STRATIGRAPHY, STRUCTURE, AND ECONOMIC GEOLOGY OF PENNSYLVANIAN ROCKS IN WAYNE COUNTY, OHIO

DISSERTATION

Presented in Partial Fulfillment of the Requirements
for the Degree Doctor of Philosophy in the
Graduate School of The Ohio State
University

By

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The Ohio State University
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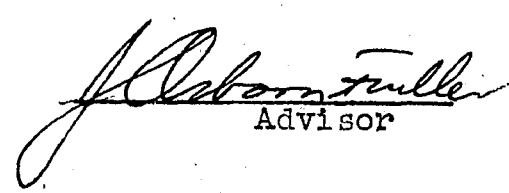

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INTRODUCTION

Location and extent: The area included in this report comprises all or parts of eleven townships located in eastern and southern Wayne County, namely: Milton, Chippewa, Baughman, Sugar Creek, Paint, Salt Creek, Franklin, Wayne, Wooster, East Union, and Clinton. This area is bounded on the east by the 81° 39' meridian and the most westerly outcrop lies approximately along the 82° 04' meridian. On the north and south the area is bounded by the 40° 59' and 40° 40' parallels respectively. The area is mapped on portions of five United States Geological Survey quadrangles, viz.: Wooster, Massillon, Navarre, Millersburg, and Loudenville (see index map, Figure 1), and comprises about 130 square miles. Wayne County is a gently rolling, maturely dissected part of the glaciated Appalachian Plateau on the west flank of the Appalachian geosyncline.

Purpose of the report: At the present time there is no published information adequately describing and correlating the rock formations of Pennsylvanian age that are exposed in the county. This study is part of the current program of the Ohio Division of Geological Survey to map and show the economic features of the rocks of the state in detail.

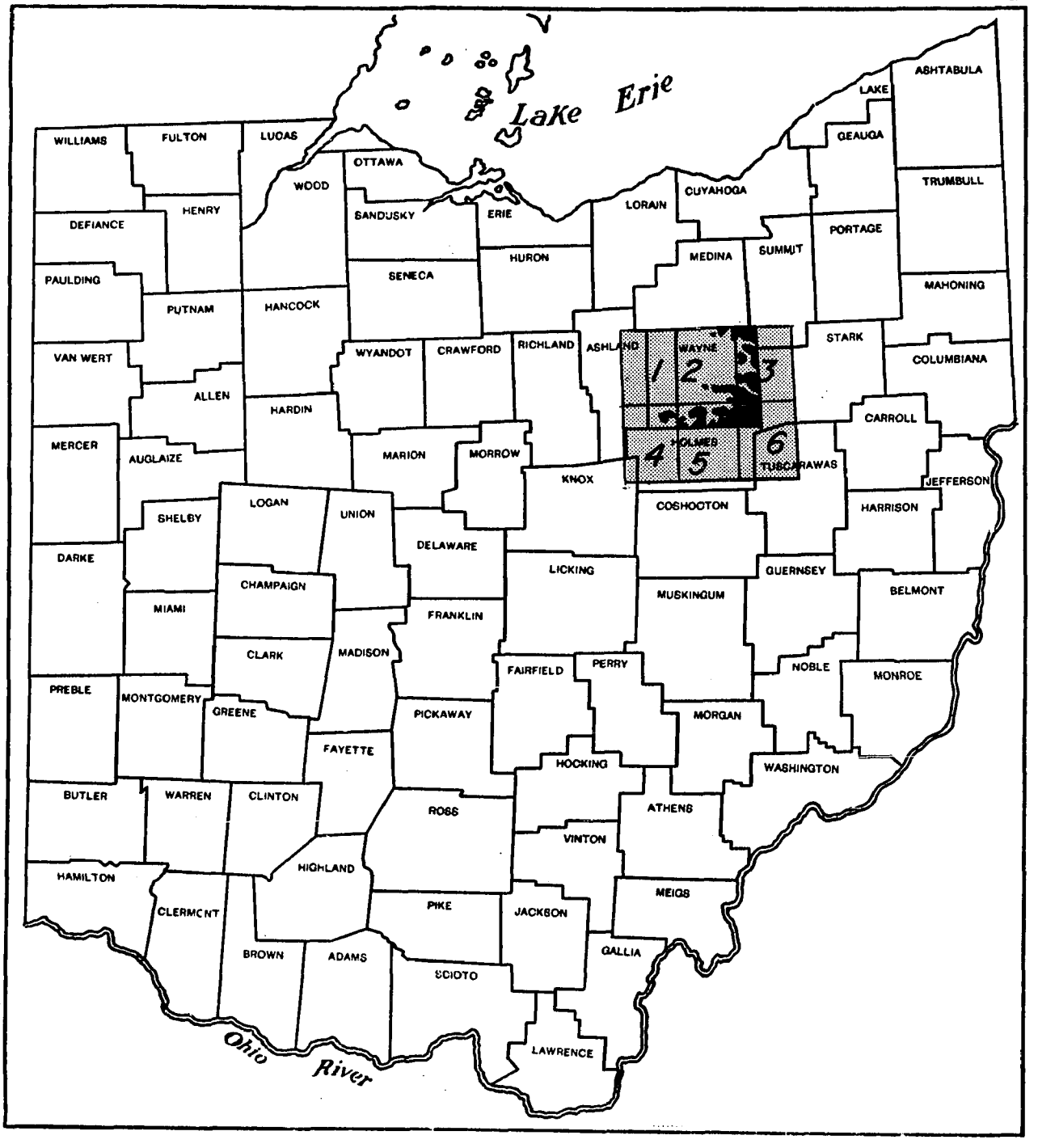

Figure 1 Extent of area; pertinent United States Geological Survey quadrangles indexed as follows: (1) West Salem, (2) Wooster, (3) Massillon, (4) Loudonville, (5) Millersburg, (6) Navarre.

Methods of study: Field work for the present study was conducted by the writer during the summers of 1953 and 1954. The areal geologic map (Plate IV) is based primarily on outcrops, with some control, approximately 30 percent being based on logs of coal-exploration test wells (cores and cuttings), and approximately 2 percent on logs of water wells. Exposures were sometimes insufficient to allow drawing of stratigraphic boundaries in the field because of thick glacial drift cover. In such cases the boundary lines were drawn by connecting elevations of a given contact on the base map using well information and structural contours as supplementary aids. Where the Mississippian-Pennsylvanian contact line could not be found in the field or located by using well logs, the line drawn by G.F. Lamb[1] was accepted.

Repetitious lithologies within relatively short vertical stratigraphic range made accurate measurements of elevations of each crop and well site imperative. Plane table, altimeter, and hand level were employed for these measurements in the field. Cross-section and panel diagrams, isopachous and structural contour maps were constructed to interpret stratigraphic and structural relationships.

Previous studies and acknowledgments: M.C. Read (1887, pp. 529-539) wrote the first discussion of the general geology

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[1]Field maps of G.F. Lamb (1912-1916) in the files of the Ohio Geological Survey.

of Wayne County in a brief report of coal deposits within the county. A soils map and geological report of the Mississippian, Pennsylvanian and surficial Pleistocene deposits of Wayne County by G.W. Conrey was published in 1921. These constitute the only known publications dealing with the Pennsylvanian of Wayne County to date.

The author wishes to acknowledge the contributions of the following individuals and organizations who aided in the preparation of this report. Dr. J.O. Fuller originally proposed the problem, advised the writer in the field, and guided the writing of this report. Miss Pauline Smyth identified fusulinids from all limestone samples. Messrs. R.A. Brant and W.H. Smith provided helpful discussion and guidance in the final writing of this report. Dr. H.H. Gray willingly discussed problems and gave assistance in the field during the first field season. Thanks are due to R.E. Bowman for advice and use of his photographic laboratory enabling the reproduction of all included photographs. Messrs. Atlee and Emanuel Mullet, coal and limestone operators, Mt. Eaton and Berlin, Ohio, kindly made all their pertinent exploratory well data available. Thanks are due Drs. R.L. Bates and A. LaRocque for aid in editing the manuscript. Barbara Multer encouraged the author throughout the project and gave assistance in proof reading the final report.

The Ohio Division of Geological Survey sponsored this

project for two summers in the field. A Grant-In-Aid from the Ohio State University sponsored the project for the academic years 1953-54 and 1954-55.

STRATIGRAPHY

Introduction: Pennsylvanian rocks of Wayne County are of Pottsville and Allegheny ages, and consist, in order of relative abundance, of sandstones, shales, clays, limestones and coals. The oldest unit is a ferruginous or conglomeratic sandstone at the base of the Pottsville; the youngest unit is the sandstone or shale above the Middle Kittanning coal of upper Allegheny age. This interval comprises an average of 375 feet of geologic section and represents fluviatile, swamp, and at least three successive marine environments. No "fresh-water limestones" were observed in Wayne County.

The area under study has been glaciated,[1] and therefore exposed rocks consist of isolated sedimentary cycles or parts of sedimentary cycles which crop out in stream gullies, road cuts, and along several strip mine faces. In some areas (e.g. Mt. Eaton and Burton City) the integration of data from exploratory wells for coal with surface mapping makes possible detailed stratigraphic analyses (see Plate I). Detailed analysis in areas of obscured outcrops was impossible, however, and contact lines were drawn, by necessity, on the basis of available well information and structural contour

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[1] For a map of these deposits see Conrey, 1921.

map data.

The best key beds for correlation are the three limestones: Putnam Hill, Upper Mercer, and Lower Mercer. With the exception of the Lower Mercer, these limestones are very persistent. The Putnam Hill limestone carries a diagnostic Fusulinella species distinct from the Fusulinella forms of the two underlying Mercer limestones. Thirty-six limestone samples were collected for faunal analysis by Miss Pauline Smyth of the Ohio Geological Survey. Results of her analyses from 21 localities are given in Table 1, and pertinent photomicrographs in Figure 2. Megafossils found in the three limestones of Wayne County and identified by Morningstar are listed by Conrey (1921, pp. 105, 109, and 115).

In Wayne County it is necessary to study as a unit the sequence of rocks between the more persistent limestones and coals, instead of individual beds, because (1) lensing-out and radical facies changes occur in all types of mapped rock types, (2) few measured sections or well logs exhibit more than one coal or limestone, and (3) a single coal bed in one section may be represented by two distinct coals in an adjacent local basin. Accordingly, the term cyclothem (Wanless and Weller, 1932) will be used in this report as a unit of subdivision, embracing that sequence of sediments from the top of one coal to the top of the succeeding coal. This interval commonly, but not necessarily, shows an ascending sequence of marine to fluviatile conditions of

TABLE 1

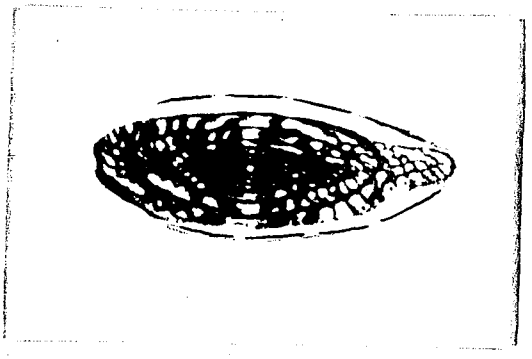
Location data for *Fusulinella*-bearing limestones

LIMESTONE HORIZON	COUNTY	TWP. & SECTION	FIELD LOCATION	SPECIES OF *FUSULINELLA*	INDEX NUMBER
Putnam Hill	Wayne	Sugar Ck. cen NE¼ 13	In field crop approx. 2000' NW of 1230' road corner	*serotina*	104
" "	"	Paint SW¼SE¼ 9	Rt.# 250 rd crop, ⅓ mile NW Mt. Eaton	*serotina**	45
" "	"	Paint SW¼NE¼ 24	At small lime-stone quarry	*serotina* ?	70
" "	"	Franklin NW¼NW¼ 22	In limestone quarry	*serotina**	90
" "	Holmes	Paint NE¼NE¼ 28	Along souther-ly extending lane, approx. 1200' W of NE corner sec.	*serotina**	68
Upper Mercer	Wayne	Baughman SE¼SE¼ 24	Rd. cut near top of steep hill.	*iowensis**	46
" "	"	Sugar Ck. SE¼NW¼ 14	Rd. cut approx. 500' west of T-rd. intersect.	*iowensis* ?	95
" "	"	Sugar Ck. NE¼SE¼ 14	Bottom gully just S of rd.	*iowensis**	98
" "	"	Sugar Ck. NW¼SW¼ 27	In stream gully approx. 700' SSE of 1145' road corner	*iowensis*	101
" "	"	Paint NE¼NE¼ 5	Near top of bank of stream cut	*iowensis**	93

TABLE 1
(Continued)

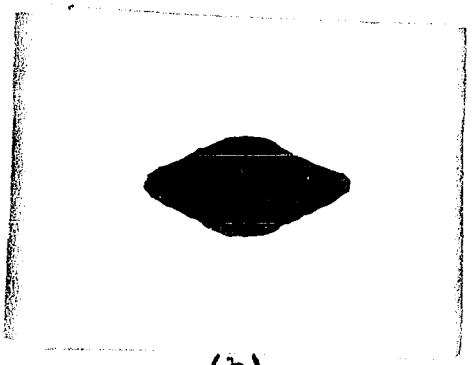
LIMESTONE HORIZON	COUNTY	TWP. & SECTION	FIELD LOCATION	SPECIES OF FUSULINELLA	INDEX NUMBER
Upper Mercer	Wayne	Paint NW¼NW¼ 10	Road cut near top of hill	iowensis*	72
" "	"	Paint SE¼NW¼ 24	Rt. #250 road cut	iowensis	61
" "	"	Salt Ck. NW¼SW¼ 3	In gully approx. 1000' east of N-S section line road	iowensis*	87
" "	"	Salt Ck. NE¼SE¼ 4	In stream cut 20' SE of black top road	iowensis	89
" "	"	Salt Ck. NW¼SE¼ 9	At stream cut just SW of bridge	iowensis	86
" "	"	Franklin SE¼SE¼ 21	Near top of hill in road cut	iowensis	92
" "	Stark	Tusca-rawas NW¼NW¼ 6	In gully approx. 300' SE of NW cor. of section	iowensis	100
Lower Mercer	Wayne	Sugar Ck. SW¼SW¼ 33	In SW bank of flat valley terrace	iowensis	102
" " ?	"	Paint NE¼SE¼ 13	Small abd. quarry NE fr farm buildings	iowensis*	67
" "	"	Paint SW¼NW¼ 23	In gully just S of farm house	iowensis*	71
" "	Stark	Lawrence SE¼NW¼ 18	Rd. cut near top of hill	iowensis	105

*Identification by thin section, all others identified in hand specimen.



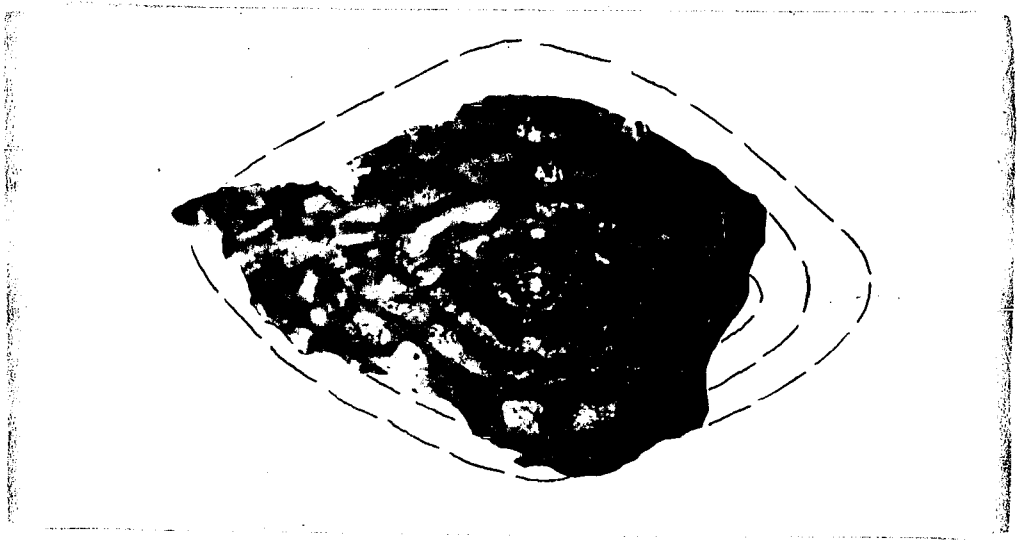
(a)

F. serotina
(Thompson)
x 20



(b)

F. iowensis
(Thompson)
x 12



(c)

F. iowensis
(Thompson)
x 45

Figure 2. Representative specimens of Fusulinella from Putnam Hill and Mercer limestones: (a) thin-section from Putnam Hill; (b) photomicrograph from Lower Mercer before sectioning; (c) same specimen as in (b) after sectioning under higher magnification. Photographs from negatives furnished by Miss Pauline Smyth.

sedimentation. Cyclothems bear the name of the coal at their top. It should be noted at the outset that most of the cyclothems in Wayne County are lenticular. The Lower Kittanning, Brookville, and Bedford cyclothems are the most persistent.

The general stratigraphic sequence of named beds or formations included in this report is listed below, from the youngest to the oldest.

Allegheny Group
- Middle Kittanning coal
- Lower Kittanning coal
- Putnam Hill limestone
- Brookville coal

Pottsville Group
- Tionesta coal
- Upper Mercer limestone
- Bedford coal
- Upper Mercer coal
- Lower Mercer limestone
- Middle Mercer coal
- Flint Ridge coal
- Lower Mercer coal
- Vandusen coal
- Bear Run coal
- Quakertown coal
- Anthony coal
- Sharon coal
- Sharon conglomerate (Harrison ore)

These units are identified on the basis of fossil content, lithology, or stratigraphic succession. The Putnam Hill limestone of Wayne County carries the diagnostic Fusulinella serotina (Thompson) and can be traced by outcrop into Holmes County where it is mapped by White (1949). Both the Upper and Lower Mercer limestones carry the diagnostic Fusulinella iowensis (Thompson), and the Upper Mercer can be traced by successive outcrops into Holmes County. The Lower Mercer is usually below drainage. Although lithologically similar to the Lower Mercer, the Upper Mercer is commonly flinty.

The Middle Kittanning, Lower Kittanning, and Brookville coals of Wayne County, together with their immediately associated rocks, are commonly lithologically distinct and are very persistent in occurrence and altitude. The Brookville and Lower Kittanning coals can be traced by successive outcrops and well data into Holmes County where they correspond to similar mapped units of White (1949). The remainder of the named units are designated on the basis of their stratigraphic succession from the above-mentioned known horizons, using the generalized section of rocks for Ohio (Stout 1947).

POTTSVILLE GROUP

General statement and stratigraphic relations: Strata belonging to the Pottsville Group make up an average of 291 feet of the oldest and lowest beds of Pennsylvanian age in Wayne County. This group includes those beds between the

top of the Mississippian rocks and the base of the Brookville coal. Rocks of the group are exposed in Milton, Chippewa, Baughman, Sugar Creek, Paint, East Union, Salt Creek, Wayne, Wooster, Franklin, and Clinton townships. The dominant rock type is sandstone; finer clastics, limestones, and coal beds occur more commonly in the upper portion of the Pottsville group. Besides numerous sandstones and shales, the Pottsville of Wayne County is known to contain 11 coal beds, 12 underclays, 2 marine limestones, at least one ore bed, and one conglomerate or conglomeratic sandstone. The upper diagnostic units (coals and clays) of individual cyclothems in Wayne County are often lenticular. When such pinching-out occurs, the remaining sediments, if any, of a cyclothem are usually indistinguishable from, and therefore grouped with, the next overlying identifiable cyclothem.

Basal Pennsylvanian contact: The Mississippian-Pennsylvanian contact of northeastern Ohio represents a surface of considerable relief and disconformity (Lamb, 1911, pp. 104-109). In Wayne County the basal Pottsville lies disconformably on the Cuyahoga and Logan formations of Osagean and Kinderhookian (?) age respectively (see Plate I). The Maxville limestone (Meramecian age), present in central Ohio, is not found in Wayne County, although cherty, fossiliferous pebbles found locally in basal Pennsylvanian Sharon conglomeratic sandstone may possibly represent detritus from

Figure 3. Mississippian-Pennsylvanian contact with horizontal Mississippian siltstone (lower left) overlain disconformably by slightly dipping Pennsylvanian conglomeratic siltstone, interbedded carbonaceous sandstone and shale, all overlain by Quakertown? shaly coal. Pre-Quakertown cut and fill and post Quakertown slump and/or differential compaction along edge of local basin is believed responsible for small angular dip relationships within Pottsville between A and B. Stream cut NW¼ SE¼ of section 21, Sugar Creek township. (Dashed lines indicate relative dip of bedding).

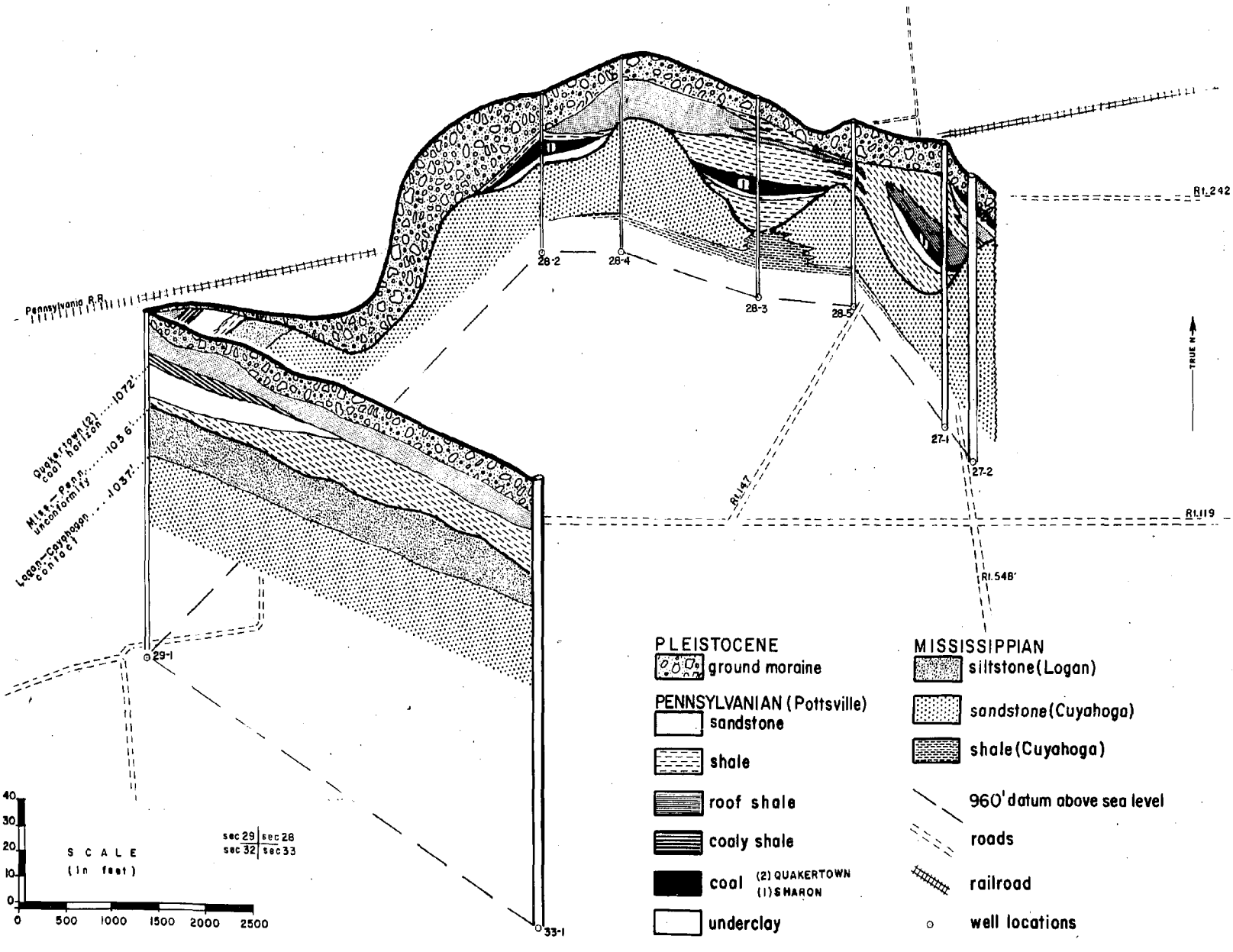


PLATE I

PANEL DIAGRAM ILLUSTRATING LOCAL BASINS OF BASAL POTTSVILLE SEDIMENTATION ON A MISSISSIPPIAN EROSION SURFACE AT BURTON CITY, WAYNE COUNTY, OHIO

HGI

the Maxville.

A structure contour map (Plate II) on the unconformable Mississippian-Pennsylvanian contact, with distribution of Mississippian formations noted, helps to illustrate several significant features of this surface:

(1) lower Pottsville beds overlie Mississippian beds from the top of the Logan siltstone of Osagean age in southern Wayne County down to Cuyahogan sandstone of Kinderhookian (?) age in northeastern Wayne County;

(2) the maximum mapped relief found on the Mississippian erosional surface in Wayne County is 269 feet, measured between two outcrops 10 miles apart in the southeastern part of the county;

(3) the average slope of this unconformable surface within the county ranges between 25 and 40 feet to the mile in a southeast direction;

(4) a dendritic pattern of channel-like depressions ("valleys") is believed present, but a more regional study will be necessary to evaluate this feature properly;

(5) the direction of drainage within the "valleys" cut on the Mississippian erosional surface appears to be to the southeast in Wayne County;

(6) comparison of the relief and structures present on the surface of the Berea sandstone with those on the Mississippian-Pennsylvanian disconformable surface indicates both superimposed similarities (east Clinton, north Franklin, and north Baughman townships) and dissimilarities (Salt Creek, Paint, Sugar Creek, and Chippewa townships) of surface features. Definite proof of the influence, if any, of the Berea surface on the configuration of the overlying Mississippian-Pennsylvanian surface must await more regional comparisons of these two surfaces. However, it should be noted that the Mississippian-Pennsylvanian disconformable surface fails to reflect the configuration displayed by the Berea surface over a considerably larger

Figure 4. The Mississippian-Pennsylvanian contact, with Sharon conglomeratic sandstone resting on Logan siltstone; at Springtown roadcut, in the SW¼ SW¼ of section 18, Franklin township.

area than that area in which the two surfaces appear to have somewhat similar trend. This fact suggests that where the configuration of the two surfaces is similar either (a) the similarity is only by chance or (b) the Berea surface only locally influences the overlying disconformable surface.

Field observations helped establish the following additional significant features relating to this unconformable surface:

(7) Mississippian "valleys" are both parallel oblique and normal to present-day drainage channels;

(8) basal Pennsylvanian beds up to and including the sandstone below the Upper Mercer ? (or younger) coal are in places found abutting against local Mississippian residual highs ("hills"; see Plate I and Figure 5);

(9) on the tops of the Mississippian "hills" and flatter "upland" surfaces, the unconformable contact most commonly shows Pennsylvanian sandstone and shale on Logan siltstone or Cayuhoga sandstone;

(10) within the deeper "valleys" the contact is represented by Pennsylvanian Sharon conglomerate and/or conglomeratic sandstone resting on Cuyahoga sandstone or Logan siltstone (see Figure 4);

(11) slump and differential compaction are common at or just above the Mississippian-Pennsylvanian contact where the contact occurs on the flanks of Mississippian "hills" (Figure 3 and Figure 5).

