

ART. XXI.—*Geologic Section of Blair and Huntingdon Counties, Central Pennsylvania;** by CHARLES BUTTS.

The geologic section in Blair and Huntingdon counties, Pa., was worked out by the writer in 1908 in a survey of the Hollidaysburg quadrangle and in 1913 in a survey of the Huntingdon quadrangle, which adjoins the Hollidaysburg quadrangle on the east. These two quadrangles include a large part of the two counties and lie across two great folds, the Nittany anticline and Broad Top Mountain syncline. The strata exposed have a maximum thickness of over 27,000 feet and an average thickness, as shown in the accompanying section, of nearly 25,000 feet. This is probably as thick as any if not the thickest section exposed in the Appalachian region in so small an area.

Geologists familiar with the region will see that the writer's contributions to the stratigraphy consist partly of detail, such as the delimitation of the Middle and Upper Devonian formations recognized by the geologists of the Second Geological Survey of Pennsylvania but the boundaries of which were not defined by them. Much that is new has, however, been added, particularly concerning the lower part of the section, where the valley limestone, No. 2 of the older geologists, has been split up into twelve formations and several members.

Brief notes, mainly on the new formations and their names, follow. In the Chemung the name Saxton conglomerate member is introduced to replace White's name Lackawaxen conglomerate, as it seems very uncertain whether this conglomerate is the same as the Lackawaxen. The conglomerate is well exhibited in and about Saxton, Huntingdon County, whence the name.

The Portage group has been divided into two formations, the Brallier shale and the Harrell shale which includes, in the bottom, the Burket black shale member. The Brallier shale is named from a station on the Huntingdon & Broad Top Mountain Railroad a few miles northeast of Everett, in Bedford County. This shale is the same as the Woodmont shale member of the Jen-

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nings formation of Maryland, except that the Woodmont extends down to the Burket black shale member, regarded by the Maryland Survey as Genesee. The Brallier is well exposed and can be most conveniently seen along the Pennsylvania Railroad west of Altoona and just east of Huntingdon. The Harrell shale is perfectly distinct lithologically from the Brallier, as shown by the descriptions of the section. In the Broad Top Mountain syncline in Huntingdon County the Harrell is about 250 feet thick and consists of soft, dove-colored fissile shale and interbedded layers of black fissile shale. In Blair County, to the west, however, the black shale is all in the bottom and is about 75 feet thick, the soft, dove-colored, highly fissile (paper) shale, about 200 feet thick, being free of black shale and forming the upper part of the Harrell. The name is taken from Harrell, a station on the Petersburg branch of the Pennsylvania Railroad, about midway between Hollidaysburg and Williamsburg where the dove-colored shale is well displayed. This shale is also well shown in a cut of the Pennsylvania Railroad in the western outskirts of Altoona and in the brick yard at Eldorado, a few miles south of Altoona.

The black shale member of the Harrell is named from Burket, a suburb of Altoona. The Burket member is well exposed in and about Altoona, at several places southwest of Altoona for 20 miles, and along the Pennsylvania Railroad between Altoona and Bellwood. As already stated, this shale has been regarded as Genesee, but it carries no distinctively Genesee fossils; on the other hand, it and the overlying part of the Harrell generally contain a good representation of the Naples fauna, found at the base of the Portage in western New York. The Burket is, therefore, believed to be basal Portage rather than Genesee.

Just below the Harrell shale there is, in places at least, a limestone about a foot thick, from which were obtained *Chonetes aurora* and a *Martinia* like one of those of the McKenzie River region of Canada, which are there also associated with the same *Chonetes*. As *Chonetes aurora* is a characteristic fossil of the Tully limestone of New York, to which it appears to be confined, the thin limestone here is probably the feather edge of the Tully extending in an embayment into this part of Pennsylvania. If so the limestone really belongs in the Upper

Devonian instead of in the top of the Hamilton, as placed in the section.

