	—	—	6.83	1.82	4.81
Metallic Mn	—	—	—	—	—	—	—	3.50	—	45.00	52.42	49.48	53.06	50.50
Silica	19.63	4.38	6.83	6.10	13.18	9.74	9.10	1.05	2.90	4.70	0.46	2.53	1.67	0.58
Phos.	0.299	1.601	0.103	0.863	0.401	0.592	0.401	0.63	0.011	0.085	0.303	0.063	0.058	0.026

1. Iron ore, given prospect, Potts Creek Valley (Oriskany).
2. " " Cornfield " " " " "
3. " " Paint Bank" " " " "
4. " " Haupt " " " " "
5. " " Rowan " " " " "
6. " " Lorp " " " " "
7. " " Johns Creek, near Newcastle "
8. " " N.W. Side of Peters Hill (Clinton?)
9. " " Craig Cree, 3 mi. S.W. of Newcastle(Oriskany)
10. Manganese ore, Sinking Creek Mtn., S.W. of Newcastle (Oriskany)
11. " " " " " " " " "
12. " " Craig Creek, 3 mi. S.W. " " "
13. " " Sinking Creek Mtn., " " " "
14. " " " " " " " " "

1 figure.

3. Stose, G. W., and Miser, H. D.; op. cit., p. 115-117.

consists of a number of openings on the southeast slope of Sinking Creek Mountain, 12 miles southwest of Newcastle. The principal working is a deep cut in Helderberg sandstones and underlying clays. The ore consists of psilomelane occuring in pockets in the clay and in fissures in the sandstone. It is reported that several hundred tons of ore were mined between 1916 and 1920, but active operation ceased after 1920.

The C. L. Hoffman Mine [4] is located about 1½ miles west

4. Stose, G. W., and Miser, H. D.; op. cit., p. 117-119.

of Simmonsville, and one mile north of Sinking Creek. This mine consists of a shaft about 80 feet deep in cherty clay upon the outcrop of Nittany dolomite. Masses of psilomelane, wad, and limonite are found in irregular masses up to a ton in weight. About a mile and a half northwest of this mine is the L. P. Hoffman and Givens prospect where analogous manganese ores were discovered by shallow prospecting in residual clays. At neither of these two points has any serious mining been undertaken.

Several other manganese prospects have also been reported, but no operations have advanced beyong superficial prospecting. The Red Brush prospect [5] on Big Branch of Johns

5. Stose, G. W., and Miser, H. D.; op. cit., p. 112-114.

Creek, 5 miles due northwest of Newcastle, shows a few small openings in sandstone along the creek. The ore is largely psilomelane which replaces the clay beneath the sandstone. The ore is reported to contain 38 per cent. manganese, 15-20 per cent. silica, and 2 to 5 per cent. iron. The Cliff Prospect [1] on the southeast slope of Sinking Creek Mountain, 3 miles south-southwest of Newcastle, consists of two tunnels in clays directly below a Helderberg sandstone (possibly the Oriskany), and some 800 feet above creek level. The ore is said to contain 40 per cent. manganese and iron together, or 14 per cent. manganese.

1. Stose, G. W., and Miser, H. D.; op. cit. p. 114-115.

As is evident from the above descriptions, the resources of Craig County, iron and manganese, are not especially promising, and it is very doubtful whether metallurgical improvements, demand for iron and manganese, and improved transportation facilities will ever cooperate so as to bring these materials into the realm of successful operation.

Lime and Cement

The anticlinal valley of Sinking Creek, and Black Valley are underlain by "Cambro-Ordovician" and Ordovician limestones, but the prospect of obtaining cement materials from these regions is small. Except for occasional strata of limited extent, the majority of the beds are too impure for this use

and the Mosheim limestone is the only member which might be suitable for this purpose. In the absence of adequate transportation facilities, it is feared that lime or cement operations would not be profitable, even if a sufficient body of good lime or cement were found.

Clay and Shale

While no tests of clay materials have been made from the local rocks, it is possible that some of the clay and shales of Craig County may prove of commercial value. "Romney" shales are used for the manufacture of common brick by the Salem Brick Company [1] about 8 miles south of Craig County,

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[1] Woodward, H. P., op. cit., p. 128.

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and it is probable that search for similar material in the "Romney" shale of Craig Creek Valley would be successful. The abundant outcrop of these shales near Newcastle, and in Craig and Johns Creek valleys, may furnish clay material of suitable quality. The residual clays of "Cambro-Ordovician" rocks in Sinking Creek Valley might furnish additional material which could be used with the clay shales of the "Romney" belt. So far as is known, no attempt has been made to investigate the clay possibilities of the county.

Miscellaneous Materials

Yellow ocher, mined along the southern bank of Potts Creek, is responsible for the name of the hamlet, Paint Bank.

The ocher is a residual clay heavily charged with limonitic material which gives it a deep yellow color. Roofing slate has been prospected near Newcastle, where some of the stiffer Devonian shales were once quarried for this purpose. It is difficult, however, to obtain the slate in slabs of any size, as the rock is badly jointed and fractured. The grade of slate is poor, and the meager operations were never continued.

Mineral Waters.

Two locally famous springs are located near the central part of the county. Craig Healing Springs are located about 12 miles west of Newcastle, between Seven Mile and Potts mountains, and Virginia Mineral Spring is located along Craig Creek about 4 miles northeast of Newcastle. Craig Healing Springs have long been known in this region as a summer resort and, because their waters are reputed to have therapeutic value, attract many guests. The springs emerge from Helderberg limestones along the valley of Grannys Run, a small branch of Johns Creek. Virginia Mineral Spring has been recently developed and is somewhat more accessible than Craig Healing Springs, as it is near a station of the Craig Valley Branch of the Chesapeake and Ohio Railway.

Water Resources

Little extensive use has been made of the water resources

of Craig County. Sinking Creek Valley is well supplied with water for domestic purposes by springs that emerge from the soluble limestones and dolomites. A few springs emerge in the Devonian shale valleys near the flanks of the mountains, but these areas are less well watered than the limestone valleys.

One of the larger springs is located on the property of Mr. C. E. Lefel, about 3 miles southwest of Newcastle and half a mile north of Looney. Another, known as the Clarence Reynolds spring is located about 9 miles south of Newcastle, and 3 miles northeast of Sinking Creek Post Office. Both emerge from calcareous beds near the axis of the Sinking Creek anticline, and furnish 2,000 and 5,000 gallons of water per minute respectively.[1]

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1. Collins, W. D., and others; Springs of Virginia; Virginia Comm. on Conservation and Development; Bull. 1, 1930, p. 28-29.

It is possible that surface-water reservoirs could be constructed in the region near Newcastle either for the storage of water or for the generation of power. A dam advantageously placed across Johns Creek in the narrowest part of its gorge through Peters Hill, or across Barbours Creek at the point where it cuts through Nutters Mountain, could be made to impound water over a considerable basin, and in neither case would the dams need to be very wide or high. The flow of both creeks is considerable and constant. A

short dam located in the narrow gap between Johns Creek and Sinking Creek mountains across Meadow Brook on the outcrop of Lenoir limestone would control a drainage basin of several square miles, and would allow a fall of over 300 feet to the level of Newcastle. Whether the fractured rocks of Sinking Creek anticline would be tight enough to retain water behind a dam is a point which the writer has not determined. In other respects, however, the situation is favorable.