Harrison ore: The Harrison ore was first named by Stout (1916, p. 481) for the iron ore or the clay and iron-cemented, flinty sandstone at the very base of the Coal Measures in Harrison township, Scioto County, Ohio. He noted also that in some places this ore may merely be the iron-cemented basal conglomerate of the Sharon rather than

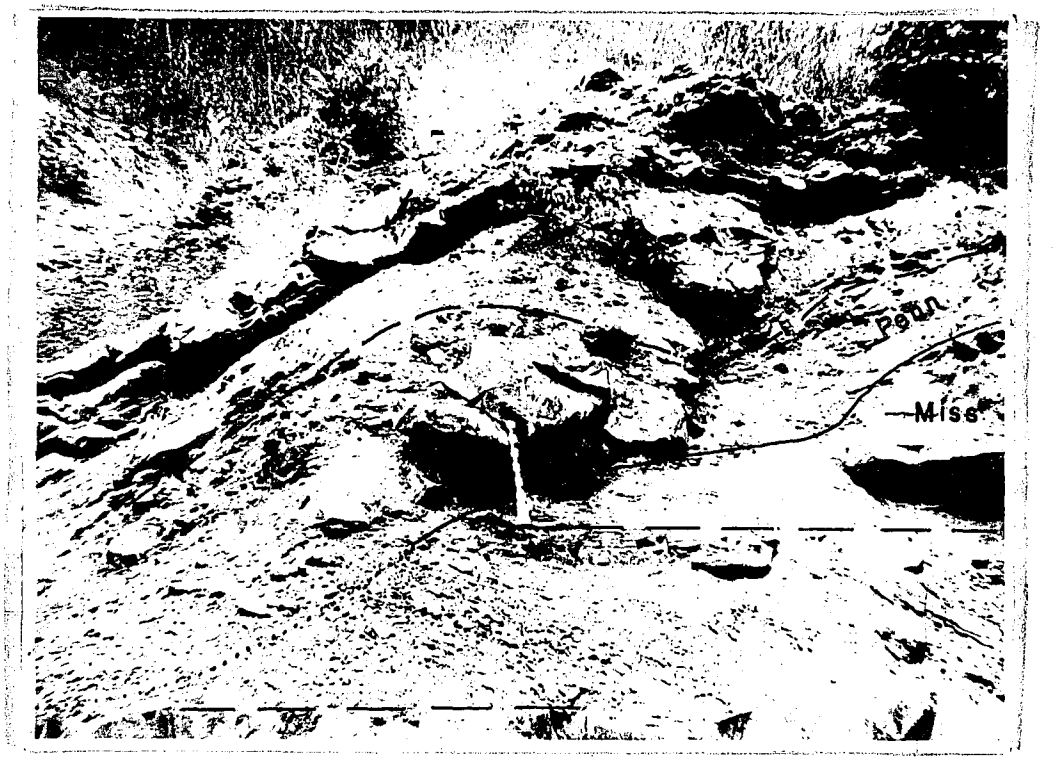


Figure 5. Mississippian-Pennsylvanian unconformity with slumped and differentially compacted Pennsylvanian interbedded shale and coaly sandstone disconformably resting on Mississippian Cuyahoga ? sandstone; at railroad cut in the NE¼ SW¼ of section 33, Chippewa township. (Dashed lines indicate attitude of bedding).

a true ore stratum in itself. In Wayne County, varieties of all three rock types appear at the base of the Pennsylvanian.

The Harrison ore is most commonly found in Wayne County as either an impure sandy, argillaceous, nodular ore up to 2 or 3 inches thick (#12859)[1] or as a heavily iron-bonded, fine grained, silty sandstone (#12652).

Where the Sharon conglomerate is found in southwestern Wayne County, the basal conglomerate bed carries fragments of iron ore and cherty, weathered, rarely fossiliferous limestone up to 2 inches in diameter and is commonly heavily stained with iron oxide (#12864, #12851, and Figure 4).

The Harrison ore, found along the contact of the Mississippian-Pennsylvanian rocks, represents a bed of variable age in Wayne County. It can be found from the base of the Sharon conglomerate up to and including a zone within the sandstone below the Upper Mercer ? (or younger) coal, where such sandstone rests disconformably on Mississippian residual "hills".

Interval between the base of the Pottsville and the top of the Quakertown coal

General statement and stratigraphic relations: This interval includes the Sharon, Anthony, and Quakertown coals and their

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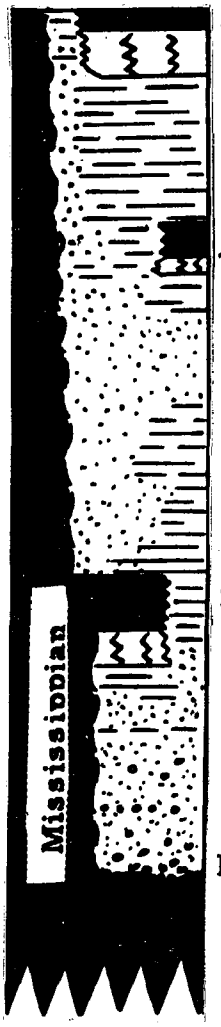
[1]All sections referred to in the text are indicated in this manner and may be found listed in numerical order in the Appendix. These sections are usually employed to illustrate and locate only one of many possible examples of the stratigraphy under discussion. All sections may be found listed by these same numbers in the files of the Ohio Division of Geological Survey, Columbus.

associated rock types as shown in Figure 6. The dominant arenaceous lithology of this interval, together with the characteristic lenticularity of its coals and cyclothems, is believed to reflect the great irregularity of the underlying Mississippian disconformable surface. Although the average thickness of this interval is 86 feet, its basal disconformable contact causes variations from 0 to 119 feet in local areas. The upper contact of the interval appears either conformable, with roof shale over the Quakertown coal, or disconformable with sandstone cutting out the coal and the underlying clay.

Nomenclature and correlations: Nomenclature within this interval is tentative, as it is based on stratigraphic succession either from known overlying Pottsville limestones or from reported Sharon coal horizons and mines. Sharon coal mines in northeastern Wayne County are discussed by Read (1878, pp. 536-538), Orton (1884, pp. 789-796), and Conrey (1921, pp. 95-97). In the general stratigraphic column of Ohio, Stout (1947) lists two coals (Huckleberry and Anthony) between the Quakertown and Sharon coal horizons. The presence of only one coal was established with certainty as superimposed in any one section between the Quakertown and Sharon coals of Wayne County. The existence of two or more coals between the Sharon and Quakertown is however possible; notable irregularities of elevation and rock types associated with coals within this



	Feet/Tenths
Quakertown coal	1.9 (.5 - 3.3)
clay	5.0 (0 - 10.0)
	14.2 (12.0 - 20.0)
Anthony coal	2.8 (0 - 6.4)
clay	1.8 (0 - 4.0)
	30.2 (21 - 50)
Sharon coal	5.1 (0 - 8.0)
clay	3.1 (0 - 11.0)
	21.8 (0 - 97)
Harrison ore	1 inch (0 - 3")

Figure 6. Diagrammatic section of the interval between the base of the Pottsville and the top of the Quakertown coal. Figures before the parentheses represent average intervals or thicknesses. Figures within the parentheses represent maximum and minimum thickness range of units and intervals. The common presence of Mississippian residual "hills" is indicated along the left edge of the columnar section.

interval have been commonly noted in the field and in well records. Designation of the one proven coal horizon between the Quakertown and Sharon as Anthony should be therefore considered tentative because it is based only on the interval above the Sharon coal and on the fact that it is the first coal encountered above the Sharon coal; no other significant data are available.

A study of White's (1949, pp. 70, 295-296) sections indicates that in Prairie township, Holmes County, just south of Wayne County, there appears to be a northerly rise in elevation of the Quakertown coal, up to 15 feet per mile. If a similar or even more gentle rise continues some 3 to 7 miles to the north, the elevations as well as lithologies of the Quakertown in Holmes County could favorably compare with five Quakertown horizons found in sections 3 and 13 of Franklin township, Wayne County. The average elevations of the above mentioned five Quakertown coal horizons is 125 feet below the Upper Mercer limestones in Wayne County, and is comparable with the 108-foot average of three similar intervals listed by White (1949, pp. 70, 294-296), for Prairie township, Holmes County. Such comparisons of intervals, lithologies, and elevations must be considered strictly tentative as considerable variations of altitudes and lithologies occur within both counties.

Sharon cyclothem

Definition and distribution: The Sharon cyclothem includes rocks from the base of the Pottsville to the top of the Sharon (#1 or Massillon) coal. This cyclothem is found locally persistent only in Chippewa, Baughman, Sugar Creek, Paint, Franklin, and Clinton townships.

Stratigraphic relations and thickness: The common lenticularity of this cyclothem is a result of deposition in the deeper "valleys" of the Mississippian erosional surface which everywhere forms its basal disconformable contact. Where erosional "valleys" are not present, the complete Sharon cyclothem is usually absent (see Plate I, well # 29-1). Where shallow Mississippian erosional valleys are present, only the upper portions of the cyclothem may be present (see Plate I, well # 28-2). Because of the erratic deposition of the Sharon upon a Mississippian surface of considerable relief, the thickness of this cyclothem is highly variable. Measurements from eight sections and wells show a thickness range of 0 to 97 feet, with an average of 25 feet.

Lithology: The rocks of the Sharon cyclothem are dominantly arenaceous. The basal beds consist of conglomerate or conglomeratic sandstone, usually of high purity, resting disconformably on Mississippian Logan siltstone (see Figure 4) or Cuyahoga sandstone. This conglomeratic phase crops

Figure 7. Sharon conglomeratic sandstone displaying thick bedding (above) and thinner planar cross bedding (below). Outcrop located along Chippewa Creek, SE¼ SE¼ of section 22, Chippewa township.

out in Chippewa, Franklin, and Clinton townships only. Thick to medium, planar cross-bedded, medium to coarse, well sorted, clean sandstone characterizes the middle portions of this cyclothem. A locally developed clay shale, impure underclay, and thick, hard, bright, very lenticular coal mark the upper portions of the cyclothem. Both coal and underclay may grade abruptly (within 10 feet) into black silty shale and carbonaceous silty sandstone, respectively. Read (1878, p. 533) notes one area where the coal is found in two benches separated by 5 feet of conglomerate.

Anthony cyclothem

Definition and stratigraphic relations: The Anthony cyclothem includes rocks from the top of the Sharon coal up to the top of the Anthony coal. The recognition of this cyclothem in the field or in well descriptions is dependent upon the presence of the highly lenticular Anthony coal at its top. When the Anthony coal is missing the sediments included within this cyclothem are indistinguishable from, and therefore grouped with, the overlying more persistent Quakertown cyclothem.

Distribution and thickness: The Anthony cyclothem is found locally in Baughman, Sugar Creek, and Franklin townships. Conrey (1921, pp. 97-98) described two exposures of tentatively correlated Sciotoville clay in Wayne County which

Figure 8. Contact between two common Sharon sandstone phases; planar cross-bedded conglomeratic sandstone (above) and massive well sorted clean sandstone (below). Picture taken along abandoned sand quarry face in the NE¼ NE¼ of section 25, Chippewa township.

would be equivalent to the clay under the Anthony coal. The clay he described west of Fredericksburg was not exposed when the present writer examined the section (#12866); White (1949, p. 58) also does not indicate the presence of the clay here. The second exposure described by Conrey, just southeast of Fredericksburg, is identified by the present writer, on the basis of elevations and stratigraphic succession, as the clay under the Vandusen coal.

The average thickness of the Anthony cyclothem is approximately 37 feet, with a range in thickness of 21 to 61 feet.

Lithology: The rocks of the Anthony cyclothem are dominantly arenaceous. Both fine to medium grained, clay-bonded, thin-bedded sandstone (#12635 and Figure 9) and black "slate" and carbonaceous shale are found at the base of the cyclothem directly overlying the Sharon coal. Very fine grained, clay-bonded sandstone appears to characterize the middle portions of the cyclothem. Interbedded dark gray silty shale and fine grained, clay-bonded sandstone are the most common rocks found below the lenticular Anthony coal and its impure (Sciotoville) underclay or clay shale (#12855). A thin ferruginous nodular bed or thin ore zone was found in two sections (#12859 and #12855) approximately 4 feet below the coal.

Figure 9. Medium to fine grained, poorly sorted, planar cross-bedded sandstone which rests with sharp contact on Sharon coal just inside abandoned mine entry at the bottom of the picture; in the SE¼ SE¼ of section 24, Chippewa township.

Quakertown cyclothem

Definition, distribution, and thickness: The Quakertown cyclothem includes those rocks from the top of the Anthony coal to the top of the Quakertown coal. Rocks of the Quakertown cyclothem occur in Chippewa, Baughman, Sugar Creek, Franklin, and Clinton townships. This cyclothem is considerably more widespread and unrestricted than the underlying cyclothems. The reason for this sheet-like distribution is that the sediments of the Quakertown cyclothem were less restricted by the relief of the underlying Mississippian dissected surface, which had been considerably subdued and filled in by the time of Quakertown deposition. The average thickness of the Quakertown cyclothem is 22 feet, with a range of 20 to 30 feet.

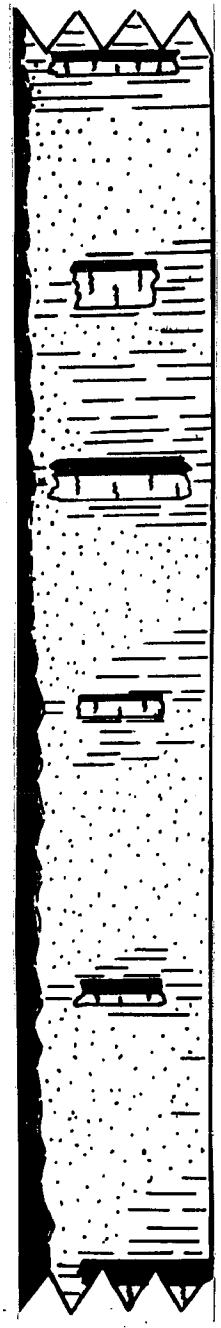
Lithology: Although exposures and well data are limited, the dominant rock type of the Quakertown cyclothem appears to be shale, in contrast to the underlying dominantly arenaceous Anthony and Sharon cyclothems. Thin bedded silty and clay shales with occasional thin limonitic seams are the most common rock types in the lower portions of the Quakertown cyclothem. A 3-foot sandstone bed is reported at the very base of the cyclothem, overlying the Anthony coal, in one well in Sugar Creek township (#677). Sandy clay shale and silty shale appear to make up the bulk of the middle portions of this cyclothem. A light gray,

Figure 10. Quakertown ? coal and shaly coal cropping out in creek bottom, overlain by fine grained silty sandstone and shale and underlain by fine grained clay-bonded sandstone. Outcrop located in the NE¼ SW¼ of section 21, Sugar Creek township.

slightly plastic, commonly sandy underclay is usually found under the Quakertown coal at the top of the cyclothem. In Sugar Creek township the Quakertown (?) coal can be observed grading into shale; the underlying clay interval is represented by a clay-bonded, fine grained sandstone (#12644 and Figure 10). The Quakertown coal is more persistent in lateral extent and thickness than the underlying Sharon or Anthony; it has been commonly referred to as the "rider vein" by drillers who look for the Quakertown as a persistent marker when drilling for the underlying Sharon coal.

Interval between the top of the Quakertown coal and the top of the Middle Mercer coal

General statement and stratigraphic relations: This interval includes in ascending order the Bear Run, Vandusen, Lower Mercer, Flint Ridge, and Middle Mercer coal beds and their associated sediments, as shown in Figure 11. Cover by glacial drift allows only fragmentary mapping of rocks within this interval. Field work has established, however, that all of the coals are highly lenticular and that their associated rocks show both facies change and vertical gradations. It should be noted, therefore, that recognition of cyclothems within this interval necessitates the presence of an overlying identifiable coal horizon. As the lithology between individual coals is usually not diagnostic, the absence of one or more superimposed coal beds results in the



	Feet/Tenths
Middle Mercer coal	.5 (0 - 1.5)
clay	1.5 (0 - 3.2)
	17.7 (11 - 23)
Flint Ridge coal	.8 (0 - 1.0)
clay	4.0 (0 - 6.9)
	14.0 (10 - 35)
Lower Mercer coal	1.0 (0 - 3.5)
clay	2.3 (0 -5.9)
	20.2 (17.2-20.2)
Vandusen coal	.5 (0 - 1.2)
clay	1.7 (0 - 3.2)
	25.7
Bear Run coal	.6 (0 - 2.0)
clay	1.8 (0 - 3.1)
	28.2 (26.2 - 30.2)
Quakertown coal	

Figure 11. Diagrammatic rock section between the top of the Quakertown coal and the top of the Middle Mercer coal. The local presence of Mississippian residual "hills" is indicated along left margin of columnar section. Average interval or thickness is indicated before parentheses; range of thicknesses and intervals is given within parentheses.

joining or merging of cyclothems. Such confluence is common in Wayne County and has been described by Gray (1954, p. 58) within this same interval in the Beach City area, southeast of Wayne County. When confluence takes place, the identification of individual cyclothems is very difficult and accuracy varies inversely with the distance from the last identifiable coal horizon.

In a few localities, such as the northwestern portion of Salt Creek township, the rocks of this interval are found abutting against Mississippian residual hills of either Logan siltstone or Cuyahoga sandstone.

Distribution: Rocks of the Middle Mercer - Quakertown coal interval have a broader distribution than those of pre-Quakertown age. They are found in all townships showing Pennsylvanian rocks (with the possible exception of Wooster township, where a single outlier is of doubtful pre-Middle Mercer coal age). This interval appears to be spread as a blanket-like deposit over most of the area under study.

Nomenclature and correlations: Nomenclature within the interval between the Quakertown and Middle Mercer coals is based primarily on stratigraphic succession from the overlying Mercer limestones. As field evidence has failed to establish any unique characteristics for any one of the cyclothems within this interval, the validity of correlation varies directly with the proximity to an overlying Mercer

limestone or known coal horizon.

Tentative correlation with some units mapped by White (1949) in Holmes County was also attempted whenever possible. Some of these attempts are listed below.

(1) White (p. 88) notes the Vandusen at approximately 1050 feet elevation resting 51 feet below the Bedford coal bed in western section 13, Prarie township, Holmes County; this elevation and interval correspond with that of a Vandusen (?) coal found approximately 5 miles to the northwest in section 21 of Franklin township in Wayne County, where the Vandusen (?) coal is found at an elevation of 1060 feet lying some 50 feet below the Bedford coal (#12868).

(2) Another comparable Vandusen-Bedford interval and associated sediments is reported by White (p. 295) approximately 2½ miles to the southeast of the above-mentioned (1) Wayne County outcrop; the Holmes County outcrop is in section 1 of Prarie township.

(3) White (p. 98) describes the top of the Flint Ridge (?) clay at a road crop in the NE¼ NW¼ of section 25, Ripley township, Holmes County, along the Holmes-Wayne County line road at an elevation of 1129 feet.

(4) The closest Holmes County horizon of Flint Ridge coal to a similar horizon in Wayne County is noted by White (p. 99) who "hesitatingly identified" the Flint Ridge coal just east of Fryburg about 11 miles southwest of the Wayne County outcrop. The elevations (1090 feet - Holmes, vs: 1115 feet - Wayne) are comparable; the interval of 9 feet between the Flint Ridge and Middle Mercer coal in Holmes County is less than the 22-foot interval in section 24, Paint township, Wayne County.

Other similar, commonly more distant, comparisons made between Holmes and Wayne County appear to both agree and disagree in elevations and intervals. However, it should be emphasized that all correlations made below the Pottsville

limestones, such as those noted above, are strictly tentative. Such tentative designation is necessary for they are based only on (1) proximity of elevations and intervals which have been found to vary within both Holmes and Wayne Counties and (2) on similar lithology, which only rarely, if ever, is found to be consistent over wide areas.

Massillon sandstone

General statement and stratigraphic relations: The Massillon sandstone represents a discontinuous Pottsville sandstone of wide lateral extent and varying vertical stratigraphic range. White (1949, p. 78) notes that:

> In Ohio, the Massillon sandstone is found in all counties in which lower Pottsville strata crop out, and it is present under cover to the eastward, down the dip, as the "Salt Sand" of the oil driller. It is named from prominent outcrops near Massillon, in Stark County, where it has been quarried in the past.

White (ibid.) also notes that the Massillon sandstone in Holmes County extends stratigraphically from the Quakertown up to at least the Vandusen coal and thins and is replaced by shale in a northerly (Wayne County) direction. It ranges in thickness from paper-thin to 91 feet thick and is coarse, iron and clay cemented, and generally thick-bedded to massive; it is locally cross bedded with occassional pebble bands in its basal portions.

Gray (1954, p. 4) found in the Beach City area, just southeast of Wayne County, that the Massillon has an even

greater stratigraphic range (Bear Run coal up to the sandstone beneath the Bedford coal). He also indicated (p. 38) a wide range in clay content, sorting, and bedding characteristics.

In Wayne County isolated sandstone intervals can be found extending from the top of the Quakertown coal up to a zone beneath the Bedford clay of upper Pottsville age. These sandstone outcrops are most commonly represented by a medium to dark brown, medium to fine grained, clay bonded sandstone in thin to thick beds, commonly displaying either planar or cut-and-fill cross bedding (see Figures 12 and 13 and corresponding sections #12656 and #12639). For a more detailed description of sandstones between cyclothems see sections illustrating the following discussions of individual cyclothems.

Nomenclature and correlations: Lack of sufficient stratigraphic controls and outcrops limit conclusions as to the genetic relationships of the isolated sandstone bodies in Wayne County. Lack of definite stratigraphic range or unique petrographic characteristics for sandstones of this interval described outside of Wayne County preclude definite correlations with such areas. However, sandstone is found in Wayne County which is similar to that described and included within the stratigraphic range of the Massillon sandstone discussed by White (1949) in Holmes County and by Gray (1954) in the Beach City area. This sandstone, within the

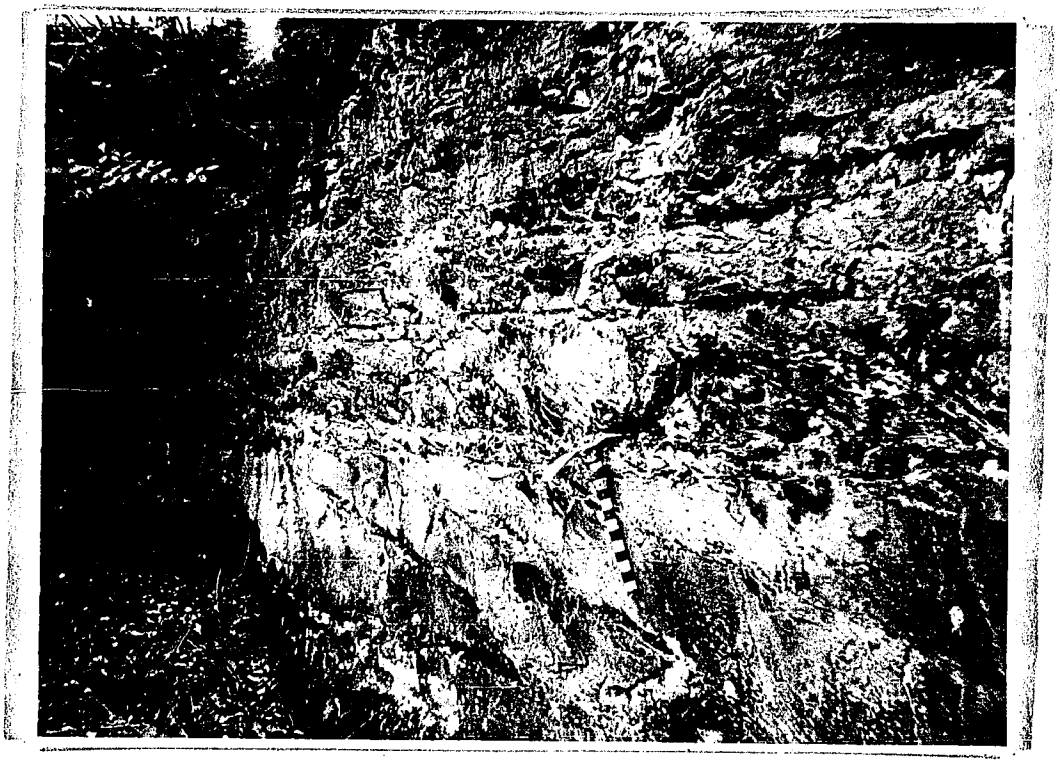


Figure 12. Planar cross-bedded, clay-bonded sandstone in an abandoned quarry in the central southwestern portion of section 11, East Union township.

indicated stratigraphic range, appears to replace in one area or another the upper (coal-clay-shale) units of all included cyclothems.

Bear Run Cyclothem

Definition, distribution, and thickness: The Bear Run cyclothem includes those rocks from the top of the Quakertown coal up to the top of the Bear Run coal. The Bear Run cyclothem has been found to have only local occurrence in Wayne County. Its distribution appears limited to parts of Clinton, Franklin, and Sugar Creek townships.

The average thickness of 28 feet for the Bear Run cyclothem is based on data from two areas in Clinton and Franklin townships. Projection of outcrop data in Sugar Creek township and from adjacent Stark County indicates probable thinning of the cyclothem in eastern Wayne County.

Lithology: Sandstone is the dominant rock of the Bear Run cyclothem. At the base of the cyclothem, coarse to fine clay-bonded sandstone (#12850) and black shale (#12854) are found lying directly upon Quakertown coal. The remainder of the cyclothem most commonly contains in ascending order, medium to thick bedded sandstone, grading upward into a finer grained, thinner bedded rock (#12852) which often contains coal spars (lenses) (#12645); a clay zone of variable composition ranging from a plastic underclay (#12853) to a brittle clay shale (#12645); the Bear Run coal, ranging from a paper-thin, coaly, clay shale (#12852) to a

hard, 10 percent bright coal, commonly displaying clay shale partings totaling 3.4 feet thick (#12857 and #12645).

Vandusen cyclothem

Definition, distribution, and thickness: The Vandusen cyclothem includes those rocks from the top of the Bear Run coal to the top of the Vandusen coal. This cyclothem is only locally persistent and appears to be mostly confined to southern and southwestern Wayne County. The Vandusen cyclothem has been found in portions of Franklin, Salt Creek, Sugar Creek, Baughman, and Chippewa townships. The thickness of the cyclothem in Clinton township is 28 feet. Although no complete intervals were found between the Bear Run and Vandusen in eastern Wayne County, the projection of outcrop and well data suggest a thickening of this cyclothem to the east.

Lithology: Sandstone is the most common constituent of the Vandusen cyclothem. Both clay shale (#12645) and very fine grained, clay-bonded sandstone (#12852) are found directly overlying the Bear Run coal at the base of the Vandusen cyclothem. The middle third of the Vandusen cyclothem is usually poorly exposed, but wherever it was observed, a heavily clay-bonded sandstone was found at this position. One outcrop showed a silty shale lens within this sandstone (#12639). The upper third of the Vandusen cyclothem is

variable in lithology. Sandstone and coaly sandstone can apparently represent this interval, at least in part (#12631). In other areas a thin, partly siliceous cemented sandstone, or sandy clay zone was found separating the Vandusen coal from the underlying clay (#12659, #12639 and Figure 13). The more usual vertical sequence of clay shale, poorly plastic underclay, and thin hard bright coal was also seen (#12654). The Vandusen coal bed can be observed to grade within 100 feet from a hard (80 percent bright) coal into a black nodular siltstone (#12639).

Lower Mercer Cyclothem

Definition, distribution, and thickness: The Lower Mercer cyclothem includes those rocks between the top of the Vandusen coal and the top of the Lower Mercer coal. This cyclothem is more widespread than the underlying Vandusen and Bear Run cyclothems. The Lower Mercer cyclothem is locally found present in all townships of Wayne County containing Pennsylvanian rocks with the exception of Chippewa, Baughman, Milton, Salt Creek, Wooster, and Wayne townships. The thickness of the Lower Mercer cyclothem appears to be rather uniform across the county. Measurements in East Union, Franklin, and Clinton townships each indicate a thickness of about 23 feet. Four measurements in eastern Wayne County indicate an average interval of 25 feet, with a range of 20 to 33 feet, between the Lower and the Middle Mercer coals.