The name Reedsville was introduced by Ulrich (Revision). The formation corresponds about to the upper half of the Martinsburg shale. The top sandstone member, with *Orthorhyncula*, etc., is 30 to 56 feet thick, and extends without change from central Pennsylvania to New River, Va. *Orthorhyncula* was found also at Gate City, Va., near the Tennessee line. It is an extremely valuable horizon marker.

The Trenton limestone here is said to agree well in character with the Trenton nearer its type locality.

The Rodman limestone is new and is named from Rodman, a station on the Pennsylvania Railroad near Roaring Spring, several miles south of Hollidaysburg, Blair County. This formation is only about 30 feet thick but is persistent throughout Nittany Valley and is identical in character and thickness in Center County and in Blair County. It can be seen in any of the quarries of the region, where it immediately overlies the quarry rock from which it can easily be distinguished by its lithologic character and by the fact that it outcrops at the top margin of the quarries on the side toward the dip. The Rodman carries a considerable and an interesting assemblage of fossils which may be listed in a future paper. *Echinosphærites* occurs in a zone of beds at Bellefonte, Pa., between the Lowville and Trenton, of identical character and in part at least contemporaneous with the Rodman. Ulrich regards the beds in this zone as upper Black River and as falling within the scope of the Chambersburg limestone as defined in the *Mercersburg-Chambersburg folio*. It is not yet decided whether this *Echinosphærites* zone is to be identified with the upper or the lower of the two *Echinosphærites* zones of that region but Ulrich is at present inclined to identify it with the lower. The fauna of the Rodman is not the same as that of the Sinuites bed in the base of which is the upper occurrence of *Echinosphærites*, while it contains forms that are so far known only in the lower *Echinosphærites* zone. In the complete section these two zones are separated by almost 400 feet of limestone.

Ulrich thinks the Rodman may be the same as the Niskey limestone of Wherry, in the Lehigh Valley, but in

view of the uncertainty regarding their equivalence the local name is here used.

The Lowville limestone is regarded as good typical Lowville. Fossils are comparatively scarce but so far as known the fauna is thoroughly in harmony with the lithologic criteria on which the correlation was originally based.

The Carlim limestone is new, named from a quarry town on the Petersburg Branch of the Pennsylvania Railroad a few miles northeast of Williamsburg, Blair County.

The Lemont member of the Carlim is named from Lemont, near State College, Center County.

Both the Carlim and the Lemont member are well displayed in all the quarries of the region, the part of the Carlim below the Lemont member, with the Lowville overlying the Lemont member, being the main quarry beds of the region, which supplies a large part of the flux rock for the Pittsburgh blast furnaces. The Lemont is not utilized except for road metal or concrete, and considerable bodies of it remain in quarries where the flux rock has been taken out.

The main body of the Carlim is very sparingly fossiliferous, but the Lemont member is locally richly so. A few of the species are listed in the description of the section. *Maclurites magna* has not been found in Blair County but is common at Lemont. The Carlim is of middle Chazyan or middle Stones River age and corresponds about to the Lenoir limestone of east Tennessee, the Ridley of central Tennessee, and the Crown Point limestone of the Champlain Valley, in northeastern New York.

The names of the Canadian formations Bellefonte, Axeman, and Nittany, were introduced by Ulrich in his "Revisions of the Paleozoic Systems" in 1911. They were taken from Bellefonte, Center County, and vicinity. The formations in Blair County agree in all respects with the same formations in Center County, except that the Bellefonte and Nittany are each only about half as thick in Blair County as in Center County. There is an exposure of nearly the full thickness of the Bellefonte and Nittany along the river a mile northeast of Williamsburg.

The divisions of the Ozarkian and their names are all

new, although the presence of the Ozarkian in this region was recognized by Ulrich in 1909 or 1910.

The Larke dolomite is named from Larke postoffice, which is several miles south of Williamsburg, in Blair County, where thick beds of the dolomite are exposed. A good specimen of *Helicotoma uniangulata* was found in the Larke near Ore Hill, farther west in the county, and shows that it contains beds, perhaps in its upper part, of the age of Ulrich's Chepultepec dolomite of Alabama, of the Gasconade limestone of Missouri, and of the upper cherty, fossiliferous zone of the Little Falls dolomite of the Mohawk valley of New York. Good exposures of the Larke occur just east of Williamsburg.

The Mines dolomite is named from the old mining town of Mines, which is several miles southwest of Williamsburg, where brown iron ore was once extensively mined by the Cambria Steel Co. This formation seems to occupy the position of the Copper Ridge dolomite of Ulrich, which in Tennessee is the main body of the Knox dolomite, lying between the Canadian (Beekmantown) part of the Knox and the Nolichucky shale. The Mines dolomite is best exhibited in the north end of the long ridge just southeast of Williamsburg, Pa.

The Gatesburg formation is named from Gatesburg Ridge, in Center County, Pa., the name having been proposed by Prof. E. S. Moore, of State College.

The Ore Hill and Stacy members were named by the writer. The Ore Hill is named from a mining town south of Roaring Spring, Blair County. This member has yielded several species of trilobites, mostly undescribed forms, the nearest relatives of which, according to Ulrich, occur in the Hoyt limestone of New York. The Ore Hill is well exposed in a quarry a mile southwest of Ore Hill and at a point just north of the road a half mile northwest of Drab in the Huntingdon quadrangle, 6½ miles southwest of Williamsburg. Most of the fossils were collected at these localities. The Stacy member is named for Stacy Hill, an isolated knob 4 miles slightly west of south of Williamsburg.

The Gatesburg is nowhere well exposed but can best be seen on the north bluff of the river, a mile northeast of Williamsburg and along the north bluff a short distance west of Williamsburg. It is also well exposed along the

main line of the Pennsylvania Railroad between Birmingham and Shoenberger.

The Gatesburg is correlated by Ulrich with a group of dolomite formations in central Alabama, lying between Ulrich's Copper Ridge dolomite and the top of the Conasauga limestone, the upper part of the Conasauga being regarded as the equivalent of the Nolichucky shale. These formations are the Briarfield dolomite of Ulrich, the Ketona dolomite, and some overlying beds of dolomite called Potosi by Ulrich in his Revision. The Larke, Mines, and Gatesburg should probably be correlated in general with the Conococheagne limestone of the Chambersburg and Mercersburg regions of Pennsylvania.

The Warrior limestone is named from Warrior Creek, in the northern part of Huntingdon County, east of Warrior's Mark. This limestone has been called the Buffalo Run limestone by Walcott (Smithsonian Miscellaneous Collection, vol. 64, p. 165), who adopted, without definition, the field name used provisionally by Prof. Moore. The best exposures of the Warrior limestone are at the type locality on Warrior Run, along the river bluff a mile west of Williamsburg, and in the western half of Bloomfield township, Bedford county, several miles south of Roaring Spring and on the Everett quadrangle.

The Pleasant Hill limestone is named from Pleasant Hill church a mile northwest of Henrietta, in the southeast corner of Blair County, where the upper part, the limestone, is excellently exposed. Ulrich regards both the Warrior and the Pleasant Hill as Upper Cambrian and Walcott regards the Warrior as Upper Cambrian. Probably the Warrior and Pleasant Hill are in part represented by local beds of relatively pure limestone that have been somewhat doubtfully included in the upper part of the Elbrook limestone of Maryland and Pennsylvania.