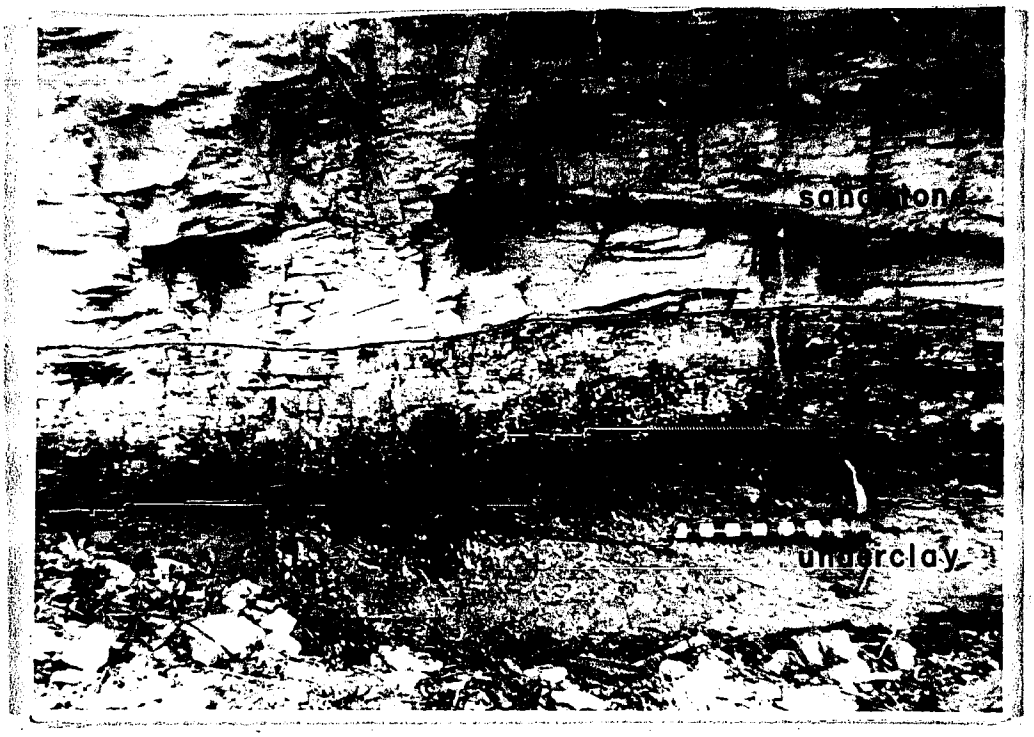


Figure 13. Cross bedded, clay bonded sandstone resting with sharp contact on Vandusen (?) coal. The coal is underlain by a locally contorted sandy clay which grades into a silty underclay. Section along creek in the NE¼ SW¼ of section 7, Sugar Creek township.

Lithology: Fine grained sandstone is the dominant rock of the Lower Mercer cyclothem. Thin sandy clay shale (#12659) or very fine grained cross-bedded clay-bonded sandstone (#12639 and Figure 13), lying directly upon the Vandusen coal, are the most common basal units of the Lower Mercer cyclothem. One white silty clay bed, 6.9 feet thick, was found over a thin Vandusen coal seam in Franklin township (#12868). The middle portion of the Lower Mercer cyclothem appears dominantly composed of fine grained, clay-bonded sandstone which occasionally features local pebble bands (#12657). The upper third of this cyclothem is in ascending order composed of thin clay shale (#12654); thick, usually sandy and silty underclay, sometimes displaying a clay shale parting (#12615); and finally the thin, usually hard, bright laminated lenticular Lower Mercer coal.

Flint Ridge cyclothem

Definition and stratigraphic relations: The Flint Ridge cyclothem is represented by those rocks lying between the top of the Lower Mercer coal and the top of the highly sporadic Flint Ridge coal. When the Flint Ridge coal is absent, this cyclothem is usually indistinguishable, and therefore is grouped with the overlying Middle Mercer cyclothem.

Distribution and thickness: The Flint Ridge cyclothem was

found only in eastern Wayne County, in portions of East Union, Sugar Creek, and Paint townships. On the basis of the only three complete sections available for this interval, it appears that an increase in thickness from north to south in eastern Wayne County occurs as follows: East Union township, 10 feet; Sugar Creek township, 13 feet; Paint township, 35 feet.

Lithology: The above-mentioned three complete sections, as well as other fragmentary sections, indicate a predominant shale composition for the Flint Ridge cyclothem. On the basis of this fragmentary evidence, it is interesting to note that at least locally this shale sequence stands in sharp contrast to the sandy underlying and overlying cyclothems. The limited lithology recorded for this interval may be summarized as follows: basal black silty shale resting on the Lower Mercer coal, which grades upwards into brown silty shale (#12657) or rarely a clay bonded sandstone; carbonaceous clay shale; thick, lenticular, poorly plastic, locally sandy underclay; and thin, commonly shaly Flint Ridge coal marking the top of the cyclothem.

In one section (#12615) measured in the vicinity of the Flint Ridge cyclothem, a marine clay shale was found containing brachiopod fragments and portions of crinoid stems in a thin fossil zone 3.9 feet above the Lower Mercer (?) coal. Designation of the coal in this section as Lower Mercer (?) is based only on stratigraphic succession from

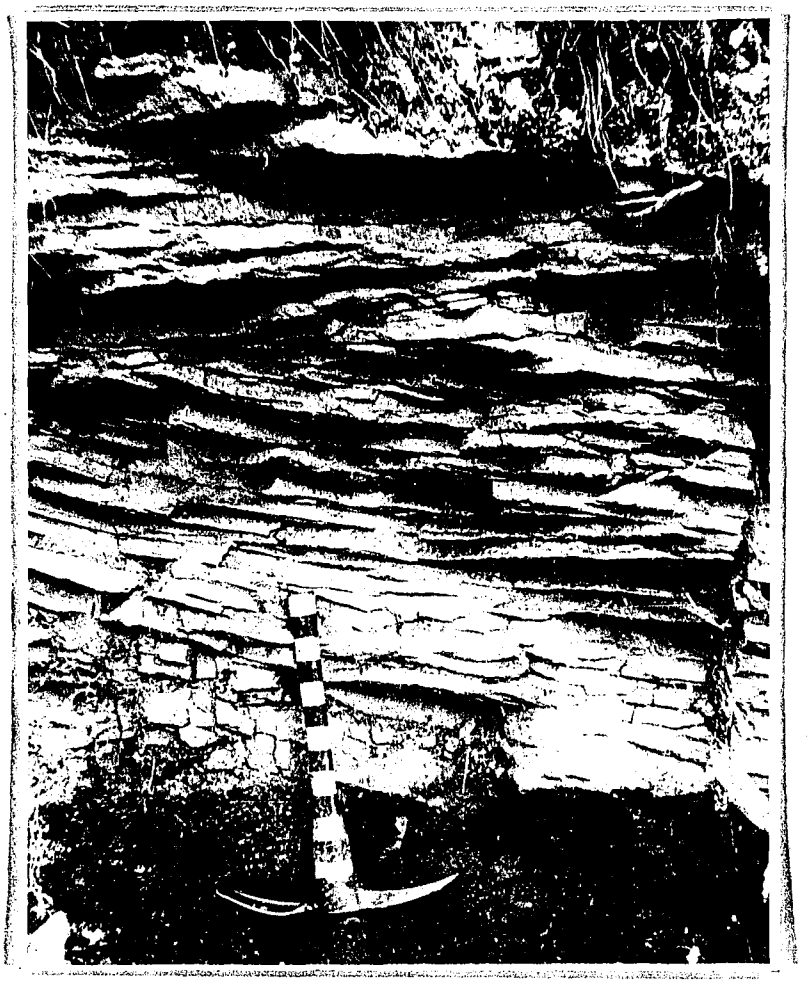


Figure 14. Clay-bonded sandstone showing cut-and-fill cross bedding, resting with sharp contact on weathered Vandusen (?) coal in the NE¼ SW¼ of section 7, Sugar Creek township.

the Lower Mercer limestone and Flint Ridge coal outcrops, both within 2000 feet. The interval from the Lower Mercer limestone is approximately 43 feet, which although abnormally large for Holmes County to the south, is apparently more normal for Wayne County (see Figure 11). If the designation of this coal as Lower Mercer is correct, the overlying marine zone may represent the single occurrence of the marine Boggs horizon found in Wayne County.

Middle Mercer cyclothem

Definition and stratigraphic relations: The Middle Mercer cyclothem includes those rocks between the top of the Flint Ridge coal and the top of the Middle Mercer coal. This interval, as previously noted on page 43, may include rocks down to the top of the Lower Mercer coal when the intervening sporadic Flint Ridge coal is absent. The Middle Mercer coal lies most commonly approximately 2 feet below the Fusulinella-bearing Lower Mercer limestone and represents the lowest reliable stratigraphic marker in Wayne County.

Distribution and thickness: The Middle Mercer coal, although persistent in Holmes County (White, 1949, p. 103) appears to have restricted distribution in Wayne County. This apparent limited distribution may be due to the fact that the overlying Lower Mercer limestone seldom outcrops in Wayne County, and both coal and limestone are commonly

covered with glacial drift. Outcrops and coal test wells indicate, however, that the Middle Mercer coal is present in portions of Paint and Sugar Creek townships. A tentative correlation indicates the possible existence of this coal in section 10 of Franklin township (#12860).

The average interval of the Flint Ridge to Middle Mercer coal is 20 feet; variations range from 11 to 33 feet. The interval appears to increase in thickness from Sugar Creek (13 feet average thickness) southeastward into Paint township (27 feet average thickness). The average of seven measurements of the Middle Mercer to Lower Mercer coal interval is 36 feet.

Lithology: Sandstone is the dominant rock type of the Middle Mercer cyclothem. Sandy shale or sandstone is found most commonly resting directly upon Flint Ridge coal (#12657). When the latter coal is absent, either sandstone (#12658) or dark gray shale (#695) are found resting upon Lower Mercer coal. The middle portions of this cyclothem, although poorly exposed, appear to be made up mostly of fine grained, clay-bonded sandstone. A usually thick clay shale (#689) overlain by the common shaly, thin Middle Mercer coal makes up the top third of this cyclothem. A dark gray, poorly plastic underclay locally intervenes between the clay shale and coal. The coal has been found represented by spars (lenses) in clay (#12614) and as a basal brittle carbonaceous shale zone or a clay shale bed (#12640).

Interval between the top of the Middle Mercer coal and the top of the Brookville coal

General statement and stratigraphic relations: This interval includes in ascending order the Upper Mercer, Bedford, Tionesta, and Brookville cyclothems, as noted in Figure 15. The interval is bounded at its top by the Putnam Hill limestone and has within its limits the Upper and Lower Mercer limestones which have been noted (p.7) as the most important stratigraphic markers in Wayne County.

A study of the intervals between these limestones and their underlying coals[1] in Wayne County reveals apparent convergences and divergences over wide areas. The four available Middle Mercer-Bedford interval measurements in Wayne County indicate an average interval of 27.3 feet with a range from 19 to 34 feet. Their distribution implies an eastern convergence from 34 feet in section 20 of southwestern Paint township to an average of 20.5 feet in section 24, in southeastern Paint township. A 34-foot measured interval in section 9 of Sugar Creek township indicates a northerly thickening of this interval from southeastern Paint township.

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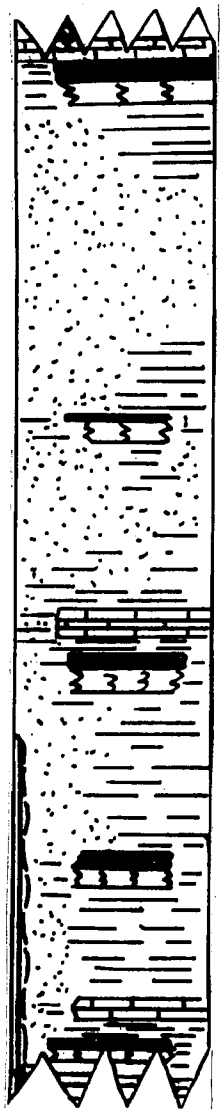
[1]As more data are available concerning coal intervals than concerning limestone intervals in adjacent counties for comparison with Wayne County, the intervals between the Middle Mercer-Bedford-Brookville coals (which either directly or closely underlie the Lower Mercer, Upper Mercer, and Putnam Hill limestones, respectively) will be used in this discussion and in the pertinent Figure 16.



	Feet/Tenths
Putnam Hill limestone	
Brookville coal	1.8' (0 - 3.1)
clay	1.5' (0 - 10.0)
	29.8 (18.0 - 50.0)
Tionesta coal	.9' (0 - 2.9)
clay	1.4' (0 - 2.6)
	14.8 (4.6 - 29.6)
Upper Mercer limestone	2.4' (0 - 7.0)
Bedford coal	1.4' (0 - 2.8)
clay	2.2' (0 - 4.0)
	14.4' (4.7 - 29.4)
Upper Mercer coal	1.4' (0 - 2.6)
clay	1.8' (0 - 5.8)
	10.7' (.7 - 27.7)
Lower Mercer limestone	2.0' (0 - 4.0)
Middle Mercer coal	

Figure 15. Diagrammatic rock section of the interval between the top of the Middle Mercer coal and the top of the Brookville coal. Figures before parentheses are average thicknesses and intervals; figures within the parentheses represent maximum and minimum measurements. Mississippian age residual "hills" locally extend up as high stratigraphically as indicated in lower left edge of columnar section.

The succeeding 51.4-foot average interval, with a range of 38 to 65 feet, between the Bedford and Brookville coals in Wayne County, varies locally more than over wide areas. The average of three intervals in Franklin township was 52 feet, with a range of from 38 to 65 feet. No intervals were available in Salt Creek township. In Paint township four intervals averaged 49 feet and had a range of 38 to 62 feet; this wide range is believed largely attributable to the undulatory nature of the Putnam Hill limestone (see Plate III), as the Upper Mercer limestone was found to vary only slightly in altitude in this township. One projected interval north of Paint township in section 13 of Sugar Creek township indicated an interval of 57 feet.

The fragmentary nature and distribution of the two limestone intervals discussed above does not permit detailed analyses within Wayne County. However, data indicate that (1) the interval between the Lower and Upper Mercer limestones appears less variable than that between the Upper Mercer and Putnam Hill limestones, and (2) the Upper Mercer limestone is steadiest of the three limestones, whereas the underlying Putnam Hill limestones have a more undulatory character.

A comparison of the average thicknesses of the Middle Mercer-Bedford and the Bedford-Brookville coal intervals of Wayne County with similar averages in adjacent areas to the south, southeast, and east, is given in Figure 16 in both

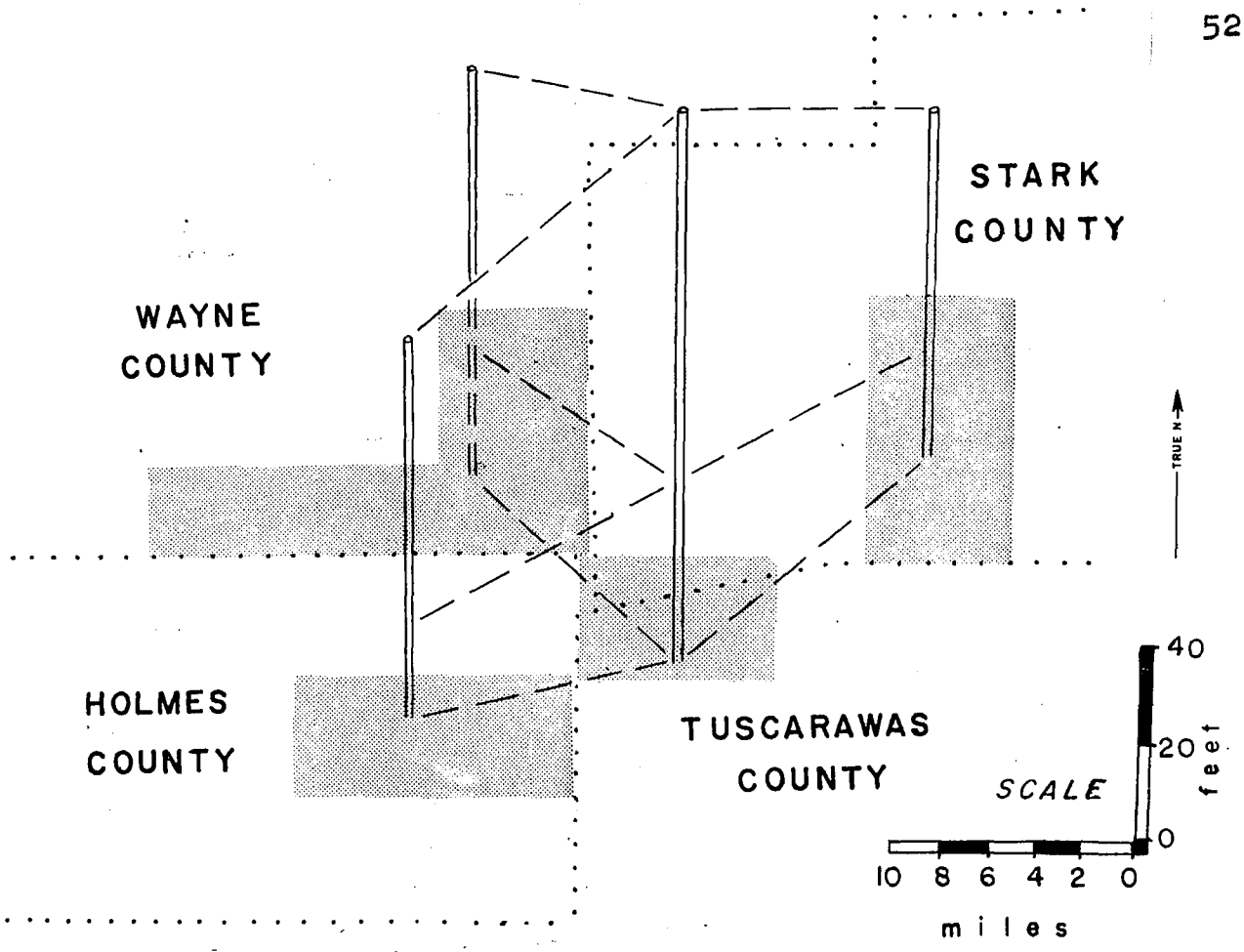
tabular and illustrative form. This comparison represents generalizations for the intervals between the Lower Mercer, Upper Mercer, and Putnam Hill limestones which overlie the indicated coals. It indicates a thickening of both intervals from three directions into the Beach City area and imply that Beach City was an area of greater deposition throughout this time.

Distribution: Rocks of this interval appear to have more restricted distribution than those rocks of the underlying Quakertown coal-Middle Mercer coal interval. Rocks of the Middle Mercer-Brookville interval are found in portions of Sugar Creek, Paint, Salt Creek, and Franklin townships. The included rocks appear to be spread as a blanket-like deposit over these four townships. Local inclusion of this interval in southeastern Baughman township may also be possible, as noted under discussion of the Tionesta cyclothem.

Nomenclature and correlations: Whenever possible, limestones of this interval were identified by their characteristic Fusulinella content, and adjacent rock units were identified on the basis of stratigraphic succession. Away from the areas of faunal control, established rock intervals, stratigraphic succession, and correlation with named units in adjacent Holmes County were used for identification.

The majority of rock units formerly identified by

Figure 16. (See following page) Comparisons of the average thickness of the Middle Mercer-Bedford and the Bedford-Brookville intervals of Wayne County with similar intervals in adjacent areas containing similar data. Data in Holmes and Stark Counties derived from a compilation of sections in the files of the Ohio Geological Survey; data from the Beach City area (Tuscarawas County) taken from Gray (1954, p. 62). In the following diagram no breakdown by individual township or smaller area is attempted.



COAL INTERVALS	WAYNE COUNTY Franklin, Salt Creek, Paint, Sugar Creek twps.	HOLMES COUNTY Berlin, Walnut Ck. townships	BEACH CITY AREA	STARK COUNTY Canton, Pike townships
Bedford & Brookville	8 51' (38-65)	5 60.2' (47-77)	15 77' (35-125)	6 49.8' (33-65)
Bedford & Middle Mercer	4 27' (19-34)	6 20.3' (15-30)	7 38' (22-28)	5 23.4' (22-28)

KEY TO TABLE

4 number of measurements
27' average interval between coals (feet)
(19-32) maximum and minimum intervals

Stout[1] or Conrey (1921) in Wayne County, were substantiated when located in the field by the author. Only a few revisions in their identification, based on new data, were found advisable and such revisions have been noted, with explanations, on the measured sections of this report (see Appendix) and in the files of the Ohio Geological Survey.

Correlations with named rock units in Holmes County can locally be made with assurance, because of the close proximity of outcrops. Commonly, however, the previously mentioned undulatory nature of the limestones in local areas of both Wayne and Holmes County precludes extensive correlations on the basis of elevations and intervals. A few correlations which might be attempted from Holmes County (data from White, 1949) into Wayne County are listed below.

(1) White (p. 288, section 3-232) notes the Putnam Hill limestone with the underlying Brookville coal at an elevation of 1225 feet 1/8th mile south of the Wayne County line. This same limestone and coal occurs at a similar elevation along a north-south trending road just across the county line in SW¼ SW¼ section 22, Paint township, Wayne County.

(2) White (p. 294, section 16-54) notes the Putnam Hill at an altitude of 1150 feet about 42 feet above the Upper Mercer limestone in Holmes County. About 2½ miles to the northwest in Wayne County (#12868), the Putnam Hill lies at an elevation of 1165 feet, some 47 feet above the Upper Mercer limestone.

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[1]A few isolated outcrops listed in the files of the Ohio Geological Survey.

(3) White (p. 289, section 6-205) notes the closest (approximately 5 miles) outcrop of the Lower Mercer limestone (elevation 1110 feet) to the most southerly known position of the same limestone in Wayne County. In the Wayne County section (#689) the limestone lies at an elevation of 1120 feet. The interval of 20 feet to the Bedford coal in Holmes County is smaller than the approximate 34 feet interval in Wayne County.

Upper Mercer Cyclothem

Definition, distribution, and thickness: The Upper Mercer cyclothem includes those rocks between the top of the Middle Mercer coal and the top of the Upper Mercer coal. Rocks lying between known horizons of these two coals are confined to eastern Wayne County, in Paint and Sugar Creek townships. The included Lower Mercer limestone is also limited to these two townships.

The average thickness of this cyclothem is 17 feet with a range of 7 to 34 feet. The interval appears to thicken in southern Sugar Creek and northern Paint townships, and to thin toward southeastern Paint township.

Lithology: Shale is the dominant rock type of this cyclothem. Sandstone is lacking in two completely exposed sections of this cyclothem in Sugar Creek and Paint townships. However, in some fragmentary sections and in areas away from known Upper Mercer coal, sandstone is found below the Upper Mercer coal (#12652). The basal portions of this cyclothem consist of a lenticular black clay shale which varies from 0 to 8.2 feet thick (average 2.0 feet) and generally separates the Middle Mercer coal from the overlying Lower Mercer limestone

(#12640, #681). The Lower Mercer limestone is a dark blue hard medium to thick bedded rock which averages 2.0 feet thick and ranges from 0 to 4.0 feet (#12614). Only one area shows a thin sandstone at this horizon; it evidently replaces the Lower Mercer limestone (#695). Black silty shale grading upward into a clay shale or poorly plastic underclay, together with the overlying Upper Mercer coal, makes up the upper third of this cyclothem. The coal averages 1.4 feet thick and varies from a hard, bright coal (#12606) to a shaly, thin bed and often consists of only a few coal spars in clay (#12614) or coal fragments in sandstone (#12640). The Upper Mercer coal has been reported with a thin rider coal approximately 0.2 foot above the main coal bed (#12873). A small abandoned stripping operation is located in section 27 of Sugar Creek township (#12649). Nearby drill records indicate that this formerly stripped coal is the first one below the Bedford in the area, and is probably of Lower Mercer age.

Bedford Cyclothem

Definition, distribution, and thickness: The Bedford cyclothem includes those rocks between the top of the Upper Mercer coal and the top of the Bedford coal. The Bedford cyclothem is found in Sugar Creek, Paint, Salt Creek, and Franklin townships. The cyclothem is tentatively identified in eastern Baughman township. The average thickness of this

cyclothem is 18 feet with a range of from 8 to 33 feet. The cyclothem appears to thin along a belt trending eastward through central Paint township, and thickens to the north and south.

Lithology: Both medium to fine grained sandstone and silty shale are found at the base of the Bedford cyclothem resting on Upper Mercer coal (#12606, #12649). In the few exposed complete sections between these two coals, clay and silty shale appear to dominate the middle portions of this cyclothem (#12637). However, the majority of the more fragmentary sections reveal thick fine grained sandstone or sandy shale sections in this interval (#12866). The upper third of this cyclothem is most commonly represented in ascending order by clay shale, grading upward into a silty underclay, overlain by the commonly shaly Bedford coal (#12866). Both underclay and coal have been found resting directly on sandstone (#12643). Shaly Bedford coal (#12154) and interbedded coal and shale are common at this horizon; carbonaceous shale may also replace Bedford coal (#12616 and Figure 17). Hard, bright Bedford coal (#12640) was rarely found in outcrop although it has been reported in wells (#691) and in section 4 of Salt Creek township where the Bedford was formerly mined. A.A. Wright in 1882 described the coal found in this latter mine and his description notes the common interbedding of this coal with shale.

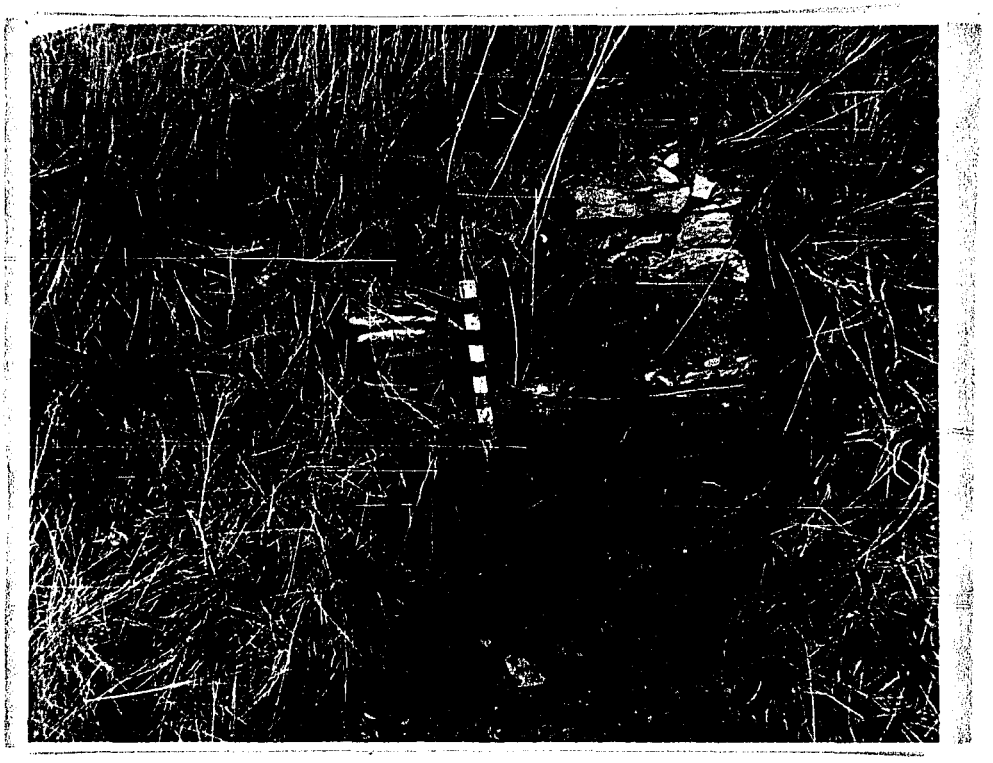

Figure 17. Upper Mercer limestone underlain by carbonaceous shale and clay at a road cut along abandoned Route # 250 and above the new road; SE¼ NW¼ section 24, Paint township.