The mapping of these limestone units has resulted in the detection of a number of hitherto unknown faults, some of considerable magnitude in both displacement and linear extent. For example, there is a great fault or narrow belt of overlapping faults of several thousand feet displacement extending from the northwestern part of Hopewell township, Bedford County, northward to Birmingham, on the main line of the Pennsylvania Railroad,

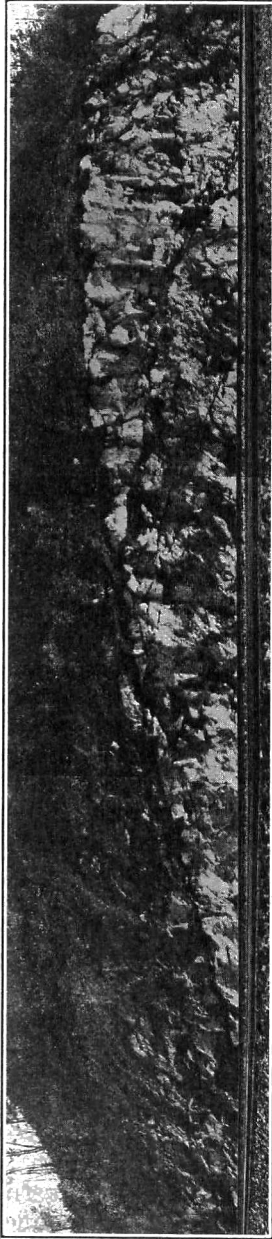


FIG. 1. Photograph of a cut on the main line of the Pennsylvania Railroad just east of Birmingham, Pa., showing an overthrust fault at the top of the white limestone. The overthrust rocks are Warrior limestone, of Upper Cambrian age, dipping eastward about 15° parallel with the fault plane. The bedding can be seen at the left. The white limestone overridden is Carlin, middle Chazyan or middle Stones River age, overturned with an east dip of about 40° . The bedding is obscured by jointing and fracturing but by careful examination can be seen at the bottom in the middle. The stratigraphic throw is 5000 to 6000 feet.—Looking south.

where a fault is plainly exposed in a cut immediately east of the station. The fault plane here dips east at about 15° , the beds of the overthrust mass being parallel to the fault plane and those below the fault being overturned with an east dip of 40° . The overthrust mass is Warrior limestone and the overridden beds are Carlum limestone. This fault is shown in fig. 1. The position of this fault or faulted zone is plainly indicated by the sharp bend or offset in Canoe Mountain, about 8 miles a little southwest of Birmingham and by the fault offsetting Bald Eagle Mountain 5 miles northeast of Tyrone. A number of other strike faults were discovered showing that this region has been faulted in a manner similar to the southern Appalachian region.

The classification followed in this paper differs from the usual classification in the following particulars: The Loyalhanna limestone is placed in the Mauch Chunk instead of in the Pocono, because the author believes that the Loyalhanna is probably the same as the Trough Creek limestone of I. C. White at the base of the Mauch Chunk in the Broad Top Mountain syncline, in Huntingdon County. The Burgoon sandstone, which forms the upper part of the Pocono, is believed to be of Keokuk or upper Fort Payne age, whereas the Loyalhanna is believed to be of Warsaw age, a belief founded on the existence of a similar cross-bedded limestone of probable Warsaw age, in a similar stratigraphic position just above the Fort Payne chert at the head of Sequatchie Valley, in eastern Tennessee. If the Loyalhanna is thus of Warsaw age it should, in the author's opinion, be classed with the beds overlying the Pocono.

The Pennsylvanian and Mississippian are recognized as systems, instead of series in the Carboniferous.

The Ordovician-Silurian boundary is placed at the base of the Oswego sandstone, in which the practice of the New York State Survey is followed. It seems reasonable to assume that the deposition of this sandstone was the result of crustal movements such as are regarded as initiating new periods of geologic time.

The only other important deviation from prevailing usage is the recognition of the Canadian and Ozarkian systems, in which, of course, the writer follows Ulrich. The writer is satisfied that there are sufficient grounds

for this classification but cannot go into the discussion of the question now.

Formation.

Description.

I.