Tionesta Cyclothem

Definition and stratigraphic relations: The Tionesta cyclothem includes those rocks between the top of the Bedford coal and the top of the Tionesta coal. The Tionesta coal is locally replaced by heavily clay-bonded, fine grained sandstone or clay shale, in which case the Tionesta cyclothem is indistinguishable from, and therefore grouped with, sediments of the overlying Brookville cyclothem (#691).

Stout (1947) in his generalized section for Ohio, and White (1949, pp. 154-158) in his report on Holmes County, list only one coal bed (Tionesta) within the Bedford-Brookville interval. Gray (1954, p. 56) notes four coal beds within this same interval southeast of Wayne County in the Beach City area. Detailed examination of all measured sections, well data, and intervals to overlying Brookville and underlying Bedford coals in Wayne County indicate the following:

(1) Areas of Tionesta coal are limited; outcrops and well control points which could be tied in directly to an overlying Brookville or underlying Bedford coal horizon were found limited as follows: Franklin township (2), Salt Creek township (1), Paint township (8), Sugar Creek township (6).

(2) No more than one coal bed was found between the Bedford and Brookville coals in any one measured section or well.

(3) Although the intervals between the Tionesta coal and the overlying Brookville and underlying Bedford coals vary when considering the entire four townships as a unit, variation within any one area of several square miles was not common and

never was found to be greater than variations of other Pennsylvanian coals (mapped with better control) in the same general area.

(4) The maximum variations in intervals from the Tionesta coal bed to adjacent named beds were found in southeastern Paint township, a location closest to the Beach City area where four Tionesta coals are reported.

(5) Present data do not justify assuming more than one coal between the Bedford and Brookville coals of Wayne County. However, the lack of control, the variations noted in item 4 above, and the presence of multiple Tionesta coals to the southeast in a smaller area of better control by Gray (ibid), should not preclude the possibility of more than one Tionesta coal in parts of Wayne County.

Distribution and thickness: The Tionesta cyclothem is found in Franklin, Salt Creek, Paint, and Sugar Creek townships. A thin coal bed in the west central part of section 36 of Baughman township is tentatively identified as Tionesta, making this cyclothem locally persistent in the southeastern portion of Baughman township. The Upper Mercer limestone is also found in all the above mentioned townships. The Tionesta cyclothem averages 23 feet thick and ranges from 13 to 38 feet. This cyclothem appears to increase in thickness slightly northward from Paint township (average 19 feet) into Sugar Creek township (average 21 feet).

Lithology: The lower portions of the Tionesta cyclothem are characterized by shale with or without the Upper Mercer limestone; the upper portions appear dominated by sandstone. Upper Mercer limestone is found in the basal portions of the

Tionesta cyclothem either lying directly upon Bedford coal (#12640, #12637) or separated from it by a clay shale which averages 3.2 feet thick (#692, #12154). Where the Bedford coal is represented by shale the base of the Tionesta cyclothem can only be estimated (#12616, #12868). The Upper Mercer limestone (Figure 17) is represented by a dark gray-blue, very hard, locally flinty, dense limestone occurring most commonly in one or two beds which weather into flinty slabs (#12640, #12868). Twenty measurements of the limestone show an average thickness of 2.4 feet and a reported maximum of 7 feet in Sugar Creek township (#12649). This limestone is known to grade laterally into shale (#691). Above this limestone is found a gray, silty shale (#681) followed most commonly by a medium grained sandstone which grades upward into a fine grained, heavily clay-bonded sandstone. This clay-bonded sandstone commonly grades upward into a sandy clay or clay shale exhibiting Tionesta coal at its top (#12651) or interbedded within the sandy clay and clay shale. Coal pods in sandstone have also been found at the Tionesta horizon (#12153). A clay shale or fire clay zone separates two individual beds of Tionesta coal in two areas (#676 and White, 1949, p. 156). in Wayne County.

Brookville Cyclothem

Definition and stratigraphic relations: The Brookville cyclothem includes those rocks between the top of the Tionesta

coal bed and the top of the Brookville coal bed. The base of the Brookville coal marks the arbitrary boundary of the top of the Pottsville group and the base of the Allegheny group of rocks in Ohio (Stout 1947). Although the Brookville coal occurs at the base of the Allegheny it will be described within the Pottsville discussion as the uppermost unit of the Brookville cyclothem, which is mostly of Pottsville age.

The Brookville coal and the overlying Putnam Hill limestone have been noted grading into shale. The best illustration of this is in southern section 26, Sugar Creek township. Here the Putnam Hill limestone and Brookville coal crop out (#12648) and are underlain by silty shale, but less than ½ mile to the west both limestone and coal are replaced by shale (#676). Other similar transitions or "cut outs" have been noted in Sugar Creek township (Conrey 1921, p. 113) and in Franklin township.

Distribution and thickness: The Brookville cyclothem has been identified in Franklin, Salt Creek, Paint, and Sugar Creek townships. This cyclothem appears to thicken eastward from Franklin (average 18 feet) to Paint townships (average 33 feet). From Paint township northward, the Brookville cyclothem appears to thicken slightly into Sugar Creek township (average 37 feet).

Lithology: Fine grained, clay bonded sandstone is the dominant rock of the Brookville cyclothem. Either fine to

medium grained sandstone or black shale is found directly overlying the Tionesta coal at the base of the Brookville cyclothem (#685). The middle portions of this cyclothem appear to be made up of sandstone which becomes finer grained, more clay bonded and shaly, as it approaches the clay under the Brookville coal (#12159).

The upper portions of the cyclothem usually contain, in ascending order, thin-bedded, locally sandy, clay shale; medium to light gray, plastic underclay; and thin, dull, but locally bright and laminated, Brookville coal (see Figure 18 and #12648). A fine grained sandstone locally lies directly below the underclay (#12157). The Brookville coal is a single, often shaly, thin coal bed, commonly only a sooty streak or blossom in Sugar Creek and Paint townships. In southern Salt Creek and Franklin townships, however, a thicker, often bright coal, with a thin clay interbed is found and has been mined in the past (see Economic Geology chapter). The undulatory nature of the Brookville coal, lying directly beneath the Putnam Hill limestone, is illustrated by a structure contour map drawn on the base of this limestone in Paint township (Plate III).

Figure 18. Dull Brookville coal, shaly and clayey in upper portions, poorly brittle and laminated in lower parts; underlain by a medium to light gray, plastic underclay and overlain by the Putnam Hill limestone, see section #12157. Photograph taken along Route #250 road cut, one-half mile northwest of Mt. Eaton, Paint township.

ALLEGHENY GROUP

General statement and stratigraphic relations: Strata belonging to the Allegheny group make up an average of 85 feet of the youngest Pennsylvanian beds in Wayne County. Shale is the dominant rock type; this dominance appears to continue the general trend toward finer clastics in the upper Pottsville, as previously noted (page 13). Besides shale, the Allegheny of Wayne County contains sandstone, three coals, two underclays, and one limestone.

The Allegheny group by definition (Stout 1947) includes those beds between the base of the Brookville coal and the top of the Upper Freeport (#7) coal. In Wayne County the upper portions of this group were either never deposited or have been eroded away, and the Allegheny group is represented by rocks from the base of the Brookville coal[1] up to and including the stratigraphically highest sandstone or shale found above the Middle Kittanning (#6) coal.

The base of the Allegheny group in Wayne County is usually well marked by the Putnam Hill limestone, overlying the Brookville coal. In north central Salt Creek township,

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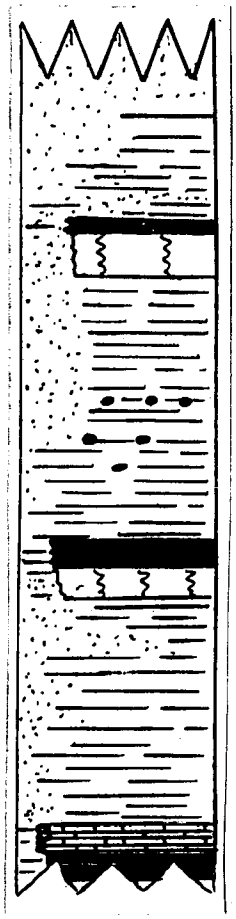
[1]Although the Brookville coal falls at the base of the Allegheny, it was described within the Pottsville discussion as the uppermost unit of the Brookville cyclothem, which is mostly of Pottsville age.

however, both limestone and coal are either absent or covered with thick deposits of glacial drift. This lack of control necessitates the drawing of the Allegheny-Pottsville boundary here on the basis of interval from the underlying Upper Mercer limestone and overlying Lower Kittanning coal, both of which are present in the area (see geologic map, Plate IV). In a few areas, such as southeastern Salt Creek township, where scattered well data indicate glacial drift up to 100 feet thick, the buried Allegheny-Pottsville boundary is appropriately dashed except where the Putnam Hill is exposed. All dashed boundaries should be considered as tentative until bedrock relationships can be studied in more detail.

Interval between the top of the Brookville coal and the top of the Allegheny Group in Wayne County

General statement and distribution: This interval includes in ascending order the Lower Kittanning and Middle Kittanning coals, and as noted in Figure 19, is bounded at its base by either the Putnam Hill limestone or a local thin clay shale lying between the limestone and the Brookville coal. The top of the interval is more indefinite and is represented by the stratigraphically highest sandstone or shale found above the Middle Kittanning coal. Rocks of this interval are found in Sugar Creek, Paint, Salt Creek, and Franklin townships.



	Feet/Tenths
Middle Kittanning coal	.8 (0 - 1.0)
clay	4.5 (0 - 11.0)
	26.0 (14.1 - 35.1)
Lower Kittanning coal	2.4 (0 - 4.3)
clay	3.8 (0 - 6.0)
	20.1 (7.4 - 35.4)
Putnam Hill limestone	3.0 (0 - 8.0)
Brookville coal	

Figure 19. Diagrammatic rock section between the top of the Brookville coal and the top of the Allegheny group in Wayne County. Figures before the parentheses represent average thickness of intervals. Figures within the parentheses represent maximum and minimum intervals and thicknesses.

Nomenclature and correlations: Wherever possible, the basal Putnam Hill limestone of this interval was identified by its characteristic fossil, Fusulinella serotina, and the overlying rocks were then identified on the basis of stratigraphic succession. Established rock intervals, stratigraphic succession, and correlation with named units in adjacent Holmes County, were used for identification in areas away from faunal control.

Owing to the lack of faunal and outcrop control, within or close to Wayne County, correlation and nomenclature for rock units above the Lower Kittanning coal is hazardous. In this report such nomenclature is based, by necessity, only on comparison of average intervals found in adjacent Holmes, Tuscarawas, and Stark counties. The problem involves differentiating the interval between the Lower Kittanning and the Strasburg (#5a) coals from the interval between the Lower Kittanning and the Middle Kittanning (#6) coals. The 32.9-foot average interval of 10 measurements in Wayne County was found closer to that interval between the Lower and Middle Kittanning coals of adjacent counties. It should be noted here also that the 21-foot minimum interval in Wayne County was found to be nearly twice as great as the minimum figure for the Lower Kittanning to Strasburg interval in adjacent counties. This does not preclude, however, the possibility that Strasburg coal does exist in Wayne County. It may be represented by one of the coals that are identified as Middle

Kittanning and lie closest to the Lower Kittanning, such as in Sugar Creek township (#676).

A few of the correlations which might be attempted from Holmes County (data from White, 1949) into Wayne County are listed below.

(1) White (p. 287, section 2-229) notes the Lower Kittanning coal at an elevation of 1248 feet some 48 feet above the Putnam Hill limestone in the SW¼ SW¼ of section 26, Paint township, Holmes County. Two miles to the north in Wayne County the Lower Kittanning coal crops out (#12175) at an elevation of 1263 feet some 39 feet above the Putnam Hill which crops out in a nearby farm lane along the southern section line of section 14, Paint township, Wayne County.

(2) White (p.294, section 16-54) notes the Brookville coal 41 feet above the Bedford coal and 41 feet below the Lower Kittanning coal in section 25 of Prairie township, Holmes County. A mile to the north in Wayne County these units rise in elevation but change only slightly in interval; the Brookville lies 38 feet above the Bedford (#12866) and approximately 39 feet below the Lower Kittanning in a nearby coal test well (#674). Confirmation of the Lower Kittanning correlation is aided by a local drift mine, lying above the Putnam Hill horizon, which is believed to be the Lower Kittanning mine noted by Conrey (1921, p. 118).

(3) White (p. 190) notes that the gray fossiliferous limestone in central section 23 of Salt Creek township of Wayne County "presents no difference from the typical Putnam Hill stratum in Holmes County."

(4) See page 53 for previously mentioned Putnam Hill correlations.

Lower Kittanning Cyclothem

Definition and distribution: The Lower Kittanning cyclothem includes those rocks between the top of the Brookville coal (and usually the base of the Putnam Hill limestone) and the top of the Lower Kittanning (#5) coal. Rocks of this interval are found in Sugar Creek, Paint, Salt Creek, and Franklin townships. Their distribution is illustrated on the geologic map (Plate IV) where both the Putnam Hill limestone and the Lower Kittanning coal horizons are indicated.

No outcrops or reports of the #5 coal have been found in southeastern Salt Creek township, where a thick glacial cover obscures the bedrock in both Wayne and adjacent Holmes Counties. However, the sufficient elevation of this area and the close proximity (within 2 miles) of known or reported Lower Kittanning coal to the south, northwest, and east, indicate that the #5 coal could also underlie this area of thick drift. To the south, the nearest reported area of #5 is in east central section 35, Salt Creek township, Holmes County (White, 1949, p. 217). To the northwest, in Salt Creek township, Wayne County, the #5 coal was located by an abandoned drift mine entry and 2 outcrops in sections 9, 4, and 10, respectively. To the east in the Mt. Eaton area, the #5 coal is found up to 52 inches thick and is presently being strip-mined.

Thickness: The thickness of the Lower Kittanning cyclothem

appears to increase from Sugar Creek township southward to the very southeastern corner of Paint township. Within Paint township this cyclothem also appears to thicken towards the southeast. The one measurement in southern Franklin township indicates a moderately thick interval of 32 feet.

Lithology: Shale, as noted by White (1949, p. 207) for Holmes County, is also the dominant rock type of the Lower Kittanning cyclothem in Wayne County. The Putnam Hill limestone is, with local exception (see p.61 and p.65), found at the base of the Lower Kittanning cyclothem. This limestone usually lies directly upon the Brookville coal with sharp lithologic contact (#690). In local areas, however, a thin clay or clay shale is found between the limestone and the Brookville coal (#12153, #684). The Putnam Hill is a medium to light, finely crystalline, hard persistent limestone, which breaks up on weathering into diagnostic thin undulating plates from one to two inches thick (see Figure 25). This characteristic weathering, together with the lighter gray color, are the main lithologic distinctions of this limestone from the Mercer limestones, which tend to be thicker bedded, darker in color, and (Upper Mercer) locally cherty. Fifty-four measurements of the Putnam Hill show an average thickness of 3.0 feet and a range of 0 to 8 feet. Although the usual maximum thickness for this limestone is 4.5 feet, one section by Wright (#12860) indicates an 8-foot

thickness in Franklin township. A structure contour map of the base of the Putnam Hill limestone, with local isopach contours in Paint township, is given in Plate III.

Clay shale, with rare ironstone concretions, grading up into a silty and commonly sandy shale, is found most commonly directly over the Putnam Hill limestone (#12153, #691). Sandstone is found only locally near the top of this cyclothem. The contact of this sandstone with the underlying shale was never seen completely exposed in outcrop, but poorly exposed outcrops and core and drill record data appear to indicate both sharp (#679) and transitional (#474) contacts. White (1949, p. 210) indicates the existence of both transitional and unconformable relationships in Holmes County to the south.

Only one reported occurrence of a limestone between the Putnam Hill and the Lower Kittanning coal was found in Wayne County. This was noted on the log (#484) of a core test well drilled in 1945 in Paint township. Unfortunately, none of the limestone samples were saved (personal communication from the contract driller). This limestone was noted graphically on the log as being in three beds interbedded with gray shale and lying between 2 and 11 feet below the base of the #5 coal and between 17.5 and 26.5 feet above the base of the Putnam Hill limestone. It is interesting to note that this one reported occurrence of a limestone between the Putnam Hill and the #5 coal might be what Stout (1947) lists

as the Vanport horizon. Identification, however, must await more detailed descriptions and observations of such a limestone.

The upper portions of the Lower Kittanning cyclothem are represented in ascending order by a silty clay shale, a thick plastic persistent underclay, and a thick bright #5 coal bed. Occasionally, a thin sandstone underlies the underclay. Eleven measurements of the underclay indicate an average thickness of 3.8 feet with a range of 0 to 6 feet. The Lower Kittanning is most commonly a persistent hard bright blocky banded coal in a single bench, averaging 29.1 inches thick. In portions of sections 13, 14, 15, and 24 of Paint township, the coal is found in two benches separated by a thin clay or shale parting averaging 0.5 foot thick. In one area in section 24, Franklin township, the #5 coal is found in three benches separated by thin shale partings (#674). Drill records and outcrop data indicate that the #5 coal is missing in northeastern section 17 and adjoining southeastern section 8 of Paint township; a 3-foot clay overlain by 13 feet of gray shale appears at the horizon of the #5 coal.

A maximum thickness of 52 inches is recorded for the #5 coal in the stripping pits of the Mullet Coal Company, east central section 21, Paint township (see Figure 24).

Middle Kittanning Cyclothem

Definition, distribution, and thickness: The Middle Kittanning cyclothem includes those rocks between the top of the Lower Kittanning coal and the top of the Middle Kittanning coal. Rocks of this cyclothem have one of the smallest distributions of any cyclothem in Wayne County; they may be found near the tops of hills in Sugar Creek and Paint townships.

An average of 10 measurements indicates this cyclothem to be 32.9 feet thick with a range of 21 to 42 feet. The Middle Kittanning cyclothem appears to thicken in a southerly direction from southern Sugar Creek township towards the very southeastern corner of Paint township. From central Paint township the cyclothem thickens both to the south and southeast.

Lithology: Thin-bedded clay shale appears to be the dominant rock type of this cyclothem. Either clay shale or silty shale was always found directly overlying the Lower Kittanning coal at the base of the cyclothem. Clay shale or silty shale with occasional ironstone concretions most commonly make up the middle portions of the Middle Kittanning cyclothem (#12622). A thick clay and thin lenticular bright Middle Kittanning coal are found at the top of the cyclothem (see Figure 20, and #12601, #12153).

Exception to the above common sequence occurs in at

Figure 20. The Middle Kittanning coal overlain by olive-drab clay shale and underlain by white, shaly clay. Photograph taken along the highwall of a strip mine operated by the Mullet Coal and Clay Mines, in the SW¼ SW¼ of section 15, Paint township.

least two local areas, namely, the NW¼ of section 24 and the SW¼ of section 15 of Paint township. In these areas the Middle Kittanning coal was either,

(1) completely absent, with thick, medium to coarse grained sandstone at or below the horizontally projected limits of the Middle Kittanning cyclothem;

(2) represented by thin allochthonous coal spars in poorly sorted sandstone (#12602, #474);

(3) interfingering with very fine grained, silty sandstone (see Figure 21).

The above cited evidence, although very limited in amount, indicates that at least locally the Middle Kittanning coal interfingers with fine grained sandstone and is possibly also cut out by coarser sandstone.

It is interesting to note that Hilty (1955, p. 25), in a study of 18 pertinent sections in Wayne, Stark, Holmes, Tuscarawas, and Coshocton counties, cites the above mentioned SW¼ of section 15 of Paint township, Wayne County, as the only area where sandstone occurs at the level of the Middle Kittanning coal.

Rocks above the Middle Kittanning cyclothem

General statement: Information concerning rocks above the Middle Kittanning coal is limited to exposures or core data from sections 12, 24, and 15 of Paint township. Only a thin clay bed and a sandstone, in sections 12 and 24, respectively, were found directly overlying the Middle Kittanning coal

(#12153, #12622). In section 15, either sandstone or silty shale, overlain by interbedded sandstone and shale, were found above the Middle Kittanning coal (#12602, #691, #12601, #474). The latter two sections represent the stratigraphically highest sections found in the county.

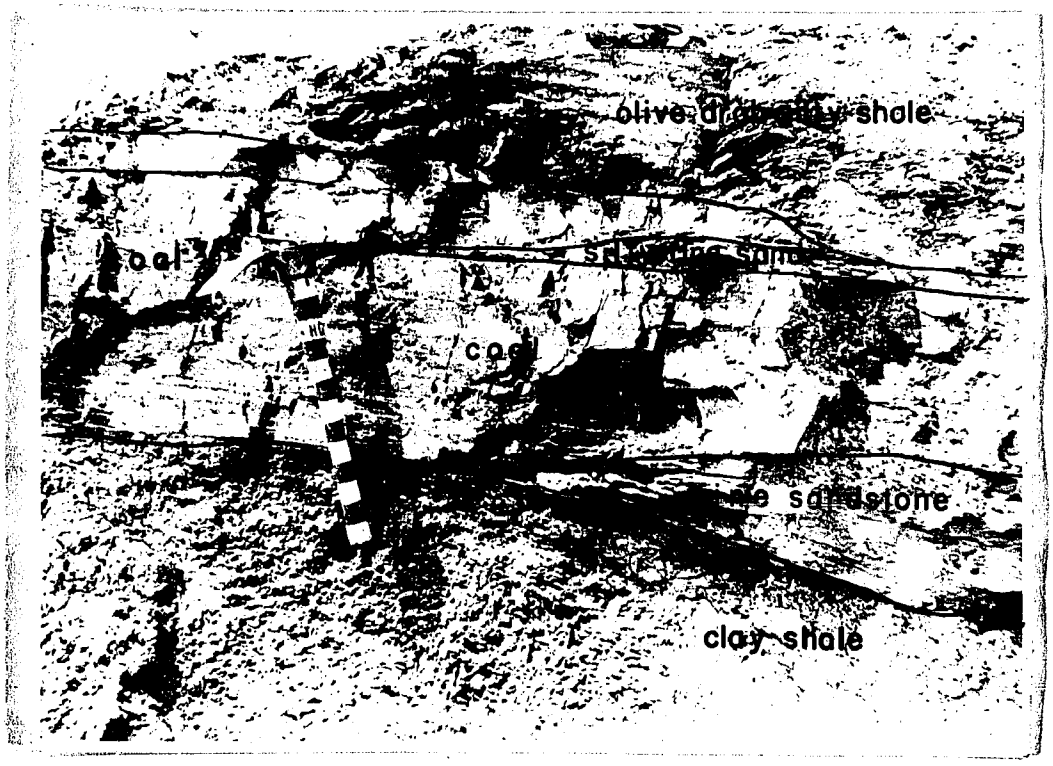


Figure 21. The Middle Kittanning coal interfingering with very fine grained silty sandstone. Photograph taken along the highwall of a strip mine operated by the Mullet Coal and Clay Mines in the SE¼ SW¼ of section 15, Paint township.

REVIEW OF THE PENNSYLVANIAN GEOLOGY OF WAYNE COUNTY BY TOWNSHIPS

General Statement: A short review of Pennsylvanian rocks found in the different townships of Wayne County is given below in an attempt to provide information to those interested in local areas of the county. Where possible, a location is given for at least one of the better exposed sections of each of the named units in each township for those interested in visiting the outcrops. However, it must be remembered that in an area covered by heavy glacial drift, outcrops may be poorly exposed and subsurface data from well records may constitute the only good information. Townships will be described starting from the northeast portion of the county and proceeding southward and then westward.

Milton and Chippewa townships

General statement: Pennsylvanian rocks in Milton township are limited to two small outliers in the northern portion of the township; their presence was first noted by G. F. Lamb[1] and his boundaries are used in this report. The present existence of these outliers is based only on

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[1]Field maps of G. F. Lamb (1912-16) in the files of the Ohio Geological Survey.

the reported occurrence of coal in local wells and the medium to fine grained, poorly sorted, feldspathic character of local sandstone outcrops.

In Chippewa township outcrop control is very limited. Elevations are sufficiently high so that Pennsylvanian limestones exposed to the south might be expected, but no such rocks were found or have ever been reported. A coal tentatively identified as Vandusen is the stratigraphically highest coal found in the township. Named units exposed and reported in Chippewa township are listed and discussed from youngest to oldest below.

EXPOSED	Vandusen coal
SUBSURFACE[1]	Quakertown (#2) coal
EXPOSED	Sharon (#1, commonly called "Massillon") coal
	Sharon sandstone and conglomeratic sandstone

Discussion: Clay-bonded sandstone may be observed on the flanks of the Doylestown hill and in road cuts along Route # 5 on the northeast and southwest edge of Doylestown. It is interesting to note that although basal Pottsville coal is found just northeast, east, southeast, and south of

[1]This includes both covered rocks above drainage and rocks below drainage.

Doylestown, Conrey (1921, p.96) reports that drilling has failed to locate this coal immediately under the town. A tentatively identified Vandusen coal is found cropping out along a road cut in the SE¼ SE¼ of section 15 (#12631). A drill record (#12632) in south central section 15 illustrates the section above and below what is apparently the Quakertown coal. The only section including an outcrop of both the Sharon coal and the underlying Sharon conglomeratic sandstone is found in southern section 24, along the northern edge of the Chippewa Creek valley (#12635 and Figures 8 and 22). A report of shallow #1 coal is noted in southwestern section 14 (#12630). For other mine locations and discussion of the Sharon coal in Chippewa township, the reader is refered to the discussion of this coal in the chapter entitled Economic Geology. A rock section below and possibly including the Sharon coal horizon is found cropping out along a creek in the SE¼ SE¼ of section 14 (#12633).

Abandoned quarries of the Sharon sandstone and conglomeratic sandstone can be found on either side of Chippewa Creek in eastern Chippewa township. Both phases of this sandstone are most readily observable in southern section 24 (#12635 and Figure 8). About 41 feet of conglomeratic sandstone can be found along a creek bottom in the NE¼ NE¼ of section 22; similar sandstone is also

present in the SE¼ SE¼ of this same section (Figure 7).

The Mississippian-Pennsylvanian contact can be observed in outcrop in the SW¼ SW¼ of section 8 (#12629). In the NE¼ SW¼ of section 33, this same contact can be found in a railroad cut displaying slumped Pennsylvanian beds on the flanks of a Mississippian residual hill (see Figure 5).

Figure 22 Sharon (#1 or Massillon) coal in an abandoned drift mine in the SE¼ SE¼ of section 24. The hard, blocky coal has a thick sandstone roof (see section #12635).

Baughman Township

General statement: Pennsylvanian rocks in Baughman township are poorly exposed because of thick glacial drift. Fragmentary outcrops, well data, and references in the literature indicate that the named rock units listed below are present at least locally.

EXPOSED	Brookville coal
	Tionesta coal
	Upper Mercer limestone
	Vandusen coal
	Quakertown coal
SUBSURFACE	Anthony coal
	Sharon (#1, Massillon) coal

Discussion: In a road cut in the SW¼ NW¼ of section 36 two coal beds are tentatively identified as Brookville and Tionesta on the basis of elevation and interval; this is the only known occurrence of these units in the township. A limestone containing the diagnostic Mercer fossil Fusulinella iowensis crops out in a road cut in the SE¼ SE¼ of section 24. What is believed to be the same limestone with an underlying silty, (Bedford ?) coaly shale crops out in a gully in the NW¼ NW¼ of section 6, Tuscarawas township, Stark County, approximately a hundred feet

east of Baughman township. These limestones are tentatively correlated as Upper Mercer.