Allegheny formation	Shale and sandstone, with workable coal beds.
Pottsville formation	Mainly sandstone, clay, and shale, with coal locally in middle.
Mauch Chunk shale	Mainly lumpy, red shale or mudrock, with 80 feet of thick-bedded sandstone at bottom to west. A little thin sandstone and limestone to east. Mostly of Chester age. Siliceous crossbedded limestone to west (Loyalhanna limestone); gray and red, partly argillaceous limestone to east (Trough Creek limestone of I. G. White) Warsaw age?.
Pocono formation	Thick-bedded, gray sandstone; Burgoon member, at top; shale, red shale, and sandstone below. Conglomerate at bottom to east. Thickest to east, in Broad Top Mountain. Most red shale to west, on Allegheny front. Osage age.
Catskill formation	Lumpy, red shale or mudrock, thick-bedded, micaceous red sandstone. 80 per cent red. Gray and greenish shale and gray sandstone with marine fossils, 20 per cent. <i>Spirifer disjunctus</i> , <i>Camarotoechia contracta</i> , <i>Grammysia elliptica</i> , <i>Pteronites rostratus</i> , and others.
Chemung formation	Mostly shale with thin sandstone layers. Some thicker sandstone and conglomerate members. Upper 1,000 feet largely purplish or chocolate colored to west on Allegheny front, and the same with red shale layers in the upper 500 feet on Raystown Branch of Juniata River on the east. Lower 2,000 feet gray and greenish. Chemung fossils common to abundant from bottom to top. <i>Spirifer disjunctus</i> at very bottom on Allegheny front.

II.

Brallier shale	Fine-grained, siliceous shale in thick, even layers revealing their fissility on weathering. Largely wavy or dimpled laminae, some even and slaty. A few thin fine-grained sandstone layers. Fossils small and very scarce. <i>Buchiola retrostriata</i> , <i>Proboloceras lutheri</i> , <i>Bactrites aciculus</i> , <i>Phragmostoma natator</i> . Upper Portage.
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Harrell shale	Dove and black fissile (paper) shale. Black at bottom to west (Burket member). Black and dove interbedded to east. <i>Buchiola retrostriata</i> , <i>Paracardium doris</i> , <i>Pterochaenia fragilis</i> , <i>Styliola fissurella</i> , <i>Probeloceras lutheri</i> . Lower Portage.
Hamilton formation	Hackly shale at top, weathers green; impure limestone layers in top 10 to 20 feet. Dark shale with thin even sandstone layers in middle to west, three thick sandstone members to east. Lower one-third dark olive shale grading into Marcellus shale below. <i>Chonetes aurora</i> in 1 foot limestone at very top (Tully?, Upper Devonian). Common Hamilton fossils abundant in hackly shale in upper one-third. Fossils scarce below.
Marcellus shale	Black fissile shale with <i>Leiorhynchus limitaris</i> and <i>Styliola fissurella</i> .
Onondaga formation	Dark shale with limestone layers. <i>Odontopleura aegeria</i> , <i>Anoplotheca acutiplicata</i> and other fossils.
Ridgely sandstone	Coarse thick-bedded sandstone. Common Oriskany fossils plenty. Upper Oriskany.
Shriver limestone	Thin-bedded siliceous limestone. <i>Dalmanites stemmatus</i> ?, <i>Craterellina robusta</i> , <i>Actinopteria textilis</i> , <i>Chonetes hudsonica</i> , and many other Oriskany fossils. Lower Oriskany.
Helderberg limestone	Thick-bedded gray limestones (Keyser, Coeymans, New Scotland). <i>Gypidula prognostica</i> , <i>Gypidula coeymanensis</i> , <i>Spirifer macropleura</i> .
Tonoloway limestone	Thin-bedded limestone. Fossils few, <i>Leperditia alta</i> ?
Wills Creek shale	Dove, calcareous, fissile shale, a little limestone. Fossils very scarce. <i>Leperditia alta</i> ?. Bloomsburg red member, shale, red and green, impure limestone and red sandstone—bottom 50 to 150 feet.
McKenzie limestone	Limestone and shale; fairly fossiliferous. <i>Kloe-denella</i> abundant.
Clinton formation	Mainly greenish shale weathering purplish. Some sandstone. Thin but workable iron ore beds. Rather fossiliferous. <i>Anoplotheca hemispherica</i> , <i>Beyrichia</i> and many other ostracods.