The Vandusen coal horizon (#12877) is found 30 feet above the Quakertown coal in the SE¼ NE¼ of section 21. Conrey (1921, p.99) notes that the Quakertown here lies about 42 feet above the base of the # 1 coal in a nearby mine. The Sharon coal has been mined both near Burton City (see Plate I) and in the Fox Lake area (see Economic Geology chapter). In the later area a well in the SE¼ SE¼ of section 1 encountered a thin coal at 1004 feet elevation, which, on the basis of the 22-foot interval above the Sharon coal, is called the Anthony.

East Union and Sugar Creek Townships

General statement: Rocks of Pennsylvanian age in East Union township are very poorly exposed because of heavy glacial drift; the Mississippian-Pennsylvanian boundary here, with local exception, was taken from maps of G. F. Lamb.[1]

Pennsylvanian rocks in Sugar Creek township are better exposed and have an approximate maximum thickness of 400 feet. Named rock units found in either of these townships are listed below from youngest to oldest.

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[1]Field maps of G. F. Lamb (1912-16) in the files of the Ohio Geological Survey.

EXPOSED	Middle Kittanning coal
	Lower Kittanning coal
	Putnam Hill limestone Brookville coal
	Tionesta coal
	Upper Mercer limestone Bedford coal
	Upper Mercer coal
	Lower Mercer limestone Middle Mercer coal
	Flint Ridge coal
	Lower Mercer coal
	Vandusen coal
	Bear Run coal
	Quakertown coal
SUBSURFACE	Anthony coal
	Sharon (#1, Massillon) coal
	conglomeratic sandstone (Sharon ?)

Discussion: In the following attempt to locate at least one of the better exposed examples of each of the above units, all references are made to Sugar Creek township unless otherwise specified.

The Middle Kittanning coal can be found in outcrop near the top of a high hill in the SW¼ SW¼ of section 26. Its relationship to the Lower Kittanning, Putnam Hill, Brookville, and Tionesta can also be seen here

(#12648, #676; see also page 61). The Tionesta, Upper Mercer limestone and underlying Bedford ? coaly clay can be seen in a road cut as one walks westward, starting from the 1180 feet T-road intersection in the center of section 14 (Conrey 1921, p.110). In section 27 the relationship of these three units plus the underlying Upper Mercer coal (in a small abandoned strip mine) is poorly exposed (#12649); see also (#12650).

The best section showing the relationships of the Upper Mercer limestone and Bedford coal to the underlying Upper Mercer coal, Lower Mercer limestone, and Middle Mercer coal, is found in a road cut and creek bottom in east central section 9 (#12640).

The only exposed outcrops of the Flint Ridge and Lower Mercer coals are in a tentatively identified section in the SE¼ NW¼ of section 13 of East Union township (#12657). An abandoned drift mine at the same level as this Lower Mercer coal occurs within a mile to the north in north central section 12.

The only exposed rock section including the Vandusen coal in these two townships is a tentatively identified rock section in the NE¼ SW¼ of section 7 (#12639 and Figure 13). The best exposed section for observing the Bear Run and Quakertown relationships is at two outcrops along a stream in the NE¼ SW¼ of section 21 (#12645,

#12644 and Figure 10). The latter section is also the best exposure of the Mississippian-Pennsylvanian contact in these two townships.

The Anthony and Sharon coals were found only in the subsurface. Both coals are found in south central section 24 where the #1 coal shows phenomenal local development in thickness (#677). Abandoned Sharon coal mines occur sporadically in a southeast-trending belt from the NW¼ of section 3 to the SE¼ of section 36 and on into the northeastern corner of Paint township. Mr. Roy Hoffecker, West Lebanon, Ohio, the owner and driller of a formerly active Sharon coal shaft mine in the SW¼ SE¼ of section 36, noted than an approximately 4-foot conglomeratic sandstone rested on "Cuyahoga shale" beneath the underclay of this coal (#12875). This represents the most southwesterly reported occurrence of a conglomeratic sand at this horizon in Wayne county. Fragments of conglomeratic sandstone are available on the gob pile of the abandoned mine shaft.

Paint Township

General statement: Pennsylvanian rocks of Paint township have a maximum thickness of approximately 420 feet, which is the thickest section in the county. The named rock units exposed and reported in the township, constituting portions of at least 10 cyclothems, are listed and discussed from youngest to oldest below.

EXPOSED	Middle Kittanning coal
	Lower Kittanning coal
	Putnam Hill limestone Brookville coal
	Tionesta coal
	Upper Mercer limestone Bedford coal
	Upper Mercer coal
	Lower Mercer limestone Middle Mercer coal
	Flint Ridge coal
	Lower Mercer coal
SUBSURFACE	Sharon (#1, Massillon) coal

Discussion: The Middle and Lower Kittanning coals and their associated sediments are best exposed in the strip mines of the Mullet Coal Company in southern section 15, eastern section 16 and 21 (#12602, #12601). In central southwestern section 15 the Middle Kittanning coal may be observed interfingering with fine grained silty sandstone (see Figure 21). Both Middle and Lower Kittanning coals are also exposed in another smaller strip mine in central NW¼ of section 24 (#12622). The Putnam Hill limestone and underlying Brookville coal are well exposed in a small quarry (see Figure 25) about 2500 feet southeast of the entrance to the last-mentioned strip mine. A thin Tionesta

coal occurs in the farm lane just northwest of this limestone quarry.

The Upper Mercer limestone and underlying Bedford coal are found along road cuts of both the new and the abandoned Route # 250 (Figure 17) in the SE¼ NW¼ of section 24. One of the most important drill holes (#681) in the county, penetrating both the Upper and Lower Mercer limestones, is located 50 feet southeast of the 1184-foot bench mark in northwestern section 24. Two nearby Putnam Hill road outcrops (#12623) enable the relationships of the Lower Mercer, Middle Mercer, and Putnam Hill limestones to be well established in this immediate area.

The Upper Mercer coal is exposed within an old drift-mine entry in the woods along a creek in the NW¼ SE¼ of section 20. Nearby drill holes (#689) establish the relationship of this coal to the Lower Mercer limestone. Lower Mercer limestone and the underlying black Middle Mercer shale crops out in a ravine in the central NE¼ of section 24. A small abandoned probably Lower Mercer limestone quarry is located in the NE¼ SE¼ of section 13. The Middle Mercer coal may be observed in a ravine approximately 300 feet northwest of a large stone farmhouse in west central NE¼ of section 24. A slumped outcrop of Flint Ridge coal may be found in central southeastern section 24 in an abandoned road cut just north of Route # 250. The

Lower Mercer coal crops out nearby to the southeast in a Route #250 road cut (#12615) approximately 700 feet northwest of the Wayne-Stark County line.

Shafts to the formerly mined Sharon (#1, Massillon) coal are found near the center of the southern section line of section 1 and in the NW¼ of section 1, just southeast of the town of West Lebanon. A 5-foot coal bed discovered while drilling is reported (#688) from the SE¼ SE¼ of section 22 as being "Massillon coal."

Salt Creek Township

General statement: Pennsylvanian rocks of Salt Creek township have an approximate maximum thickness of 220 feet. Named rock units found in the township are listed below in stratigraphic order, and at least one outcrop of each is described.

EXPOSED	Lower Kittanning coal
	Putnam Hill limestone Brookville coal
	Tionesta coal
	Upper Mercer limestone Bedford coal
	Upper Mercer coal
	Vandusen coal

Discussion: The best outcrop of the Lower Kittanning coal can be found at a spring just west of the road in south central section 10 (#12653). An old mine entry and coal blossom in northeastern section 9, as well as a coal blossom in south central section 4, indicate the second occurrence of this coal in Salt Creek township (see also p. 69). A small abandoned quarry of Putnam Hill limestone is located in the SW¼ NE¼ of section 23. Conrey (1921, p.114) notes that the underlying Brookville coal attains a thickness of 3 feet and was formerly extensively mined in this locality. He also notes a probable Tionesta coal that is reported here about 30 feet below the Putnam Hill; a well (#12870) within ½ mile to the north of this quarry confirms this Tionesta interval. Tionesta coal blossom also occurs in a road cut in the NW¼ NE¼ of section 15.

The Upper Mercer limestone, underlain by a thin Bedford coal, crops out just southwest of the bridge in central SE¼ of section 9. A hill in south central section 4 is underlain by this same limestone, and a reportedly thick Bedford coal was formerly mined from several slope-mine entries on the southwestern and northern slopes of the hill. The Upper Mercer limestone, bearing Fusulinella iowensis, crops out nearby at the head of a gully a few feet east of the highway, approximately 1300 feet southwest of the crossroads in the SE¼ NE¼ of section 4.

A coal tentatively correlated as Upper Mercer is found exposed in two benches just above a high Mississippian residual hill in the SE¼ SE¼ of section 6 (#12652). Two good exposures which include tentatively correlated Vandusen coals are found in southern Salt Creek township. One is located along a deep streamcut approximately 1000 feet east of the bridge in the SW¼ SW¼ of section 14 (#12654) and the other, which is just above the Mississippian-Pennsylvania contact, is found in a road cut in the SE¼ NE¼ SE¼ of section 20.

Franklin, Clinton, Wooster and Wayne Townships

General statement: Pennsylvanian rocks in Franklin township have an approximate maximum thickness of 250 feet. Rocks of similar age in Clinton, Wooster, and Wayne townships are represented mostly by thin outliers of limited extent whose Pennsylvanian age has been established only on the basis of observed or reported occurrences of coals. Such coals, far from identified limestones, can only be tentatively correlated.

Named units occuring in at least one of these townships are listed from youngest to oldest below.

EXPOSED	Lower Kittanning coal
	Putnam Hill limestone Brookville coal
SUBSURFACE	Tionesta coal
EXPOSED	Upper Mercer limestone Bedford coal
	Lower Mercer coal
	Vandusen coal
	Bear Run coal
	Quakertown coal
	Anthony coal
	Sharon coal
	Sharon conglomerate or conglomeratic sandstone

Discussion: In the following examples of the better exposed outcrops of each of the above units, all references are to Franklin township unless stated otherwise.

The Lower Kittanning coal is found only in southeastern Franklin township where the coal crops out near an old mine entry on the western slope of a hill in the NW¼ SE¼ of section 23 (#12865). A well record (#674) also indicates the position of the coal in southwestern section 24.

Outcrops of the Putnam Hill limestone, Brookville coal, and Upper Mercer limestone are limited to central and southeastern Franklin township. An abandoned Putnam Hill

limestone quarry is located in the central NW¼ of section 22. A 5-foot outcrop of Putnam Hill limestone underlain by a 1.6-foot Brookville coal was observed at a spring site in the SE¼ SE¼ of section 15 (#12863). Numerous abandoned Brookville drift mines are also found in Franklin township (see Economic Geology chapter). Evidence of the Tionesta coal, although probably reported by Wright in 1882 (#12860) as exposed, was only found in well records (#675) by the present author. The best section showing the relationships between the Putnam Hill limestone, Fusulinella iowensis-bearing Upper Mercer limestone, Bedford coal, and tentatively correlated Lower Mercer and Vandusen coals, is found in the NW¼ SW¼ of section 22 and the SE¼ SE¼ of section 21 (#12868). A coal tentatively correlated as Lower Mercer was formerly mined in the NW¼ SW¼ of section 10 in Clinton township.

A tentatively correlated section including both Bear Run and Quakertown coals is found along a farm lane in the NW¼ NE¼ of section 3 (#12854). A coal tentatively identified as Anthony was formerly mined in the SW¼ SW¼ of section 10 and can be found at the drift entry just above the Mississippian-Pennsylvanian contact (#12859).

The best exposure of Sharon conglomerate and conglomeratic sandstone is located at Springtown in the SW¼ SW¼ of section 18, where the conglomerate lies on

Mississippian siltstone (Figure 4). A nearby coal blossom on the hill south of this crop is believed to be the Sharon coal (#12864).

STRUCTURE

Regional structure: Pennsylvania rocks of Wayne County are regionally situated on the west flank of the Appalachian basin and subsequently broadly reflect a southeasterly dip. This regional dip is demonstrated by the occurrence of the youngest bedrock of the county in southeastern Wayne County, with progressively older rocks occurring in a general northwest direction. Superimposed regional and local flexures, discussed below, make estimations of this regional southeasterly dip hazardous. However, the average of random regional calculations within the county indicate a dip of 11.7 feet per mile in a S 20° E direction.

It is noted that the southeasterly dip of the Putnam Hill limestone is greater than that of the overlying Lower and Middle Kittanning coal beds. This is believed due to the southeastward thickening of the intervals between these rocks in Wayne County. Similar southeastward thickening of underlying rock intervals is noted and illustrated in Figure 16. Such thickening indicates contemporaneous subsidence of areas to the southeast during deposition of these Pennsylvania rocks in Wayne County.

Superimposed on the regional southeastward dip are flexures associated with the north-northwest-trending regional Cambridge arch and the Parkersburg-Lorain syncline. Lamborn (1938, p.8-9) describes these two structural trends

in Ohio as follows:

> The most prominent structure in the eastern half of Ohio and secondary only to the Cincinnati anticline in height and extent is the Cambridge arch. This arch is a broad, irregular structure, the axis of which may be represented by a line extending from St. Marys, Pleasant Township, West Virginia, to the northwest in the direction of Cleveland. This structural arch is narrowest and most strongly expressed in Washington, Monroe, and Noble counties, becoming broader and less pronounced to the northwestward. The highest part of this structure is generally near its western edge but the surface of the arch is marked by many structural depressions, noses, and terrace-like features.
>
> From the west edge of the Cambridge arch the beds dip steeply in a westerly direction for a few miles before again rising with the regional slope toward the Cincinnati arch. A structural trough is thus formed which parallels the Cambridge arch and lies a few miles to the west of it. As the axis of this trough can be roughly represented by a line extending from Lorain, Lorain County, through Millersburg, and Coshocton, to the Ohio River near Parkersburg, West Virginia, it can be appropriately called the Parkersburg-Lorain syncline. This syncline is best developed in the Marietta region..... The trough becomes narrower and shallower to the northwest of Marietta in the east-central part of the State, and in Lorain County in the northern part it is poorly defined.

Evidence for the Cambridge arch in Wayne County is best seen on a regional subsurface map of the Mississippian Berea sandstone (shown in part in Plate II). On this map the arch appears as a broad undulating high with local closures, in eastern Wayne and western Stark Counties. The western edge of this arch appears to enter Wayne County in southeastern Paint township, and to extend in a

northwesterly direction to east central East Union township, then north to northeastern Green township. North from Green township its western limit is poorly defined. A local closure on the top of the arch is found in northwestern Baughman and northeastern Green township.

It is interesting to note that a projection of this western edge of the arch from Holmes County[1], based on contours drawn on the Putnam Hill limestone (a younger stratum than the underlying Berea), indicates a slight westerly shift of at least 5 miles for the western edge of the Cambridge arch from Paint into Salt Creek township. Lack of data precludes contouring the Putnam Hill in Salt Creek township, Wayne County; however, two bedrock observations tend to confirm the existence of the arch at the surface in Salt Creek township and thus also indicate a western shift of the west rim of the arch since Berea time. These outcrop data are as follows: (1) the highest recorded evelation (1203 feet) of the Upper Mercer limestone in the County is found in east central section 4 of Salt Creek township, (2) one of the highest Mississippian-Pennsylvanian disconformable contacts (1145 feet) can be observed in a road cut in the SE¼ SE¼ of section 6 of Salt Creek township.

Evidence for the Parkersburg-Lorain syncline can also be observed in both the surface and the subsurface of Wayne

[1]Projection of a line delimiting the western rim of the arch in Holmes County by Lamborn in White (1949, map VI).

County, and a westerly shift of the syncline appears to have occurred and to correspond with the shift of the Cambridge arch described above. Regional subsurface contours on the Berea sandstone (see Plate II) indicate that the syncline is a broad flexture centering in south central Salt Creek township and extending northward into Green township. North of Green township it is poorly defined. Projection of data based on the structure of the Putnam Hill limestone in Holmes County[1] indicates that the axis of the syncline in these younger rocks should enter Wayne County in Franklin township. Outcrops in southern Franklin township are insufficient for contouring but they are consistently lower in elevation than those to the east in Salt Creek or Paint townships, and therefore tend to confirm the existence of the syncline in Franklin township. The lowest elevation recorded for the Putnam Hill limestone or the underlying Brookville coal in the county occurs at an abandoned mine entry in the east central SW¼ of section 24 of Franklin township.

Local structure: In addition to the regional structural trends discussed above, minor local structures occur with measured dips up to 400 feet per mile, which appear to lack preferred orientation and are believed due to either differ-

[1] Contours and axis of syncline drawn by Lamborn in White (1949, map VI).

ential compaction, slide, slump, or a combination of these phenomena. Evidence for such phenomena as observed in the field is cited below.

(1) Two outcrops, approximately 11 miles apart, show steeply sloping well-indurated residual hills of Mississippian sandstone or siltstone. On the flanks of these residual hills occur differentially compacted, slumped, and locally contorted Pennsylvanian shales and clay bonded sandstones (see Figure 5 (#12636) and Figure 3 (#12644).

Conditions favoring differential compaction, slide, slump, or a combination of these phenomena in the stratigraphic column of Wayne County can be listed as follows,

(1) The presence of readily compacted underclays, shales, (both of these often capable of flowing under pressure) and heavily clay bonded sandstones of Pennsylvanian age disconformably overlying relatively non-compactable Mississippian sandstones and siltstones. The latter show widespread structural relief (Plate II) which may act as a source of slopes and ridges for early slump phenomena and later differential compaction.

(2) The common lenticularity of coals, clays, and associated shales, and the replacement of these beds with less compactable sandstone bodies, providing local conditions for small scale differential compaction.

(3) The presence of structural relief (necessary for sliding and slump phenomena) in early Allegheny time during or prior to the deposition of the Putnam Hill limestone in Paint township. This information is based on structural and isopach data (Plate III) which indicate that the thickest limestone was deposited in the structural lows. A thickening of the whole Brookville cyclothem (beneath the Putnam Hill limestone) over structural lows and thinning over structural highs is noted by Gray (1954, p.83) in the Beach City area a few miles to the southeast of Paint township, Wayne County.

Although outcrop control is not sufficient for measuring the extent or size of the phenomena discussed above, it is believed that anomalous dips due to buried ridges (especially buried Mississippian residual "hills") may be reflected up through a considerable thickness of sediments and should therefore be regarded as the possible source of many so called "local surfical anomalous dips."

ECONOMIC GEOLOGY

Introduction: Pennsylvanian rocks of eastern Ohio have long been know for their great variety of mineral wealth. Deposits of coal, clay, shale, limestone, sandstone, and iron have been found in these rocks on the surface; reserviors of water, oil, gas, and salt brine have also been found in subsurface Pennsylvanian rocks. In Wayne County, deposits of Pennsylvanian coal, clay, limestone, and sandstone have been or are being worked. Subsurface Pennsylvanian sandstones serve as a primary local source of water supply in areas of the county underlain by these rocks.

Coal

General statement: Past coal production in Wayne County has included the Massillon (#1, Sharon or locally named "Blue Chippewa") coal, the Brookville (#4) coal, and limited amounts of Anthony, Lower Mercer, Upper Mercer, Bedford, and Tionesta coals. Present production in the

county is chiefly from the Lower Kittanning (#5) coal, and restricted amounts from the Middle Kittanning (#6) coal. The established original reserves of the Lower Kittanning coal bed in Wayne County is given as 12,547,000 tons by Brant (1954, p.54). Potential future production, besides limited deposits of the coals presently being worked, includes (1) isolated undiscovered basins of the Massillon coal, (2) strippable peripherial areas of abandoned Massillon coal mines and (3) strippable areas of local thickening of the usually thin coals of the county. Each of these three - past, present, and potential future production topics will be briefly discussed.

Past coal production: Past coal production of the Massillon (#1, Sharon) coal has been limited to numerous shafts and a few slope and drift mines in Chippewa, Baughman, Sugar Creek, and Paint townships. This area represents the western edge of the Massillon coal field, which is centered in adjacent western Stark County. The reader is referred to a discussion of this field by Orton (1884, p.773-815) and to discussions of the coal in Wayne County by Conrey (1921, p.129-132) and Read (1878, p.532-533).

Abandoned mine entries found by the author in the field or located by old mine maps, indicate that the Massillon coal was formerly mined in portions of the following sections: Chippewa township, sections 2,3,12,15, 26,35,36; Baughman township, sections 12,21,25,27,28; Sugar

Creek township, sections 2,3,10,11,15,24,25,36; Paint township, sections 1,12. Drill-hole records and mine maps often indicate that thick Massillon coal extends into areas adjacent to the above sections in which the coal was mined. The most accessible and best exposed occurrence of the Massillon coal in the county is located just inside an abandoned drift-mine entry in the NE¼ NE¼ of section 25, Chippewa township, approximately 150 feet north from the road (see Figure 22 and section #12635). At this entry the hard, blocky Massillon coal is over two feet thick and has a well exposed thick sandstone roof. Although sandstone, as in this case, sometimes forms the roof, shale is the more common roof rock of the Massillon coal.

This basal Pottsville coal does not occur as a sheet-like deposit but rather as lenticular bodies representing former local basins of swamp environment. Both the floor and the roof of the coal are known to be uneven. Orton (1884, p.776), in discussing the discrepancies in elevations of this coal of the Massillon field, notes that

> .....it is necessary to bear in mind that the elevations of the coal in different parts of the same mine have a play of 20 to 50 feet, irrespective of any general dip.

The possibility of such local dips must be kept in mind when dealing with the Massillon coal of eastern Wayne County; divergences of 40 feet within a mile can be demonstrated, as in the Hametown area, approximately 1½ miles northeast of Doylestown. Another possible error is the

mistaking of the Quakertown coal for this undulating Massillon coal, as the former can ride down to within 35 feet of the Massillon coal.

In Wayne County the Massillon coal is usually found in a single hard thick bed, averaging 5.1 feet thick with a range of 0 to 8 feet. Only one occurrence has been reported of the coal occurring in two benches; in northern section 12 of Chippewa township 5 feet of coal is overlain by 3 feet of conglomerate, which in turn is overlain by 3 feet of coal having a thick sandstone roof.

The quality of the coal of the Massillon field has been described by Orton (1884, p.777-778), and Bownocker and Dean (1932, p.8-13), and summarized by Bownocker (1917, p.38). The latter author notes the following:

> The coal is open burning (that is, it does not fuse during combustion), lustrous, produces a good proportion of lump, and stands transportation well. Films of calcium carbonate known as "white cap" are common on the surface of the coal and give it a spotted appearance. The coal along the western margin of the field, although good, is not quite up to the highest standard of the bed. The great use of the coal has always been for domestic purposes. It is clean, ignites easily, makes a hot fire, and produces little ash. It contains an average of about 53½ per cent of fixed carbon, 37 per cent of volatile matter, 5½ per cent of moisture, and 4 per cent of ash. Fifteen samples gave an average of 4.2 per cent of ash, two of these showing less than 2 per cent and the highest 6.6 per cent. Cleveland has always been the principal market for the coal.

The low sulphur and ash content which make this coal very desirable is illustrated by two recent analyses from the

Burton City area. (Baughman township), kindly furnished by Mr. Atlee E. Mullet of the Mullet Coal Company, Mt. Eaton, Ohio, listed below.

PROXIMATE ANALYSIS	Sample from hole#2 AIR DRY	Sample from hole#2 MOISTURE FREE	Sample from hole #1 AIR DRY	Sample from hole #1 MOISTURE FREE
Moisture (oven dry)	2.01 %		1.02 %	
Ash	3.82	3.90 %	3.20	3.23 %
Volatile Matter	42.41	43.26	41.89	42.31
Sulphur	.74	.75	.58	.59
Fixed Carbon	51.02	52.09	53.31	53.87
Calorific Value(B.T.U.)	13,675	13,948	14,010	14,150

Analyses by Wadsworth Testing Laboratory, Canton, Ohio. November 1949

The Brookville (#4) was extensively mined in the past in the southeastern quarter of section 23, Salt Creek township, as reported by Conrey (1921, p.112). He notes that the coal is 2½ feet thick, has one 2-inch shale parting, and is overlain by a 4-foot bed of Putnam Hill limestone. Two abandoned drift mine entries of the Brookville coal can be observed in the eastern part of the SW¼ of section 24 of Franklin township. A description of the coal at one of these mines and its analysis is noted by White (1949, p.184-185):

	Feet	Inches
Limestone, Putnam Hill		
Shale, calcareous	0	1/2
Coal, sampled	0	6 1/2
Shale, rejected	0	1/4
Coal, sampled	0	2 3/4
Mother coal, sampled	0	1/4
Coal, sampled	0	3 1/2
Shale, dark, rejected	0	2 1/2
Coal, sampled	1	5 1/2
Shale, black, sampled	0	1/4
Coal, sampled	0	3 1/2
Clay	4	0

	As received	Moisture free
Moisture	6.81 %	0.00
Volatile mat.	42.64	45.76
Fixed carbon.	40.54	43.50
Ash	10.01	10.74
	100.00	100.00

	As received	Moisture free
Carbon	64.53 %	69.24 %
Hydrogen	5.55	5.14
Oxygen	15.87	10.55
Nitrogen	.76	.81
Sulphur	3.28	3.52
Ash	10.01	10.74
	100.00	100.00

Air drying loss 2.03 per cent

		As received	Moisture free
Heating value	Calories	6,548	7,072
	B.T.U.	11,787	12,649
Fusion of ash	Incipent	2300° F.	
	Complete	2399° F.	

Capacity of mine, about 25 tons per day. Analysis by D. J. Demorest.

Numerous abandoned drift mines of the Brookville coal can also be found in sections 22 and 23 of Franklin township. The coal in eastern section 23 is reported from 3 to 4 feet thick with one 6-foot zone reported in the "Frenchmans" mine, the entry of which is located in the central NE¼ of section 23. Conrey (1921, p.112) notes the Brookville coal in drift mines under Sterrett Knob and Munser Knob, 3 feet and 2 feet 7 inches, respectively.

The Brookville has been mined locally in the past to serve as fuel for burning the overlying Putnam Hill limestone. The site of some of these localities will be noted under the discussion of limestone.

Local abandoned drift and slope mines and rare shaft mines testify to the local thickening of commonly thin coals in Wayne County. Identification of these formerly mined coals is not always possible. However, evidence such as the type of mine (drift, slope, shaft) and examination of mine gob piles, mine maps (if available) as well as outcrops, elevations and intervals of nearby known coals or limestones, commonly makes identification possible or tentative.

A tentatively identified small Anthony coal drift mine is located in the SW¼ SW¼ of section 10, Franklin township (#12859), where 1.9 feet of coal (50 per cent bright) occurs at the entrance of the mine entry. The local owner reports that the coal dips and was mined

for 500 feet to the south east, with resulting water trouble causing abandonment of the mine.

A drift mine is located in the NW¼ SW¼ of section 10 of Clinton township and is tentatively related to a thick Lower Mercer? coal bed which has been also noted in local drill records of the area.

A coal believed to be the Upper Mercer coal is reported as 2 feet thick by the owner who stripped a small part of this coal in the SE¼ NE¼ of section 27 of Sugar Creek township (#12649).

The Bedford coal was formerly mined 2 miles south of the town of Apple Creek where several slope-mine entries can be found around a hill in the SE¼ of section 4. Both the limestone and coal are reported as unusually thick here; the Upper Mercer limestone ranging from 4 to 6 feet thick and the underlying coal up to 4 feet thick with several thin shale partings.

Only two small abandoned Tionesta coal mines were found. One drift mine is located in the SW¼ SW¼ of section 10 of Paint township on the northwestern slope of Mt. Eaton hill. A local thickening of the Tionesta in the NE¼ of section 13 of Salt Creek township and adjoining NE¼ of section 18 of Paint township has been the site of former Tionesta drift and strip mines, respectively. White (1949, p.155) describes the Tionesta coal at the strip mine as follows:

.....the coal was mined by stripping in 1945 by the Blue Crystal Mine, Inc.....A section measured at the east end of the pit is as follows:

	FT.	IN.
Glacial drift; till, pebbly to cobbly, with silty matrix; ranges in thickness from 0 to 20	12	0
Sandstone, coarse: preglacially weathered to 1 - to 2 - inch beds and into brick-like blocks	8	0
Coal, bright, fine-banded, with ½ - inch anthraxylous layers	2	5
Shale, carbonaceous, dark gray to black	0	3
Coal, bright, blocky, anthraxylous	2	4
Sandstone, white, clay-bonded	2	0

Approximately 1.9 feet of Brookville coal and 2.0 feet of Putnam Hill limestone can be found in the western parts of this strip mine.

Limited amounts of the Lower Kittanning coal have been mined by shafting and drifting in Paint township according to Conrey (1921, p.133). All discussion of this coal, however, is made in the following section on present coal production.

Present coal production: Wayne County coal production within the past 8 years has been limited to parts of sections 15,16,21,24, Paint township. Production is confined mostly to the Lower Kittanning (#5) coal; local occurrences of the Middle Kittanning (#6) coal are also stripped when it occurs above desired Lower Kittanning

coal. The Mullet Coal Company, Mt. Eaton, Ohio, is the sole coal producer in the county at present.

The lower Kittanning coal is usually a hard bright blocky banded coal averaging 29.1 inches thick. A maximum thickness of 52 inches is recorded for the coal in east central section 21 (see Figure 24). The coal is underlain by a thick, commonly plastic clay and is overlain by shale (#12601).

The Middle Kittanning coal is a thin bright lenticular coal averaging 10 inches thick (see Figure 20). The coal is most commonly underlain by clay and overlain by shale; but it is locally replaced by silty sandstone and shale (see Figure 21).

Coal from the Mt. Eaton strip mines is trucked from a centrally located tipple to nearby cities for both domestic and industrial use. The production figures listed for 1946-54 in Figure 23 represent output from the above-mentioned Paint township strip mines of the Lower and Middle Kittanning coals.

Future coal production: Only small amounts of Lower and Kittanning coal remain in Paint township of Wayne County. The #5 coal occurs in sections 4,9, and 10 of Salt Creek township, as discussed on page 69, however, its distribution is confined to the tops of two small hills and the thickness has been established at the only one place (#12653). The high, heavily drift-covered southeastern

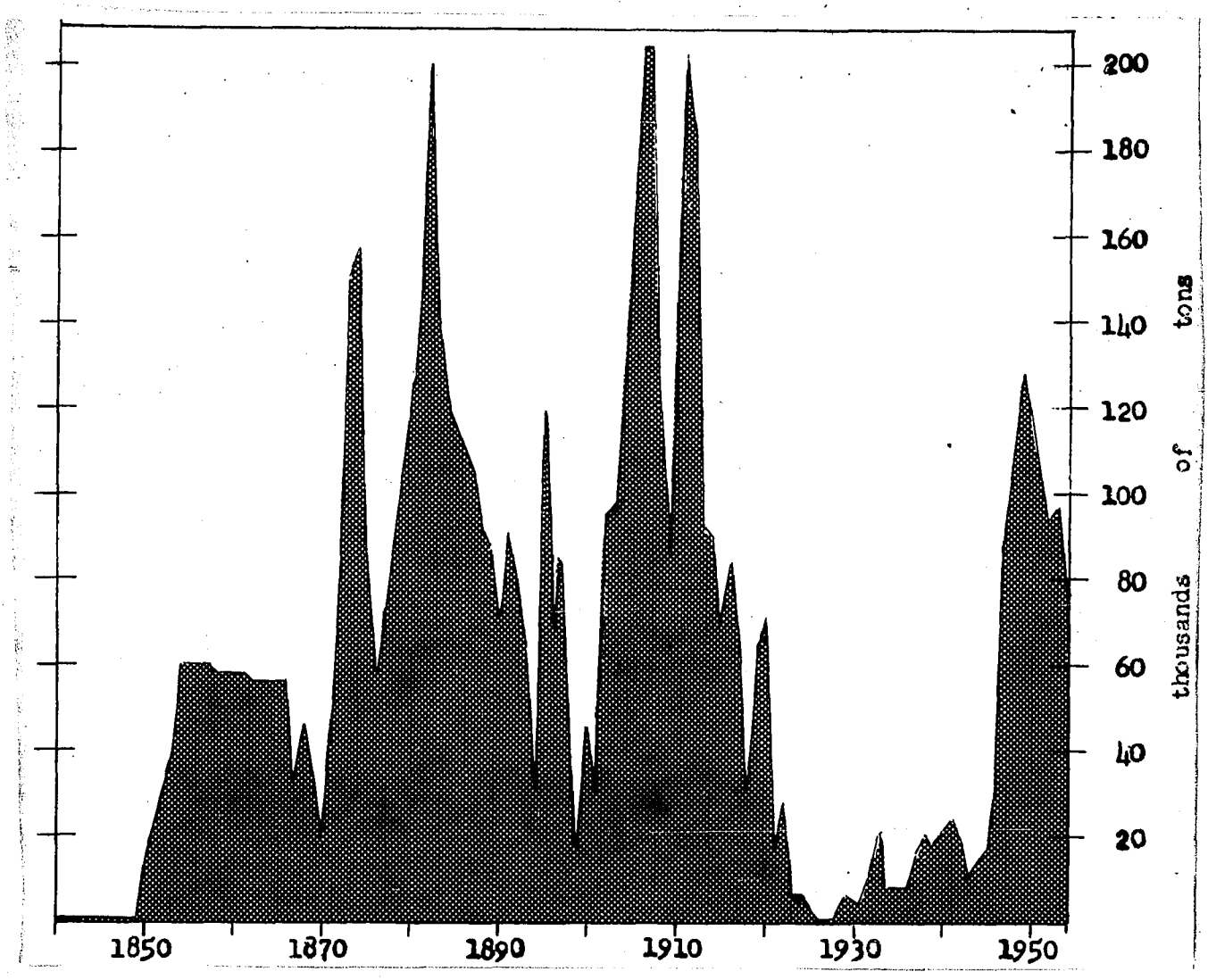

Figure 23 Annual reported coal production in Wayne County. Production figures from part of a pending state publication by Mrs. Marion S. Klein, Ohio Divison of Geological Survey. Production estimated for 1944.

portion of Salt Creek township, disucssed on page 65, represents the largest potential area for the #5 as well as the #6 coal left in the county, although no indications have been found to indicate the presence of either coal here. Conrey (1921, p.114) reports the #5 coal as being 3 feet thick in southwestern section 24 of Franklin township; a drift-mine entry and a drill record (#674) also indicate the local presence of the #5 coal under this hill, however, further drilling would be necessary to determine the coal's continuity and thickness.

Numerous areas mentioned in the previous discussions indicate the presence of a Brookville coal more than 2 feet in thickness. The tendency for this coal to become shaly necessitates closely spaced drilling to define desirable acreage. The overlying high-calcium Putnam Hill limestone and underlying clay should be considered as possible by-products of this coal.

Abnormal thicknesses of the coals lying between the Brookville and the Massillon coals have been noted above in the discussion of past production. The discovery of similar locally thick deposits of such coals may be expected and may result in local production.

Future production from Massillon coal beds appears limited unless considerable exploration in one of the following two forms is undertaken: (1) exploration drilling for additional pockets of Massillon coal, preceded by

Figure 24 Strip mining the Lower Kittanning coal in section 21, Paint township, by the Mullet Coal Company, Mt. Eaton, Ohio. The coal at shovel is 52 inches thick.

a survey using such aids as elevations, intervals, and outcrop information on basal Pottsville coals, as well as old mine maps, and drill-hole data. Some recent drilling has isolated several local thick undeveloped areas of this coal, proving that such coal pockets do exist. (2) Exploration drilling along fringe areas of abandoned mines where topographic relief would permit stripping operations in the peripheral areas of unmined coal. A survey of old mine maps of Massillon coal indicates that very often considerable peripheral areas of proven coal were not mined owing to the indicated notation "poor roof" on the maps.

A discussion of the rare element germanium, found in small quanities in coal ash, is given by Brant (1953) and Stadnichenko et al. (1953). The results of the only known analysis of the Massillon coal in Wayne County for germanium are listed below. They were kindly furnished by Mr. E. P. Weckesser, Doylestown, Ohio, who took the following 5 samples from a Massillon coal seam located in the SE¼ SW¼ of section 15 of Chippewa township.

E-P Spectro ref. number	sample description	% oxidation residue	%Ge oxide residue	% Ge in sample
5305-842	top 5" of seam	7.77	0.030	0.0023
5305-843	center of seam	2.77	0.0038	0.00111
5305-844	bottom 5"of seam	21.57	0.021	0.0045
5303-682	gob pile	84.99	less than 0.001	less than 0.00085
5210-393-	refuse from gob pile	36.05	0.0105	0.0038

CLAY and SHALE

General statement: Pennsylvania clays under both the Brookville and Bedford coals of Wayne County have been worked in the past for raw material for local ceramic plants. Small amounts of shale have been worked for similar use. Current production of Pennsylvanian clay is small and limited to infrequent shipments of the clay under the Lower Kittanning coal to plants outside the county. Data concerning the quality of Pennsylvanian clays in the county are few, but information is more available concerning distribution, thickness, and accessibility for possible future development.

Past clay and shale production: The clay under the Brookville #4 coal is noted by Stout et al. (1923, p.234-235, 242) as being formerly mined near Fredericksburg by the Sampson Brick and Clay Company for the manufacture of building blocks. The abandoned mine from which the clay was taken is located in the SE¼ SW¼ of section 24, Franklin township. Stout also notes that the overlying 2-foot-10 inch Brookville coal and adjacent Pottsville shale were used as sources of fuel and raw material, respectively. An analysis of this clay by D. J. Demorest is given below.

Moisture at 105°.....	2.09 %
Ignition loss.....	10.13
Silica, SiO_2.....	51.31
Alumina, Al_2O_3.....	28.39

Ferric oxide, Fe_2O_3.....	2.95 %
Titanic oxide, TiO_2.....	2.01
Lime, CaO.....	.38
Magnesia, MgO.....	.60
Sodium oxide, Na_2O..... ...	.28
Potassium oxide, K_2O.....	1.78
Phosphorous pentoxide, P_2O_5	.01
Manganese oxide, MnO.....	.01
Sulfur, S.....	1.00
Inorganic carbon.....	.00
Total carbon.....	.75

Stout et al. (1923, p.235) notes an exposure of 2 feet 7 inches of Brookville coal and 10 feet of underlying clay in section 21 of Franklin township.

Along the southern section line of south central section 14 of Salt Creek township, an abandoned slumped clay pit is reported by Mr. C. J. Hosseld, local resident, to contain 4 to 5 feet of formerly worked "ceramic clay" under 3.5 feet of Brookville coal.

The clay underlying the Bedford coal was used by the E. Houghton and Co. ceramic plant in Dalton for many years. This clay was obtained from a 8-foot bed of siliceous clay overlain by 1 foot of Bedford coal in the SW¼ NE¼ of section 9, Sugar Creek township. Stout et al. (1923, p.192) states that the clay showed exceptionally good working and burning qualities, burning to a good clear color. They also note possible use for this clay as follows: low-heat refractories, face brick, hollow block, fireproofing, sewer pipe, stoneware. A chemical analysis by D. J. Demorest of this clay from the Houghton and Company pit is given below.

	%
Moisture at 105°	1.82
Ignition loss	6.86
Silica, SiO_2	60.41
Alumina, Al_2O_3	23.71
Ferric oxide, Fe_2O_3	1.93
Titanic oxide, TiO_2	1.05
Lime, CaO	.22
Magnesia, MgO	.50
Sodium oxide, Na_2O	.16
Potassium oxide, K_2O	2.84
Phosphorus pentoxide, P_2O_5	.02
Manganese oxide, MnO	.02
Sulfur, S	.04
Inorganic carbon	.09
Total carbon	.19

Current clay production: Only limited quantities of the clay under the #5 coal are currently being mined in Wayne County. This clay is removed in stripping operations of the Mullet Coal Company in section 21 of Paint township and sold for ceramic use in the nearby city of Massillon.

Future clay and shale production: Information on distribution and thickness of the clays under each of the Pennsylvanian coals in the county can be gleaned from the discussion and diagramatic rock sections (pages 22,33,49, and 66) in the section on stratigraphy. Pertinent remarks concerning a few of these clays are given below.

Considerable quantities of the clay under the Lower Kittanning coal, and smaller quantities of the clay under the Middle Kittanning coal, are found in the currently operated or abandoned stripping pits in the Mt. Eaton area. An average of 11 measurements indicate that the clay under

the lower Kittanning coal is 3.8 feet thick with a range of 0 to 6 feet. Eight measurements of the clay under the Middle Kittanning coal indicate an average of 4.5 feet thickness with a range of 0 to 11 feet.

It is interesting to note here that the shales between the Putnam Hill limestone, Lower Kittanning coal and Middle Kittanning coal, have been used in Clark township, Holmes County, for the making of drain tile. White (1949, p.208-209) gives a detailed account of this shale, including a chemical analysis and tests on physical properties and firing behavior. The latter tests indicate that the shale could also be used for face brick, common brick, and possibly for hollow tile. Shales of similar stratigraphic position occur in Wayne County, but to the authors knowledge, no chemical or physical tests of such shales have been made.

The clay under the Brookville coal represents the greatest volume of readily accessible Pennsylvanian clay in the county. This clay is found beneath the Brookville coal and the overlying Putnam Hill limestone in portions of Franklin, Salt Creek, and Paint townships, as well as in small areas of Sugar Creek township. Local isolated knobs and high flat ridges held up by the limestone make this clay more readily available for strip mining. The overlying limestone and coal should be considered as possible marketable by-products of the clay mining. Although the average of 20 measurements of this clay indicate

a thickness of only 1.5 feet, with a range of 0 to 4 feet, local deposits are consistently thicker than this average figure and reports indicate clay up to 10 feet thick.

The average of 11 measurements of the clay under the Bedford coal indicates a thickness of 2.2 feet thick with a range of 0 to 4 feet. Local occurrence of this clay up to 8 feet thick has been reported. This clay is found in the same townships as noted above for the clay under the Brookville coal, but due to its lower stratigraphic position and consequent lower elevation, it is less accessible for stripping than the overlying clay deposits.

The clay under the Massillon coal is one of the thickest but also one of the most inaccessible clays in the county. This clay was found to average 3.1 feet thick and to have a range of 0 to 11 feet thickness. The only data available on the quality of this clay are those given the author by Mr. E. P. Weckesser, Doylestown, Ohio, who sent two samples of the clay found below the Massillon coal in SE¼ SW¼ of section 15 of Chippewa township to the laboratories of the National Lead Company for analysis. The results of a petrographic examination and x-ray analysis show that both clay samples contain about 65 % quartz, 30 % kaolin and 5 % muscovite. The germanium content was noted as less than .005 %.

LIMESTONE

General statement: Only three Pennsylvanian limestone beds are known to occur in Wayne County, namely the Lower Mercer, Upper Mercer, and Putnam Hill limestones. Outcrops of the Lower Mercer limestone are rare, as the rock commonly lies at or below drainage in the county. The Lower Mercer was found to average 2 feet thick and to range from 0 to 4 feet. Outcrops of the Upper Mercer limestone are more common and thicker than those of the Lower Mercer limestone. The Upper Mercer averages 2.4 feet thick and ranges from 0 to 7 feet thick. Although farmers report burning this limestone for agricultural lime, the common occurrence of flint in this rock would appear to limit its use to such purposes as road metal.

The Putnam Hill limestone of Wayne County has been and is being used locally for both agricultural lime and road metal. The Putnam Hill is a medium to light, finely crystalline, hard persistent limestone which breaks up on weathering into diagnostic thin, easily quarried, undulatory plates from 1 to 2 inches thick (see Figure 25). An average of 54 measurements of the Putnam Hill limestone indicates an average thickness of 3.0 feet and a range of 0 to 7 feet.

Local small farm quarries of this limestone can be found in Paint township, as in the SW¼ NE¼ of section 24,

along the northern section line of section 16, and in the NE¼ SW¼ of section 8. Somewhat larger abandoned quarries can be found in the NW¼ of section 24 and the SE¼ of section 17 of Paint township; the SE¼ of section 23 of Salt Creek township; and in the NW¼ of section 23 of Franklin township. Considerable areas of strippable, flat-topped hills capped by this limestone occur in Paint and Franklin townships as well as in local areas of Salt Creek townships. The underlying Brookville coal and clay should be considered as possible marketably by-products of the limestone. Both the limestone and clay are mined by the Holmes Limestone Co. in adjacent Salt Creek township of Holmes County. Current production in Wayne County is limited to isolated small farm quarries.

A map illustrating the undulating character and local thickness of this limestone in Paint township is given in Plate III.

Chemical analyses of a Putnam Hill limestone sample taken from a quarry of Clinton M. Harrold, section 24, Paint township (sample #1 below), and another taken from a quarry of the Schwartzentroger Brothers (sample #2 below), in section 22 of Franklin township, are listed below.

	spl. #1	spl. #2
	%	%
Silica, SiO_2	3.53	1.80
Alumina, Al_2O_3	1.70	0.77
Ferric oxide, Fe_2O_3	0.03	0.08

(see page 124 for remainder of analyses)

Figure 25 Weathered Putnam Hill limestone showing characteristic thin, undulating beds and plates, in a small farm quarry in the SW¼ NE¼ of section 24, Paint township. The stone is quarried by hand for road metal and for burning for agricultural purposes.

	%	%
Ferrous oxide, FeO	1.12	0.73
Iron disulphide, FeS_2	0.05	0.08
Magnesium oxide, MgO	1.02	0.99
Calcium oxide, CaO	50.16	52.27
Strontium oxide, SrO	0.01	0.01
Barium oxide, BaO	0.01	0.01
Sodium oxide, Na_2O	0.03	0.02
Potassium oxide, K_2O	0.10	0.11
Water, hydroscopic, H_2O	0.25	0.19
Water, combined, H_2O	0.49	0.20
Titanium dioxide, TiO	0.08	0.05
Phosphorus pentoxide, P_2O_5	0.18	0.15
Sulphur trioxide, SO_3	0.09	0.03
Manganous oxide, MnO	0.11	0.13
Carbon, organic, C	0.14	0.04
Hydrogen, organic, H	0.01	----
Carbon dioxide, CO_2	41.00	42.45
(Downs Schaaf, Analyst)	100.09	100.09

Sandstone

General statement: Although large amounts of Pennsylvanian sandstone have been quarried in Wayne County in the past, there is no current production.

Abandoned quarries of the clean conglomeratic Sharon sandstone, used extensively to the northeast as a premium material for industrial uses, can be found on both sides of Chippewa Creek valley in eastern Chippewa township. The greatest recorded thickness of this sandstone here is 75 feet. The sandstone most commonly occurs as a clean, fine to coarse grained, poorly sorted sandstone in thick, locally cross-bedded beds (#12635 and Figures 7 and 8).

Bownocker (1926, p.19, 28-29) describes two of these sandstone quarries and states that the sand was sold for use in steel castings, furnace bottoms, cores, and traction lines. He also gives the following chemical analyses of

unwashed steel molding sand from quarries of the Oliver Silica Sand Company (#1 below) and Franklin Industrial Co. (#2 below).

	# 1	# 2
Silica, SiO_2	98.30	97.47
Alumina, Al_2O_3	.89	.72
Ferric Oxide	.27	.38
Calcium Oxide CaO	.02	.00
Magnesium Oxide MgO	.05	.06
Titanium Oxide TiO_2	.07	.09
Loss on Ignition	.32	.60

Considerable quantities of this sand appear still available on both sides of Chippewa Creek.

Local isolated Pennsylvanian sandstone quarries which were once the source of building stone were found in the following portions of indicated townships: SW¼ of section 11 (see Figure 12), NE¼ of section 26, NE¼ of section 13 of East Union township; SE¼ of section 8 of Sugar Creek township; and the SE¼ of section 4 of Salt Creek township. Some of these quarries still contain considerable quantities of building stone in various degrees of accessibility.

SUMMARY OF STUDY

This report is a stratigraphic study of the Pennsylvanian rocks of Wayne County, which cover an area of approximately 130 square miles. These rocks consist, in order of relative abundance, of sandstone, shale, clay, limestone, and coal, and show a maximum thickness of approximately 420 feet, in Paint township in the southeastern corner of the county. The strata range from the Sharon conglomerate at the base of the Pottsville up to the shale and sandstone overlying the Middle Kittanning coal of upper Allegheny age. Plate IV is the first topographic-base map of these deposits ever compiled.

Thick glacial drift over the county necessitated the examination of nearly every stream course and road cut, as well as a compilation of all available subsurface data, for adequate mapping control. At least 70 percent of the outcrops had to be dug out. A total of 116 sections were found; elevations and correlations were determined for each section. Seventy-three of these sections are listed in the Appendix and are referred to in the text; the remaining may be found in the files of the Ohio Geological Survey. Over 65 percent of these sections are described for the first time; the remaining sections, previously described in general terms, were redescribed in detail, and elevations were determined for all coals and limestones.

A study of the Mississippian-Pennsylvanian contact reveals that Pennsylvanian Pottsville beds lie disconformably on Mississippian beds of both Osagean and Kinderhookian age, with a maximum of 269 feet of relief on this surface in the southeastern portion of the county. The average slope of this disconformable surface was found to be 25 to 40 feet to the mile to the southeast, with buried Mississippian "valleys" lying both parallel and oblique to present present-day drainage channels. Sharon conglomerate and sandstone are found in these deep Mississippian "valleys." Slump, slide, and differential-compaction phenomena are common at the disconformable contact when it occurs on the flanks of Mississippian "hills." A contour map drawn on the top of the Mississippian surface in Wayne County (Plate III) is the first large-scale attempt to map the disconformable surface in the state. Future regional studies will be necessary to properly evaluate tentative conclusions made in this report concerning the apparent dendritic pattern and southeasterly direction of the drainage on the disconformable surface, as well as the amount of structural influence, if any, of older rocks on this surface.

Pennsylvanian rocks of the county were found most readily divisible into cyclothems, each constituting a sequence of sediments from the top of a coal to the top of the succeeding coal. This interval commonly, but not in-

variably, shows an ascending sequence of marine to fluviatile conditions of sedimentation. Cyclothems in this report bear the name of the coal at their top. The diagnostic units (coal, clay, limestone) of individual cyclothems in Wayne County often appear to be lenticular. When such lateral changes occur, the remaining sediments, if any, of a cyclothem are ususally indistinguishable from, and therefore grouped with, the next overlying identifiable cyclothem.

No single rock unit was found to extend over the whole county. Field and well data indicate lateral gradation, interfingering, local cut-outs and non-deposition are responsible for such lateral limitations.

Within the Pottsville the dominant rock type is sandstone; finer clastics and limestones occur more commonly in the upper portions of the group. This generalized trend toward finer clastics appears to continue into the Allegheny group, where shale is the dominant rock type. Rock units tend to become more extensive laterally with decrease in age.

Deposition of Pennsylvanian rocks up to Quakertown time was erratic due to the presence of Mississippian residual "hills." Subsequent deposition was more blanket-like, although Pennsylvanian beds up to and including the sandstone below the Upper Mercer (?) (or younger) coal are in places found abutting against local Mississippian residual

"hills."

Rocks of Pottsville age were found to contain 11 coals, 12 underclays, two marine limestones, and at least one ore and one conglomerate. More than half of the Pottsville coals were identified and described for the first time in Wayne County. These latter coals are the Anthony, Bear Run, Vandusen, Lower Mercer, Flint Ridge, and Upper Mercer. Allegheny rocks of the county were found to contain three coals, two under clays, and one marine limestone. The youngest coal (Middle Kittanning) was described [1] and mapped for the first time in Wayne County.

A short summary of the Pennsylvanian rocks in each township with the location of at least one of the better exposed sections of the named units in each township, is given for those interested in visiting the outcrops.

Nomenclature and correlations below the Middle Mercer coal are by necessity usually tentative and are based on stratigraphic succession from known occurrences of either Mercer limestones or Sharon coal. Rock units above the Middle Mercer coal can usually be named and correlated with more certainity because of the presence of the Fusilinella-bearing Mercer and Putnam Hill limestones.

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[1] Conrey (1921, p.117) indicated the possible presence of the Middle Kittanning coal in one measured section of Paint township.

Distribution of Fusulinella species in Wayne County is recorded, (Table 1). Their occurrence is found to agree with outcrop correlations of named rock units from Holmes County, and their value for stratigraphic work is emphasized and defined.

The average of random regional dips of Pennsylvanian rocks in Wayne County indicates a dip of 11.7 feet per mile in a S 20° E direction. The southeasterly dip of the Putnam Hill limestone is greater than that of the overlying Lower and Middle Kittanning coal beds, probably due to a southeastward thickening of the intervals between these rocks. Such thickening indicates contemporaneous subsidence of areas to the southeast during deposition of these Pennsylvanian rocks in Wayne County.

Evidence for the presence of the regional north-northwest-trending Cambridge arch and Parkersburg-Lorain syncline is found in both surface and subsurface rocks of Wayne County. These flexures are superimposed on the regional southeasterly dip. Both the west rim of the arch and the axis of the syncline appear to have migrated at least five miles to the west between Berea and Allegheny times. Field evidence of, and conditions favoring, differential compaction, slide, and slump, are found in Pennsylvanian rocks of Wayne County. These phenomena are believed responsible for local structures which display a lack of preferred orientation and dips up to 400 feet per mile.

Deposits of Pennsylvanian coal, clay, limestone, and sandstone have been or are being worked in Wayne County. Past coal production has included the Massillon (#1 or Sharon) coal, the Brookville (#4) coal, and limited amounts of the Anthony, Lower Mercer, Upper Mercer, Bedford, and Tionesta coals. Present production is chiefly from the Lower Kittanning (#5) coal, with minor amounts from the Middle Kittanning (#6) coal. Potential future production, besides limited amounts of the coals presently being worked, includes (1) isolated undiscovered basins of Massillon coal, (2) strippable areas around abandoned Massillon coal mines, and (3) strippable areas where there is local thickening of the usually thin coals of the county.

Pennsylvanian clays under both the Brookville and Bedford coals of Wayne County have been worked in the past for raw materials for local ceramic plants. Current production is limited to infrequent shipments of the clay under the #5 coal. Shales between the Putnam Hill limestone and the # 6 coal, as well as clays under the Middle and Lower Kittanning, Brookville, Bedford, and Massillon coals, represent potential future reserves in various degrees of accessibility and quality.

The Putnam Hill limestone is the most readily available and highest quality Pennsylvanian limestone in the county.

Although large amounts of Pennsylvanian sandstone have been quarried for both industrial and building purposes in

Wayne County in the past, there is no current production. Considerable quantities of both industrial sand and building stone are still available in varying degrees of accessibility.

BIBLIOGRAPHY

Bownocker, J. A. (1917) "The Coal Fields of Ohio," in The Coal Fields of the United States, U. S. Geol. Survey Prof. Paper # 100-B.

_____(1926) "Glass Sands of Ohio," Ohio Jour. Science vol. 26, no. 1, pp. 25-41.

_____and Ethel S. Dean (1929) "Analyses of the Coals of Ohio," Ohio Geological Survey, Bull 34.

Brant, R. A. (1953) "Germanium Deposits in Ohio," Ohio Chamber of Commerce Release No. 14.

_____(1954) "The Lower Kittanning No. 5 Coal Bed in Ohio," Ohio Geological Survey R. I. # 21.

Conrey, G. W. (1921) "Geology of Wayne County," Ohio Geological Survey Bull. 24.

Fuller, J. O. (1955) "Sources of Sharon Conglomerate of Northeastern Ohio," Bull. Geol. Soc. Amer., Vol. 66, pp. 159-176.