- Tuscarora
quartzite Thick-bedded white quartzite. *Arthropycus alleghenyensis*, (*harlani*), in upper part. Extensively used for silica brick. Called ganister.
- Juniata
formation Red lumpy shale or mudrock, red and greenish gray sandstone. Some finely cross laminated. No fossils.
- Oswego
sandstone Medium thick-bedded gray sandstone. Some finely cross laminated. No fossils. Bald Eagle sandstone of Grabau. Oneida conglomerate of Pennsylvania Second Geological Survey.




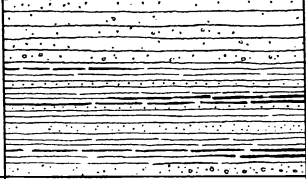
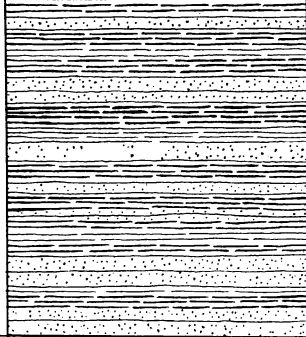
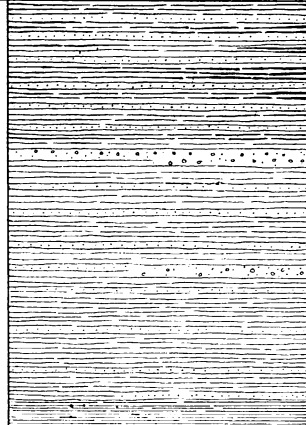
III.

- Reedsville
shale Thick, dark, rusty weathering, sandstone at top with *Orthorhyncula linneyi*, *Byssonichia radiata* and others. Maysville age. Persistent to Tennessee. Shale with thin limestone layers in upper half. Fissile (shoe peg) shale in lower half. *Calymene senaria*, *Dalmanella multisepta*, *Rafinesquina*. Black shale at bottom with graptolites. Eden age.
- Trenton
limestone Thin-bedded black limestone weathering with a gray film on surface. Sparsely fossiliferous. *Cryptolithus tessellatus* = *Trinucleus concentricus*, *Plectambonites sericea*.
- Rodman
limestone Dark crystalline limestone weathering with a rough granulated surface; very characteristic and persistent. Fossiliferous. *Echinosphaerites* zone at top. Upper Black River.
- Lowville
limestone Dark, thick-bedded, pure limestone, glassy to fine-grained. Extensively quarried for flux. *Streptelasma profundum*, *Tetradium cellulorum*, *Beatrecia gracilis*, *Lichenaria typa*?. Lower Black River.
- Carlisle
limestone Dark, fine-grained limestone, extensively quarried for flux. Fossils scarce except in Lemont argillaceous limestone member. *Leperditia fabulites*, *Isochilina amiana*, *Leptaena incrassata* in bottom. *Tetradium syringoporoides* throughout; Lemont member impure, not quarried. *Hebertella vulgaris*, *Rafinesquina champlainensis*, *Protorhynca ridleyana*?, *Maclurites magna*.
- Bellefonte
dolomite Thick-bedded dolomite yielding much dense chert. Fossils scarce.