Gray, H. H. (1954) "Stratigraphy and Sedimentation of Pottsville Rocks near Beach City, Ohio," unpublished dissertation for Ph.D., The Ohio State University.

Hilty, R. E. (1954) "A Stratigraphic Study of the Sediment Overlying the Middle Kittanning Coal in Wayne, Stark, Holmes, Tuscarawas and Coshocton Counties," unpublished report of results of a Senior Independent Study project, Dept. Geology, College of Wooster.

Lamborn, R. E. (1951) "Limestones of Eastern Ohio," Ohio Geological Survey Bull. 49.

_____, C. R. Austin and D. Schaaf (1938) "Shales and Surface Clays of Ohio," Ohio Geological Survey Bull. # 39.

Lockett, J. R. (1924) "General Structure of the Producing Sands in Eastern Ohio," Bull. Amer. Assoc. Petrol. Geol., Vol. 11, p. 1024.

Orton, Edw. (1884) "The Massillon Coal Fields," in Report of the Geological Survey of Ohio, Vol. V, pp. 773-815.

Read, M. C. (1878) "Geology of Wayne County," in Report of the Geological Survey of Ohio, Vol. III, pp. 529-539.

Stadnichenko, T., K. J. Murata, P. Zubovic and E. L. Hufschmidt (1953) "Concentration of Germanium in the ash of American Coals, A Progress Report," U. S. Geol. Survey, Circular # 272.

Stout, Wilber (1916) "Geology of Southern Ohio," Ohio Geol. Survey Bull. 20.

_____(1931) "Pennsylvanian Cycles in Ohio," Ill. Geol. Survey Bull. 60, pp. 195-216.

_____(1944) "Sandstones and Conglomerates in Ohio," Ohio Jour. Sci., Vol. 44, pp. 75-88.

_____(1947) "Generalized section of rocks of Ohio," Ohio Geol. Survey Info. Circ. no. 4.

_____, R. T. Stull, Wm. J. McCaughen and D. J. Demorest (1923) "Coal Formation Clays of Ohio," Ohio Geol. Survey Bull. 26.

Wanless, H. R. (1931) "Pennsylvanian Cycles in Western Illinois," Ill. Geol. Survey Bull. 60, pp. 179-193.

_____and J. M. Weller (1932) "Correlation and Extent of Pennsylvanian Cyclothems," Bull. Geol. Soc. Amer. Vol. 43, pp. 1003-1016.

White, G. W. (1949) "Geology of Holmes County, Ohio," Ohio Geol. Survey Bull. 47.

A P P E N D I X

SECTION # 474

WELL RECORD (from recovered cores) from coal test well drilled and described by N.W.Andrix, Columbus, Ohio. Location of well is approximately 1600' north and 1100' east of the SW corner of section 15, Paint township, Wayne County (Massillon quadrangle).

Ground elevation of well: 1308' (transit)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	17	Clay	17
17	28	Sandstone	11
28	52	Hard sandy shale with sandstone lenses	24
52	58	Hard sandstone with coaly streaks (base MIDDLE KITTANNING coal horizon: elev. 1251') *	6
58	74	Light silt shale	16
74	76.5	Carbon silt shale	2.5
76.5	79	Coal No. 5 (base LOWER KITTANNING COAL: elev. 1229') *	2.5
79	80	Gray plastic clay - siliceous	1
80	81	Hard sandy silt shale	1

T.D. 1227' * ADDED BY H.G.MULTER

SECTION # 484

WELL RECORD (from recovered cores) from coal test well drilled and described by N.W. Andrix, Columbus, Ohio. Location of well is approximately 350' west and 2300' south of the northeast corner of section 16, Paint township, Wayne County (Massillon quadrangle).

Ground elevation of well: 1277' (transit)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	9	Clay and gravel	9
9	20	Weathered sandy shale	11
20	36	Blue shale	16
36	38	Carb. shale	2
38	39	Coal No. 6 (base MIDDLE KITTANNING COAL: elev. 1238')*	1
39	50	Soft gray clay shale	11
50	70	Gray blue silt shale	20

SECTION # 484
(continued)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
70	72	Carb. shale	2
72	75	Coal No. 5 (Base LOWER KITTANNING COAL: elev. 1202')*	3
75	86	Gray shale and lime	11
86	99.5	Blue gray shale	13.5
99.5	103.5	Limestone - gray P.H.	4
103.5	105	Coal No. 4 (Base BROOKVILLE COAL: elev. 1172') *	1.5
105	109	Gray brown clay	4

T.D. 1168' * ADDED BY H.G.MULTER

SECTION # 674

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by Mullet Coal Co., Mt. Eaton, Ohio. Location of well is approximately 500' east and 3800' south from the NW corner of section 24, Franklin township (Millersburg quadrangle, Wayne County.

Ground elevation of well: 1272' (H.L.)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	8	Surface	8
8	14	Gray shale	6
14	17.5	Slabby sandstone	3.5
17.5	22	Dark shale	4.5
22	27	Dark Sandy shale	5
27	52	Dark shale	25
52	52.2	Coal	.2
52.2	52.5	Dark shale	.3
52.5	53.3	Coal	.8
53.3	54.3	Dark shale	1.0
54.3	55.8	Coal (Base LOWER KITTANNING COAL: elev. 1216') *	1.5
55.8	57.5	Dark clay	1.7
57.5	60.4	White clay	2.9

T.D. 1212' * ADDED BY H.G.MULTER

SECTION # 675

(14-1)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by Mullet Coal Co., Mt. Eaton, Ohio. Location of well approximately 900' east and 1200' north of the SW corner of section 14, Franklin township (Millersburg quadrangle), Wayne County.

Ground elevation of well: 1254' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	30	Surface	30
30	56	Light shale	26
56	64	Dark shale	8
64	66.3	Coal (Base TIONESTA COAL: elev. 1188')*	2.3
66.3	67.4	Clay	1.1

T.D. 1187' (Note: Putnam Hill limestone and Brookville coal are found cropping out within 1/2 mile to the southwest of this well; these two units have apparently gone to shale in this well)*

* ADDED BY H.G.MULTER

SECTION # 676

(26-1)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by Mullet Coal Co., Mt. Eaton, Ohio. Location of well approximately 500' east and 200' north of the SW corner of section 26, Sugar Creek township (Navarre quadrangle), Wayne County.

Ground elevation of well: 1285' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	5	Surface	5
5	5.5	Coal blossom (Base MIDDLE KITTANNING COAL horizon: elev. 1279')*	.5
5.5	13	Fireclay	7.5
13	25.5	Gray shale	12.5
25.5	26.7	Coal (Base LOWER KITTANNING COAL: elev. 1258')*	1.2
26.7	75	Gray shale	48.3
75	85	Gray sandy shale	10

SECTION # 676
(continued)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
85	90	Yellow sandrock	5
90	100	Gray shale	10
100	100.5	Coal	.5
100.5	101.5	Fireclay	1
101.5	102.5	Coal (BaseTIONESTA COAL: elev. 1182') *	1
102.5	105.1	Fireclay	2.6
105.1	110.1	Light sandy shale	5
110.1	124.1	Gray shale	14

T.D. 1161' (Note: Putnam Hill limestone and Brookville coal have apparently gone to shale in this well; both rock units crop out within ½ mile to the east - see section # 12648)*

* ADDED BY H. G. MULTER

SECTION # 677

(24-2)

WELL RECORD (from recovered drill cuttings) from coal test well drilled and described by Mr. Melvin Weisgarber, Dalton, Ohio. Location of well approximately 2500' east and 700' north of the SW corner of section 24, Sugar Creek township (Massillon quadrangle), Wayne County.

Ground elevation of well: 1072' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	48.5	Surface	48.5
48.5	54.5	Light gray soapstone	6
54.5	59.5	Dark soapstone	5
59.5	62.5	White sandrock	3
62.5	65.5	Dull hard coal	3
65.5	68.9	Coal hard bright (Base ANTHONY ? COAL: elev. 1003') *	3.4
68.9	72.9	Fireclay	4
72.9	82.9	Coal and shale stringers	10
82.9	84.4	Soapstone	1.5
84.4	85.5	Coal	1.1
85.5	95	Coal and shale stringers	9.5
95	97.3	Coal hard bright	2.3
97.3	97.8	Shale seam in coal	.5
97.5	99.3	Coal hard bright	1.5
99.3	102.3	Gray hard clay slate	3
102.3	105.8	Massillon coal (Base #1 COAL:966')*	3.5
105.8	107.3	Sandrock	1.5

SECTION # 679

(24-24)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well approximately 1400' west and 2600' south of the NE. corner of section 24, Paint township (Navarre quadrangle), Wayne County.

Ground elevation of well: 1250' (H.L.)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	7	Surface	7
7	9	Coal blossom (Base LOWER KITTANNING COAL: elev. 1241') *	2
9	12	Clay	3
12	15	Gray shale	3
15	18	Sandrock	3
18	29	Gray shale	11
29	35.5	Dark shale	6.5
35.5	39.5	Limestone crevice (PUTNAM HILL)*	4
39.5	40	Dark shale	.5
40	40.8	Coal (Base BROOKVILLE COAL: elev: 1209')*	.8
40.8	41.9	Clay	1.1

T.D. 1208' * ADDED BY H. G. MULTER

SECTION # 681

(24-21)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location approximately 50' southeast from bench mark # 1184 in the SW¼ NW¼ of section 24, Paint township (Navarre quadrangle), Wayne County.

Ground elevation of well: 1178' (H.L.)

TOP	BOTTOM	DESCRIPTION	THICKNESS
0	3	Surface	3
3	8	Soft sandrock	5
8	17	Gray shale	9
17	21	Limestone crevice (UPPER MERCER)*	4
21	28	Dark shale(Base BEDFORD COAL horizon: elev. 1150')*	7
28	33	Wash formation	5
33	35	Light gray shale	2
35	37	Dark shale	2

SECTION # 681
(continued)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
37	41	Limestone hard (LOWER MERCER)*	4
41	42	Dark shale (Base MIDDLE MERCER COAL horizon: elev. 1136')*	1
42	43	Gray shale	1

T.D. 1135' * ADDED BY H. G. MULTER

SECTION # 684

(23-8)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well approximately 3900 west and 50' south of NE corner of section 23, Paint township, (Navarre quadrangle), Wayne County.

Ground elevation of well: 1234' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS
0	7	Surface	7
7	10.4	Limestone, hard (Putnam Hill)*	3.4
10.4	11	Soft shale	.6
11	12.75	Coal (Base BROOKVILLE COAL: elev. 1221')*	1.7
12.75	13.5	Clay	.75

T.D. 1220' * ADDED BY H. G. MULTER

SECTION # 685

(23-7)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well approximately 3200' west and 200' south of the NE corner of section 23, Paint township (Navarre quadrangle), Wayne County.

Ground elevation of well: 1213' (altimeter)

SECTION # 685
(continued)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	1	Surface	1
1	30	Sandrock	29
30	32	Blue shale	2
32	36	Sandrock	4
36	37.25	Black shale	1.25
37.25	38.65	Coal (Base TIONESTA COAL: elev. 1174') *	1.4
38.65	39.45	Clay	.8

T. D. 1174' * ADDED BY H. G. MULTER

SECTION # 688

(22-2)

WELL INFORMATION: the following data was secured from local farmer-owner of well which was drilled for oil and/or gas some years ago. Location of well is approximately 650' west and 1000' north of the SE corner of section 22, Paint township (Navarre quadrangel) Wayne County.

Ground elevation of well: 1090' (topo)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	160	"Massillon coal" (Base #1 coal elev: 930') *	5

T.D. unknown *ADDED BY H. G. MULTER

SECTION # 689

(20-1)

WELL RECORD: (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well approximately 2100' west and 1900' north of the SE corner of section 20, Paint township, Wayne County (Navarre quadrangle).

Ground elevation of well: 1162' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	8	Wash formation	8
8	35	Sandrock	27

SECTION # 689
(continued)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
35	36.25	Coal (Base UPPER MERCER COAL: elev. 1136')*	1.25
36.25	48.25	Dark shale	12
48.25	52.25	Limestone (LOWER MERCER)*	4
52.25	52.45	Coal (Base MIDDLE MERCER COAL: elev: 1120	.2
52.45	66.25	Dark gray shale	14

T.D. 1106' *ADDED BY H.G.MULTER

SECTION #690

(16-2)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well is approximately 1650' west and 500' south of the NE corner of section 16, Paint township (Navarre quadrangle), Wayne County.

Ground elevation of well: 1253' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	5	Surface	5
5	17	Gray shale	12
17	2.15	Dark shale	4.5
21.5	25	Limestone, hard, solid (PUTNAM HILL)*	3.5
25	27	Coal, hard (Base BROOKVILLE COAL: elev: 1226')*	2
27	28	Clay	1

T.D. 1225' *ADDED BY H.G.MULTER

SECTION # 691

(15-2)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well is approximately 300' south and 120' east from "Y" road fork ¼ mi. south of Mt. Eaton, Paint township (Navarre quadrangle), Wayne County.

SECTION # 691
(continued)

Ground elevation of well: 1284 (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	4	Surface	4
4	8	Sandrock	4
8	11	Shale	3
11	19	Slate (Base ? MIDDLE KITTANNING COAL horizon: elev. 1265')*	8
19	52	Shale	33
52	55.3	Coal (Base MIDDLE KITTANNING COAL: elev: 1229')*	3.3
55.3	56.8	Clay	1.5
56.8	73.8	Shale	17
73.8	77.8	Limestone (PUTNAM HILL)*	4
77.8	78.8	Coal or slate (Base BROOKVILLE COAL Horizon: elev. 1205')*	1
78.8	82.8	Clay	4
82.8	99.8	Shale	17
99.8	119.8	Sandrock	20
119.8	130.8	Shale	11
130.8	132.8	Coal hard slabby (Base BEDFORD COAL: elev: 1151')*	3
132.8	135.8	Clay	3
135.8	147.8	Sandrock	12
147.8	155.8	Shale	8
155.8	161.8	Sandrock	6

T. D. 1122.2 * ADDED BY H. G. MULTER

SECTION # 692

(14-10)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well is approximately 2400' west and 1250' south of the NE corner of section 14; at 90 degree turn in road; Paint township (Navarre quadrangle), Wayne County.

Ground elevation of well: 1178' (altimeter)

(see following page)

SECTION # 692
(continued)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	3	Surface	3
3	12	Brown shale	9
12	28	Wash formation	16
28	29	Dark Shale	1
29	33.5	Limestone (UPPER MERCER)*	4.5
33.5	35	Dark shale	1.5
35	36	Coal (Base BEDFORD COAL: elev. 1142')*	1
36	38	Clay	2
38	39	Gray sandy shale	1

T.D. 1139' * ADDED BY H. G. MULTER

SECTION # 695

(14-7)

WELL RECORD (from recovered drill cuttings) from coal test well. Record furnished by the Mullet Coal Co., Mt. Eaton, Ohio. Location of well approximately 175' west and 1200' north of the SE corner of section 14, Paint township (Navarre quadrangle), Wayne County.

Ground elevation of well: 1127 (H.L.)

TOP	BOTTOM	DESCRIPTION	THICKNESS (feet)
0	4	Surface	4
4	16	Yellow shale	12
16	19	Gray shale	3
19	24.5	Gray sandy shale	5.5
24.5	27	Gray shale	2.5
27	28.5	Black slate	1.5
28.5	31.5	Sandrock	3
31.5	32	Dark shale	.5
32	32.5	Coal (Base MIDDLE MERCER COAL: elev. 1094')*	.5
32.5	35.5	Clay	3
35.5	37	Gray shale	1.5
37	39	Dark gray shale	2
39	44	Light shale	5
44	47	Gray sandrock	3
47	57.5	Dark gray shale	10.5
57.5	57.7	Coal (Base LOWER MERCER ? COAL: Elev. 1069')*	.2
57.7	58.7	Clay white	1
58.75	60	Gray sandrock	1.2

T.D. 1067' * ADDED BY H. G. MULTER

SECTION #12153
(12-1)

MEASURED SECTION: section starts in the south central portion of section 12 along dirt road at top of hill decending northward to crossroad, then proceeding eastward to the first northeasterly trending T-road located in the NW¼ SE¼ of section 12; Paint township (Navarre quadrangle), Wayne County.

Elevation top of section 1265'(H.L.)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		119.7
1. Clay medium-light gray,shaly,30% ironstone nodules in lenticular beds and lenses;basal contact gradational.	3.9	115.8
2. Coal 10% bright, crumbly to very poorly brittle, laminations rare; basal contact sharp;base MIDDLE KITTANNING COAL(elev.1261')	0.7	115.1
3. Underclay medium-light gray,starchy fracture, plastic; basal contact covered.	4.9	110.2
4. Covered	2.0	108.2
5. Shale silty with local irostone concretions.	1.5	106.7
6. Shale gray-brown, clayey, very thin bedded; basal contact covered.	18.7	88.0
7. Covered	13.8	74.2
8. Coal 20% bright, hard, poorly laminated, brittle to poorly brittle; basal contact sharp with local relief (slump?)on clay; base LOWER KITTANNING COAL(elev. 1219')	0.8	73.4
9. Underclay light to medium gray, starchy fracture, poorly plastic to crumbly; basal contact gradational.	5.0	68.4
10. Shale light gray,silty, clayey with limonitic mottling and wavey rippled bedding planes,poor slope former; basal contact gradational.	6.0	62.4
11. Clay with irostone nodules.	1.5	60.9
12. Covered	5.0	55.9

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
13. Limestone medium-dark gray, thinly bedded finely crystalline, weathers to pseudo-nodular surface, ridge former; basal contact sharp; PUTNAM HILL LIMESTONE	1.1	54.8
14. Clay brownish-gray, plastic, sticky, limey, occuring thickest within uneven basal limestone surface.	0.1	54.7
15. Coal dull, poor, laminated, poorly brittle; basal contact sharp; base BROOKVILLE COAL (elev. 1200').	1.1	53.6
16. Underclay light gray, starchy fracture; basal contact covered	0.6	53.0
17. Covered	8.0	45.0
18. Sandstone as last below, gradually changing to light gray, mineral composition similar to basal sandstone unit; bedding locally controted which may alter true thickness; basal contact covered	29.0	16.0
19. Covered	10.0	6.0
20. Coaly sandstone as below except brownish-gray, more silty and micaceous; random bright coal pods and spars up to 1" X 1/16" X ¼" size; basal contact gradational; TIONESTA COAL ? horizon (elev. 1151').	1.0	5.0
21. Sandstone light gray, medium to coarse grains in 20% clay-silt bond, well sorted, medium bedded, micaceous; basal contact covered	5.0	0.0

Elevation base of section 1146'

SECTION # 12154
(3-1)

MEASURED SECTION: Section measured along dirt road on south side and top of hill, SW¼ SW¼ section 3, Paint township(Navarre quadrangle), Wayne County.

Elevation top of section 1162 (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		20.7
1. Covered	3.0	17.7
2. Underclay with coal pods; TIONESTA COAL (elev. 1158')	2.0	15.7
3. Covered	8.8	6.9
4. Limestone UPPER MERCER LIMESTONE, (elev.1148')	1.2	5.7
5. Clay shale gray-brown, carbonaceous	2.6	3.1
6. Coal poor, shaly, BEDFORD COAL (ele. 1143')	1.3	1.8
7. Underclay gray, with one .1'thin coal spar	1.8	0.0

Elevation base of section 1141'

SECTION # 12157
(9-1)

MEASURED SECTION: Section measured along Route # 250 on top of hill 3/4ths of a mile NW of Mt. Eaton, section 9, Paint township (Navarre quadrangle), Wayne County.

Elevation top of section 1247' (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		9.7
1. Limestone medium-light gray, finely crystalline fossiliferous with heavy crinoidal concentration .3'thick at base, wavy irregular surface yielding similar angular plates on weathering, ridge former; basal contact sharp; PUTNAM HILL LIMESTONE (elev: 1244')	2.2	7.5

SECTION # 12157
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
2. Coal dull, brown limonitic staining on surfaces, shaly and clayey in upper ½ interval, poorly brittle in lower ½ interval, laminated,; basal contact sharp; base BROOKVILLE COAL (elev: 1244').	0.8	6.7
3. Underclay medium-light gray, plastic, starchy fracture, .1'basal contact zone is gradational.	2.4	4.3
4. Sandstone gray-white, persistent, 90% quartz, 8 % clay, 2% muscovite; fine well sorted grains in silty-clay bond; mica shows poor to no orientation; locally limonitic, poor slope former; basal contact gradational.	1.6	2.7
5. Clay medium-light gray, poorly plastic to crumbly, persistent; basal contact gradational.	0.9	1.8
6. Sandstone gray-white, thin-medium bedded, persistent, 78 % quartz, 20% clay, 2% muscovite flakes showing fair to good parallel orientation; basal contact covered.	1.8	0.0

Elevation base of section 1237'

SECTION # 12159
(11-3)

MEASURED SECTION: Section measured in gully and washed out field in the SW¼ SE¼ of section 11, Paint township (Navarre quadrangle), Wayne County.

Elevation top of section 1217'(H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		44.6
1. Coal BROOKVILLE COAL (basal elev:1215')	1.2	43.4
2. Underclay gray	2.0	41.4
3. Sandy clay shale gray, very fine grained sand	13.8	27.6
4. Sandstone medium-fine grained becoming very fine grained and heavily clay bonded at top interval	14.8	12.8

SECTION # 12159
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
5. Sandstone medium to fine grained, massive	1.0	11.8
6. Sandstone thin bedded, medium to coarse grained	11.8	0.0

Elevation base of section 1172'

SECTION # 12175
(14-22)

MEASURED SECTION: Section measured along a Route # 250 road cut approximately 2000' southeast of 1250 road corner, section 14, Paint township(Navarre quadrangle), Wayne County.

Elevation top of section 1267'

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		8.5
1. Clay medium-light gray, plastic, starchy fracture, common brown limonitic staining, poor slope former; basal contact sharp.	0.8	7.7
2. Carbonaceous clay shale medium to dark gray, poorly plastic to poorly crumbly, common limonitic staining, poor slope former; basal contact gradational.	0.9	6.8
3. Coal dull, laminated, poor, crumbly; basal contact sharp; LOWER KITTANNING COAL (basal elev. 1263').	2.1	4.7
4. Underclay medium-lihgt gray, plastic at top to crumbly at base, starchy fracture, clay has 10% very fine grained sand at base of interval; heavily crusted with limonite in basal 1' yielding tough, hard frags; poor slope former; basal contact covered	4.7	0.0

Elevation base of section 1258'

SECTION # 12601
(15-6)

MEASURED SECTION: Section measured in strip mine in the NW¼ SW¼ of section 15, Paint township (Navarre quadrangle), Wayne County. Strip mine operated by the Mullet Coal Company.

Elevation top of section 1281' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		45.8
1. Sandstone (90%) with interbedded black shale(10%) SANDSTONE gray-white, very fine to fine grained, thin bedded with 2 massive beds in middle of interval, steep ridge former; basal contact sharp; SHALE black,silty, very thin bedded.	10.0	35.8
2. Shale dark brown with purplish cast, thin bedded persistent, hard, brittle, finely micaceous, carbonaceous; good slope former; basal contact sharp.	2.1	33.7
3. Clay with sand lense at top SAND LENSE gray-white, medium-coarse, well sorted, clean, sand; loose,friable, up to .2' thick with contact above and below in clay gradational; CLAY dark gray, persistent, hackly fracture; basal third of interval becomes shaly and silty with tough angular frags; basal contact of interval gradational through .4' zone.	4.0	29.7
4. Shale black, silty, thin-bedded, poorly laminated poor slope former; basal contact sharp.	2.1	27.6
5. Coal hard, bright, common conchoidal fracture, brittle; basal contact sharp; MIDDLE KITTANNING COAL (basal contact elev. 1262').	1.0	26.6
6. Clay medium-dark gray, compact, poorly plastic to firm, starchy fracture; poor slope former; basal contact gradational.	11.8	14.8
7. Clay shale with ironstone interbeds dark green-gray silty, firm to poorly brittle, thin-bedded clay shale with reddish green ironstone concretion interbeds occuring most commonly in middle third of interval as lenticular beds up to .4' thick; interval is poor slope former; basal contact sharp	11.8	3.0
8. Coal hard, brittle, bright, laminated; basal contact covered; LOWER KITTANNING COAL (basal contact estimated at 1235')	3.0	0.0
Elevation base of section 1235'		

SECTION # 12602
(15-5)

MEASURED SECTION: Section measured in Lester Miller's quarry in NE¼ SW¼ section 15, Paint township (Navarre quadrangle), Wayne County.

Elevation top of section 1264' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		21.0
1. Sandstone brownish-white, medium-coarse, well sorted, clean, friable, cross bedded, sandstone with local plant impressions; oil stained in lower portions of interval; basal contact gradational.	15.0	6.0
2. Impure lenticular sandstone with coal lenses light gray, medium-fine sand in 15 % clay bond with local coal pods up to .1' thick and local crude oil staining along zones of higher permeability; grades laterally into very poorly sorted sandy conglomerate featuring shale and siltstone pebbles which in turn grades laterally into sandstone, medium-coarse with local coal frags and oil staining; basal contact of interval sharp; MIDDLE KITTANNING COAL horizon (elev. approximately 1246').	3.0	3.0
3. Clay shale light gray, limonitic and nodular; grades laterally into blue-gray, pure, plastic clay; basal contact covered.	3.0	0.0
Elevation base of section 1243'		

SECTION # 12606
(20-2)

MEASURED SECTION: Section measured at and within old drift mine entry along creek in woods, NW¼ SE¼ of section 20, Paint township, (Navarre quadrangle), Wayne County.

Elevation top of section 1148' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		11.9
1. Sandstone medium-thick bedded, medium-fine grained sand in 20% clay bond, 2% muscovite, firm-friable, limonitic, fair slope former; basal contact sharp	10.0	1.4

SECTION # 12606
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
2. Coal hard, brittle, bright UPPER MERCER COAL (basal elev. 1136')	1.1	0.3
3. Underclay gray	0.3	0.0

Elevation base of section 1136'

SECTION # 12614
(23-9)

MEASURED SECTION: Section measured in gully at head of stream by house in the SW¼ NW¼ of section 23, Paint township, Wayne County (Navarre quadrangle).

ELEVATION TOP OF SECTION 1118' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		2.9
1. Limestone dark bluish-gray, three beds; LOWER MERCER LIMESTONE	1.4	1.5
2. Coaly clay two coal seams up to .1' thick in gray clay; MIDDLE MERCER COAL horizon; approximate elevation base of coal is 1116'.	0.4	1.1
3. Clay dark grayish-black, poorly plastic to crumbly; basal contact covered	1.1	0.0

Elevation base of section 1115'

SECTION # 12615
(24-1)

MEASURED SECTION: Section measured in road cut approximately 700' northwest of county line along Route # 250, section 24, Paint township (Navarre quadrangle), Wayne County.