- Axeman limestone Thin-bedded blue limestone with dolomite layers. Fossils. *Liospira strigata*, *Hormotoma artemesia*, *Hormotoma linearis*, *Dalmanella wemplei*?, *Bolbocephalus seeleyi*.
- Nittany dolomite Thick-bedded, cherty dolomite. Fossils, but not abundant. *Lecanospira (Ophileta) compacta*, *Eccyliopterus planibasalis*, *Eccyliopterus planidorsalis*, *Syntrophia lateralis*, *Cryptozoon steeli*.
- Larke dolomite Thick-bedded, coarse, steely blue dolomite. *Helicotoma uniangulata*, *Lingulella*?
- Mines dolomite Cherty dolomite, oolitic, yields much oolitic and platy scoriaceous chert. *Cryptozoon*, 2 species, common.
- Gatesburg formation Thick-bedded, steely blue, coarsely crystalline, dolomite with many interbedded quartzite layers up to 10 feet thick. Surface deeply covered with sand and strewn with quartzite boulders. Considerable silicified oolite. Ore Hill limestone member, thin-bedded, blue limestone; several species of trilobites nearest relatives of which are in the Hoyt limestone of New York. Stacy dolomite member coarse, thick-bedded, steely blue, but without quartzite.
- Warrior limestone Thick and thin-bedded, blue limestone with thin siliceous shaly layers or partings. A few thin quartzite layers and an occasional bed of limestone full of large well-rounded quartz grains. Some oolite. *Cryptozoon* common. Several species of trilobites. *Millardia avitas*.
- Pleasant Hill limestone Thick-bedded limestone at top, fossils. *Acrocephalites aoris*. Argillaceous thin-bedded limestone at bottom weathering to shale.
- Waynesboro formation Sandstone, conglomerate, and red and greenish shale.

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I.

SYSTEM SERIES GROUP	FORMATIONS	COLUMNAR SECTION	Thickness in feet	MINOR DIVISIONS
MISSISSIPPIAN	Allegheny formation		200±	Homewood sandstone Meron shale Connoquenesing ss
	Pittsville formation		130-280	
	Mauch Chunk shale		180-1000	Loyalhanna-Trough Cr. ls
	Pocono formation		1130-1400	Burgoon sandstone
DEVONIAN UPPER DEVONIAN	Catskill formation		2000-2500	
	Chemung formation		2400-3300	Saxton conglomerate Allegrippis sandstone Pine Ridge sandstone

II.

SILURIAN	MIDDLE DEVONIAN	Portage group	Brallier shale	1350 1800	
			Harrell shale	250	<i>Burket black shale</i> <i>(highly) limestone</i>
		Hamilton formation	800 1200		
	LOWER DEVONIAN	Oriskany	Marcellus shale	150	
			Onondaga form.	50	
			Middleby ss	100	
			Shriver ls	200	
			Helderberg ls.	150	
	CAYUGAN		Tonoloway limestone	450	
			Wills Creek shale	600	
			Mc Kenzie limestone	275 ±	<i>Bloomsburg red member</i>
		NIAGARAN	Clinton formation	800	<i>Keeler ss.</i> <i>Marklesburg ore</i>
			Tuscarora quartzite	400	<i>Frankstown ore</i> <i>Block ore</i>
		MEDINAN	Juniata formation	850	
Oswego sandstone	800				

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III.

ORDOVICIAN	UPPER ORDOVICIAN	Reedsville shale		1000	
	MIDDLE ORDOVICIAN	Trernton limestone		320	
		Rodman limestone		30	
		Lowville limestone		180	
	LOW ORDOVICIAN	Carlism limestone		180	Lemont ls
CANADIAN	BEEKMANTOWN	Bellefonte dolomite		1000	
		Axeman limestone		100	
		Nittany dolomite		1000	
OZARKIAN		Larke dolomite		250	
		Mines dolomite		250	
		Gatesburg formation		1750	Ore Hill ls. Stacy dolomite
CAMBRIAN	UPPER CAMBRIAN	Warrior limestone		250	
		Pleasant Hill limestone		600	
	MIDDLE CAMBRIAN		Waynesboro formation		250+