Elevation top of section 1099'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		32.1

SECTION # 12615
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		32.1
1. Sandstone gray-white, fine-medium, well sorted, angular to sub-rounded grains in 10% silty-clay bond, persistent; common plant impressions; basal contact gradational with carbonaceous film and sand pockets up to 2mm thick common at base; basal contact sharp.	11.5	20.6
2. Clay medium-light gray, plastic, starchy fracture with rare ironstone nodules and common limonitic staining; basal contact sharp at an ironstone nodule zone.	1.0	19.6
3. Clay shale dark gray to black, thick, unevenly bedded, persistent, 2% muscovite, yellow-brown stains on weathered surfaces yield putrid odor; one thin fossil zone 3.9' above base of coal yields brachiopod frags, crinoid stems; one red ironstone nodule zone .2' thick in middle and one .3' thick ironstone nodule zone at top interval; basal contact gradational.	2.9	16.7
4. Clay shale as last above only thin to paper thin bedded shale, platy; basal contact sharp.	2.9	13.8
5. Coal 90% bright, 10% dull; hard, brittle, poorly conchoidal, laminated; basal contact sharp; LOWER MERCER ? COAL (basal elev. 1080')	0.5	13.3
6. Underclay medium-gray, poorly plastic to crumbly, starchy fracture, impure with 10 % very fine sand, rare coal frags, random plant frags, poor slope former; basal contact gradational.	2.4	10.9
7. Clay shale black, lenticular, thin-bedded to paper thin beds, rare mica; basal contact sharp.	0.1	10.8
8. Underclay as last underclay above (unit 6); basal contact gradational;	2.1	8.7
9. Sandstone gray-white, fine to very fine grains in 30% silty clay bond, medium-thin bedded, persistent, 2 % muscovite, common brown-black plant frags crossing and parallel to bedding, mica parallel to bedding, limonitic staining common, poor to fair slope former; basal contact covered.	0.2	8.5

SECTION # 12615
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
10. Covered	7.5	1.0
11. Sandstone as in unit 9 (above); basal contact covered.	1.0	0.0

Elevation base of section 1067'

SECTION # 12616
(24-3)

MEASURED SECTION: Section measured approximately 1800' southeast of bench mark 1184, along new Route # 250 road cut, in the SE¼ NW¼ of section 24, Paint township (Navarre quadrangle), Wayne County.

Elevation top section 1153'

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		8.1
1. Limestone medium-dark bluish black, medium-thick bedded, hard, tough, fossiliferous, ridge former; basal contact sharp; UPPER MERCER LIMESTONE (basal contact elev. 1151')	1.8	6.3
2. Carbonaceous paper shale dark gray to black, brittle paper shale with common muscovite flakes parallel to bedding; limonitic stains and black plant frags common; coaly streaks at very base interval; poor slope former; basal contact sharp; BEDFORD COAL horizon (basal contact elev. 1148')	2.9	3.4
3. Clay medium-light gray, plastic, starchy fracture, 5 % very fine grained sand, limonitic staining common, local plant frags and black shale chips also common; poor slope former; basal contact gradational over .2' zone.	2.3	1.1
4. Sandstone medium-light gray, crumbly, 38% clay, 2 % muscovite, black plant frags common; basal contact covered.	1.1	0.0

Elevation base of section 1145'

SECTION # 12622
(24-28)

MEASURED SECTION: Section measured in strip mine approximately 1300' south and 900' east of the NW corner of section 24, Paint township (Navarre quadrangle), Wayne County.

Elevation top of section 1267' (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		42.7
1. Sandstone gray-white, medium-fine, poorly sorted sub-rounded grains in 20% clay bond, 2% dark minerals; firm-friable; limonitic; plant stem cast locally common; basal contact not clearly seen due to slump and drift cover and contamination.	2.0	40.7
2. Coal poor, mostly weathered, dull, laminated; basal contact sharp; MIDDLE KITTANNING COAL (basal contact elev. 1264').	1.0	39.7
3. Underclay dark gray, tough, plastic, starchy fracture; basal contact gradational.	0.8	38.9
4. Clay medium-light gray with rusty limonitic stains common; lower 2/3rds crumbly, upper 1/3rd plastic; persistent, starchy fracture; basal contact gradational over 1.5' zone.	5.1	33.8
5. Silty clay shale (90%) and interbedded silty ironstone lenses (10%) SHALE greenish-gray, firm, brittle to plastic, usually always easily carved with knife, persistent, thin-bedded; IRONSTONE LENSES dark red, hard, tough, lenticular, up to .3' thick, commonly feature "core" of rounded siltstone pebbles up to 2 inches longest demension, are ledge formers; basal contact of interval gradational through 1.' zone.	29.5	4.3
6. Clay shale medium-dark gray (local greenish cast) poorly brittle to plastic, thin bedded, persistent, poor slope former; common limonitic staining; gradational change to lighter gray color as well as tendency to interbed with greenish-gray clay shale in upper .5'; basal contact sharp.	2.0	2.3
7. Coal brittle, poorly laminated; grades into carbonaceous shale in upper .8'; basal contact under water (thickness data from stripper) LOWER KITTANNING COAL (basal elev. 1224')	2.3	0.0

SECTION # 12623
(24-29)

MEASURED SECTION: Section measured along a Route # 250 road cut, approximately 200' northwest of bench mark 1184, section 24, Paint township(Navarre quadrangle), Wayne County.

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
Elevation top of section 1229'		26.0
1. Slumped underclay with coal pods CLAY medium-light gray plastic, starchy fracture, persistent, with coal pods up to .2' thick; COAL 70 % bright, brittle; coal is not believed to have slumped more than 5 feet vertically; coal is believed to be the LOWER KITTANNING COAL; basal contact of interval gradational.	2.2	23.8
2. Clay shale dark gray to light brown, thin bedded, platy, poorly brittle to crumbly and clayey; local limonitic staining; gray color predominately in lower ½ interval and brown in upper ½ interval; top 2' displays brick red staining; basal contact gradational.	20.1	3.7
3. Clay shale gray, plastic with dark brown limonitic stains, poor slope former; basal contact covered.	2.2	1.5
4. Covered	1.0	0.5
5. Limestone medium-light gray, persistent, hard, common crinoid frags, blocky fracture, ridge former; basal contact covered; PUTNAM HILL	0.5	0.0
Elevation base of section 1203'		

SECTION # 12629
(8-1)

MEASURED SECTION: section located in central SW¼ of section 8, along north-south trending road ditch near top of hill, section 8, Chippewa township (Massillon quadrangle), Wayne County.

(see following page for section)

SECTION # 12629
(continued)

Elevation top of section 1083' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		10.8
1. Sandstone dark yellow-orange, fine grained, well sorted sand in 10% silty clay bond, 4% feldspar, local mica parallel to bedding; medium bedded; basal contact sharp.	6.0	4.8
2. Sandstone dark yellowish-orange, very fine grained to fine grained sand in heavy silt bond; thin bedded; mica parallel to bedding, basal contact sharp.	0.5	4.3
3. ELEVATION OF MISSISSIPPIAN-PENNSYLVANIAN CONTACT 1076': ALL UNDERLYING BEDS ARE OF MISSISSIPPIAN AGE.		
4. Clay medium-gray, plastic silty; basal contact sharp.	0.3	4.0
5. Siltstone moderate yellow-brown, thin bedded, firm, poorly brittle to tough, mica parallel to bedding; basal contact covered.	4.0	0.0
Elevation base of section 1072'		

SECTION # 12630
(14-2)

COAL CONTROL POINT: Control point located in the central part of the SW¼ of section 14, approximately 1300' east and 1100' north of the SW corner of the section, Chippewa township (Massillon quadrangle), Wayne County. Information given by local resident who dug coal at point of reference; information is believed reliable and is confirmed by elevations of nearby coal entrys as well as by other local farmers.

Elevation of surface of ground 1060'(altimeter)	Thickness of unit Ft/Tenths
1. Coal "Massillon, #1" elevation 1042'	2.5

SECTION # 12631
(14-1)

MEASURED SECTION: Section measured in the SE¼ SE¼ of section 15 along road ditch, Chippewa township (Massillon quadrangle), Wayne County.

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
Elevation top of section 1178' (altimeter)		78.8
1. Sandstone brownish-white, fine-medium, poorly sorted grains in 0-5% clay-silt bond; thin bedded, mica parallel to bedding; local .2' thick ironstone vuggy lenses at top of interval; basal contact covered.	18.0	60.8
2. Clay brownish-gray, plastic, silty; basal contact sharp.	0.5	60.3
3. Sandstone brownish-white, medium grained, well sorted sand in 5% clay bond; hard to firm; mica parallel to bedding; blocky fracture; basal contact covered.	6.0	54.3
4. Covered	26.0	28.3
5. Sandstone white, fine to very fine grains in 0-5 % clay bond, mica parallel to bedding, thin bedded, hard, brittle; one .2' coaly sand seam at very base of interval. VANDUSEN ? COAL horizon (elev. 1116')	11.8	16.5
6. Covered	5.9	10.6
7. Sandstone as in 8 below except this sandstone has local coal frags in it.	1.8	8.8
8. Sandstone yellowish-white, medium-fine grained, poorly sorted sand in 1-5 % clay bond; hard, tough, thick bedded; basal contact sharp.	5.9	2.9
9. Coaly sandstone blackish-gray, fine, well sorted sand grains in 10% silty bond; common coal frags up to 1 inch longest demensions; firm to soft sandstone; basal contact sharp.	2.1	0.8
10. Sandstone brownish-white, medium-fine, poorly sorted grains in clay bond; hard, tough, medium bedded; basal contact covered.	0.8	0.0
Elevation base of section 1099'		

SECTION # 12632
(15-1)

WELL RECORD: (from recovered drill cuttings) from water well. Location of well is approximately 3000' east and 900' north of the SW corner of section 15, Chippewa township (Massillon quadrangle), Wayne County.

Ground elevation of well 1229' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS
0	5	Clay and gravel	5
5	69	Brown sandstone	64
69	74	Light sandy shale	5
74	103	Brown sandstone	29
103	109	Gray sandy shale	6
109	129	Brown sandstone	20
129	130	Coal (QUAKERTOWN ? COAL: elev. 1097')*	3
132	137	Light shale	5
137	173	Dark shale	36
173	174	Brown sandstone	1
174	178	Dark shale	4
178	180	Light shale	2

T.D. 1049' * ADDED BY H.G.MULTER

SECTION # 12633
(14-4)

MEASURED SECTION: Section measured northeast from bridge, upstream along creek bottom and along creek banks; in the SE¼ SE¼ of section 14, Chippewa township (Massillon quadfangle), Wayne County.

Elevation top of section 1055 (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		54.5
1. Clay shale light gray, thin bedded, plastic; basal contact sharp.	3.0	51.5
2. Sandstone light brown, very fine grained sand in 20% clay-silt bond, medium-thin bedded; basal contact sharp.	1.5	50.0
3. Alternating black carbonaceous shale and dark brown clay shale thin bedded, poorly brittle; basal contact sharp; SHARON COAL HORIZON ?? elev. 1047'	3.0	47.0

SECTION # 12633
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
4. Clay shale light gray, soft, plastic, thin bedded; basal contact sharp.	1.0	46.0
5. Sandstone light brown, very fine to fine grained in 20 % clay bond, hard, tough, ridge former; basal contact sharp.	2.5	43.5
6. Siliceous sandstone white, fine grain sand in siliceous bond with common black coaly plant frags parallel to bedding; thin, undulating bedding; basal contact sharp.	8.0	35.5
7. Interbedded silty clay shale (25%) and sandstone (75%) SANDSTONE white, medium-fine sand in 10% silt-clay bond, hard, tough; CLAY SHALE light gray, firm to poorly brittle, shaly, mica parallel to bedding, thin bedded; basal contact sharp.	4.0	31.5
8. Sandstone white, medium-fine, well sorted sand in 5 % clay bond; thin to massive beds (avg. .1' thick); basal contact sharp.	5.4	26.1
9. Sandstone dark brown, fine-coarse, poorly sorted, medium bedded with planar cross beds; grades upward into a white, medium-fine, well sorted, thin bedded sandstone; basal contact sharp.	11.8	14.3
10. Massive conglomeratic sandstone white, fine-very coarse poorly sorted grains in 0 - 5 % clay-silt bond, hard, in one bed with pockets and isolated round quartz pebbles up to ½ inch diameter; basal contact gradational; SHARON CONGLOMERATIC SANDSTONE	6.4	7.9
11. Conglomeratic sandstone white, fine-very coarse, poorly sorted grains in 0 - 5 % clay-silt bond; thin bedded, hard, with round quartz pebbles up to 1 inch longest diameter; local cut and fill cross bedding; basal contact covered; SHARON CONGLOMERATIC SANDSTONE.	7.9	0.0

Elevation base of section 1000'.

SECTION # 12635
(25-1)

MEASURED SECTION: Section measured from old sandstone quarry (SE¼ SW¼ section 24) up to road; then southeast along road to old abandoned mine entry (still open) located in the NE¼ NE¼ of section 25; Chippewa township (Massillon quadrangle), Wayne County.

Elevation top of section 1070'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		106.8
1. Sandstone brownish-white, fine-medium, poorly sorted grains in 0 - 5 % clay bond; thin bedded with planar cross beds (1.5' set and 6.' sweep averages); basal contact sharp on the coal as seen inside mine entry.	24.0	82.8
2. Coal hard, blocky, good; basal contact covered; SHARON (#1, MASSILLON) COAL elev. 1044'	2.0	80.8
3. Covered	59.0	21.8
4. Conglomeratic sandstone brownish-white, fine-very coarse, poorly sorted sand in rare clay bond; thin to thick bedded; planar cross beds (sweep avg. 5', set avg. 1½'); basal contact sharp with local angular relationship with conglomeratic sandstone abutting upon basal sandstone unit; SHARON CONGLOMERATIC SANDSTONE.	11.8	10.0
5. Sandstone white, fine, sub-rounded, well sorted grains, no clay bond, massive, with local medium- thick bedding; basal contact covered; SHARON SANDSTONE	10.0	0.0
Elevation base of section 963'		

SECTION # 12636
(33-2)

MEASURED SECTION: section measured along railroad cut approximately ½ mile NE of the town of Marshallville; section 33, Chippewa township (Massillon quadrangle), Wayne County.

Elevation top of section 1107'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		36.6

(see following page)

SECTION # 12636
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
1. Sandstone yellow-white, medium-fine, well sorted, sub-rounded to sub-angular grains in 5 % clay bond; 5 % weathered feldspar; medium to thick bedded, hard, poorly friable; basal contact sharp.	4.0	32.6
2. Interbedded silty shale (70 %) and silty sandstone (30%) in thin-medium beds; SILTY SHALE medium to kark gray, thin bedded, micaceous, brittle; SILTY SANDSTONE very light gray with common pale brown mottling, thin to thick (up to .6' thick) bedded; hard, tough; local coal stringers and plant frags; very fine grained sand in heavy silt-clay bond; basal contact for interval covered and/or lies with sharp angular relationship on underlying sandstone.	14.0	18.6
3. MISSISSIPPIAN-PENNSYLVANIAN CONTACT (elev. 1070-1088'): ALL ROCKS DESCRIBED BELOW ARE OF MISSISSIPPIAN AGE.		
4. Sandstone medium to dark gray, medium to fine, poorly sorted grains in 15 % clay-silt bond; micaceous; basal 2' thin bedded, upper 4'massive; local limonitic pinpoint mottling; sand becomes cleaner towards top of interval; upper .2' contains coarse to very coarse sand in fine-medium grain sand bond; basal contact sharp.	6.0	12.6
5. Interbedded silty shale (30%), silty sandstone (60%) and lenticular siltstone (10%) in thin tomedium beds; SILTY SHALE medium to dark gray, thin bedded, poorly brittle, mica parallel to bedding, clayey; SILTY SANDSTONE medium to light gray, fine to very fine grain sand in heavy silt bond; mica parallel to bedding; hard, tough, thin bedded, local black carbonaceous plant frags; contacts usually gradational with silty shale; SILTSTONE light olive gray, 1 bed,lenticular (averaging .3'thick), hard, tough; basal contact of siltstone with shale sharp, with sandstone sharp also.	3.6	9.0

SECTION # 12636
(continued)

6. Sandstone yellowish-gray, fine grained, well sorted sand in 0-5 % clay-silt bond; hard, poorly friable; lower 7 feet medium bedded, upper 2' thick-massive bedded; rare local round coarse grains; common brown pinpoint limonitic mottling throughout; basal contact covered.	9.0	0.0

Elevation base of section 1070'

SECTION # 12637
(17-6)

MEASURED SECTION: section measured in the NE¼ NW¼ of section 17, Paint township (Navarre quadrangle), Wayne County, section starts at top of hill in small cross roads quarry and goes down to creek cut approximately 300' south of road. See also Ohio Geological Survey measured sections # 10670, #5254 and #5614, showing different correlations. Correlations given below are based on interval to 4' limestone (Lower Mercer) found in nearby well (#689).

Elevation of top of section 1224'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		79.5
1. Limestone, basal contact sharp; PUTNAM HILL	3.2	76.3
2. Coal basal contact covered; BROOKVILLE COAL ELEV. 1219'.	1.2	75.1
3. Covered	32.0	43.1
4. Coal blossom; TIONESTA COAL, elev. 1187'.	0.2	42.9
5. Underclay; basal contact covered	0.4	42.5
6. Covered	28.0	14.5
7. Limestone dark blue-gray, one massive bed, very hard, tough; basal contact sharp. UPPER MERCER?	2.2	12.3
8. Coal shaly, 20% bright; BEDFORD COAL?, elev. 1154'	2.1	10.2
9. Underclay medium-light gray	1.8	8.4
10. Clay shale medium-light gray, thin bedded, silty, hackly fracture; basal contact sharp.	0.6	0.8

SECTION # 12637
(continued)

11. Coal shaly, 10 % bright; UPPER MERCER ? COAL, elev. 1145'.	0.6	0.8
12. Underclay light gray, plastic; basal contact covered.	0.8	0.0

Elevation base of section 1144'

SECTION # 12639
(7-2)

MEASURED SECTION: section measured in the NE¼ SW¼ of section 7, Sugar Creek township (Wooster quadrangle), Wayne County. Section starts at coal crop in stream and proceeds northward downstream toward Route #30.

Elevation top of section 1074' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		24.4
1. Sandstone brownish-white, very fine to fine, poorly sorted grains in 10 % clay bond; thin bedded, cross bedded with cut-outs common; basal contact sharp.	6.0	18.4
2. Coal good, hard, 80% bright; Note: coal passes laterally within 100' into black nodular siltstone. Basal contact sharp; VANDUSEN ? COAL, elev. 1067'.	1.0	17.4
3. Sandy clay dark gray-black, very fine grained sand in very heavy clay bond; common plant frags; basal contact is gradational and has local relief of .4' with underclay.	0.5	16.9
4. Underclay light-medium gray, silty, firm with local plant frags; basal contact sharp.	1.5	15.4
5. Sandy shale dark gray, very fine grained sand in very heavy silt matrix, highly carbonaceous, thin bedded, very common plant frags parallel to bedding; one lenticular siltstone nodule zone is .2' thick and lies 1.0' below top of interval; basal contact covered.	4.2	11.2

SECTION # 12639
(continued)

6. Covered	7.1	4.1
7. Sandstone medium-brown, very fine grained sand in heavy (30%) silty-clay bond, thin wavy bedded, limonitic, hard, tough, local randomly oriented plant frags and mica flakes; basal contact gradational.	1.2	2.9
8. Silty shale dark gray, brittle, very thin bedded, finely micaceous; basal contact sharp.	1.2	1.7
9. Sandstone white, very fine grained sand in siliceous bond, very hard, tough, medium bedded, local black randomly oriented plant frags, rare black and gray laminations parallel to bedding; basal contact covered.	0.3	1.4
10. Sandstone dark brown, medium-fine, sub-rounded to sub-angular grains in 5 % clay bond, thick bedded; basal contact covered.	1.4	0.0

Elevation base of section 1050'

SECTION # 12640
(9-1)

MEASURED SECTION: Section measured along east-west trending road in the NE¼ SE¼ of section 9 and in creek in NW¼ SE¼ of section 9, Sugar Creek township(Massillon quadrangle), Wayne County.

Elevation top of section 1190' (altimeter)	Thickness Ft/Tenths	Interval Ft/Tenths
		70.9
		70.9
1. Sandstone dark brown, medium-fine, poorly sorted grains in 5 % clay bond; thick to massive bedded; basal contact covered.	5.0	65.9
2. Covered	26.3	39.6
3. Upper Mercer limestone dark blue, hard, tough, local thin flinty slabs.	1.5	38.1
4. Coal 70 % bright; BEDFORD COAL, elev.1155'.	2.0	36.1
5. Underclay gray-white, impure.	2.0	34.1

SECTION # 12640
(continued)

6. Covered	12.0	22.1
7. Sandstone white, medium, sub-angular to sub-rounded grains in 5 % clay bond; thin bedded, firm-friable; basal contact covered.	4.0	18.1
8. Covered	4.0	14.1
9. Sandstone as below (in 10) except no coal frags.	0.2	13.9
10. Coaly sandstone gray-white, fine-coarse, poorly sorted, sub-rounded to sub-angular grains in 20% clay bond; common coaly frags throughout; highly limonitic; mica parallel to bedding; basal contact sharp; UPPER MERCER ? COAL, elev. 1132'.	0.5	13.4
11. Clay shale white, plastic, soft, thin bedded; basal contact gradational.	0.1	13.3
12. Silty shale rusty brown, very thin bedded, heavy limonitic staining, common limonitic nodular lenticular zones up to .1' thick; basal contact sharp.	2.2	11.1
13. Limestone dark blue, hard, tough, in 2 slabby beds; basal contact sharp; LOWER MERCER	0.3	10.8
14. Carbonaceous shale black, weathered, poorly brittle, very thin bedded; basal contact gradational.	4.2	6.6
15. Clay shale dark brown, silty, very thin bedded, firm, limonitic; basal contact gradational.	4.0	2.6
16. Carbonaceous shale paper thin, brittle; basal contact sharp; MIDDLE MERCER COAL horizon, elev. 1121'	0.4	2.2
17. Clay shale dark gray, silty, micaceous, blocky-hackly fracture; basal contact covered.	2.2	0.0

Elevation base of section 1119'

SECTION # 12643
(13-5)

MEASURED SECTION: Section measured along creek bottom in the SE¼ SE¼ of section 13, Sugar Creek township (Massillon quadrangle), Wayne County.

Elevation top of section 1173' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		44.0
1. Coal weathered, punky; TIONESTA COAL, elev.1172'	1.0	43.0
2. Covered	11.0	32.0
3. Limestone dark blue, platy to thick bedded; UPPER MERCER LIMESTONE	1.0	31.0
4. Coal, weathered; BEDFORD COAL, elev. 1159'	1.0	30.0
5. Sandstone poorly exposed	30.0	0.0
Elevation base of section 1129'		

SECTION # 12644
(21-2)

MEASURED SECTION: Section measured in the NE¼ SW¼ of section 21 along stream cut approximately 500' south of bridge; Sugar Creek township (Massillon quadrangle), Wayne County.

Elevation top of section 1048' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		20.8
1. Silty shale dark yellow-brown, thin bedded, brittle to crumbly; basal contact gradational.	5.0	15.8
2. Interbedded silty shale and silty sandstone paper thin brittle;SHALE dark yellowish-brown SANDSTONE medium gray, very fine grained sand in 20% silt bond; basal contact of interval is gradational.	1.0	14.8
3. Silty sandstone medium gray, fine grained sand in 20 % silty bond; thin bedded, hard, brittle; basal contact sharp.	0.8	14.0

SECTION # 12644
(continued)

4. Coal and shaly coal upper 1.' is 60% bright coal, lower 2.3' is dull and shaly; basal contact sharp and/or locally shows angular relationships with underlying sandstone; QUAKERTOWN ? COAL, elev. 1038'	3.3	10.7
5. Silty carbonaceous sandstone medium dark gray, fine to medium grained sandstone in very heavy clay bond, common fine carbonaceous frags; poorly sorted; poorly hackly to thin bedded; local conglomerate sand pebbles up to ½ inch diameter; several medium-light gray, hard, fine grained sandstone beds and lenticular nodules containing carbonaceous pods and plant frags; basal contact gradational.	4.2	6.5
6. Conglomeratic siltstone medium-light gray with round quartz pebbles in silt and very fine grained sand matrix, pebbles average ¼ inch diameter and are up to 1 inch largest demension; basal contact sharp with local angular relationships on underlying siltstone.	0.5	6.0
7. MISSISSIPPIAN-PENNSYLVANIAN CONTACT, elev. 1033'; ROCKS NOTED BELOW ARE OF MISSISSIPPIAN AGE.		
8. Sandy siltstone grayish-orange, thin bedded, with fine pin-point limonitic mottling up to 1 mm diameter; hard, tough, weathers to dark brown; basal contact covered.	6.0	0.0

Elevation base of section 1027'

SECTION # 12645
(21-1)

MEASURED SECTION: section measured in east-central SW¼ of section 21 in stream bank southwest of section # 12644; section in Sugar Creek township (Massillon quadrangle), Wayne County.

Elevation top of section 1058' (altimeter)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		7.3
1. Coaly sandstone dark gray, very fine grained sand in coaly silty matrix; very friable; basal contact sharp.	0.3	7.0

SECTION # 12645
(continued)

2. Sandstone light brown, very fine grained sand in heavy (40%) clay bond; thin bedded, hard, tough, limonitic; basal contact sharp.	0.3	6.7
3. Clay shale light gray, very thin bedded, poorly brittle, hackly, plastic at base interval; basal contact sharp.	1.3	5.4
4. Coal weathered, 10% bright, with one .1' clay seam .1' from top of coal; basal contact sharp.	0.5	4.9
5. Clay shale light gray, thin bedded, limonitic, poorly brittle with one .1' coal spar in middle; basal contact sharp.	1.3	3.6
6. Coal 10 % bright; base BEAR RUN ? COAL, elev. 1054'.	0.4	3.2
7. Clay shale light gray, thin bedded, common limonitic staining, brittle; basal contact sharp.	1.8	1.4
8. Coaly sandstone very fine to medium grained sand in heavy carbonaceous clay bond; fine coal spars are 5 % bright; sandstone is hard, firm; thin bedded; basal contact covered.	1.4	0.0

Elevation base of section 1051'

SECTION # 12648
(26-2)

MEASURED SECTION: Section measured from top of hill, along north-south road in south central section 26, westward to near top of highest knob in SW¼ SW¼ of section 26, Sugar Creek township (Navarre quadranle), Wayne County. See also section # 676.

Elevation top of section 1277'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		61.2
1. Coal blossom; MIDDLE KITTANNING COAL, elev.1277'	0.4	60.8
2. Underclay white, starchy fracture.	4.0	56.8
3. Covered	23.0	33.8

SECTION # 12648
(continued)

4. Coal Note: this coal only seen by writer as dark clayey streak in plowed field; thickness data from farmer-owner and should be considered as only approximate; elevation considered accurate to within 10'. LOWER KITTANNING COAL, elev. approximately 1246'.	4.0	29.5
5. Covered	20.0	9.8
6. Limestone medium-light gray, thin slabs; PUTNAM HILL LIMESTONE	1.5	8.3
7. Coal; BROOKVILLE COAL, elev. 1222'	2.4	5.9
8. Underclay	1.1	4.8
9. Silty clay shale	4.8	0.0

Elevation base of section 1216'

SECTION # 12649
(27-5)

MEASURED SECTION: Section measured in SW¼ NE¼ of section 27, Sugar Creek township (Navarre quadrangle), Wayne County; from old drift opening SW of T-road to 4 year old strip mine NE of T-road; also at spring SE of T-road; some information (as indicate) from property owner who formerly stripped Upper Mercer coal and drilled through Upper Mercer limestone on his land.

Elevation top of section 1192'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		54.9
1. Sandstone dark brown, medium to coarse grained sand in 10 % clay bond, thick bedded; basal contact covered.	3.0	51.9
2. Coal reported; TIONESTA COAL, elev. 1188'	0.9	51.0
3. Covered	10.0	41.0
4. Limestone, UPPER MERCER LIMESTONE; Note: only frags observed by writer; great thickness reported by land owner who drilled through rock and took out coal from under it in small drift mine.	7.0	34.0

SECTION # 12649
(continued)

5. Coal, weathered	1.0	33.0
6. Covered	27.0	6.0
7. Shale black, weathered, poorly exposed	4.0	2.0
8. Coal poorly exposed; thickness reported by local farmer-stripper; UPPER MERCER COAL, elev. 1137'.	2.0	0.0

Elevation base of section 1137'

SECTION # 12650
(27-3)

MEASURED SECTION: Section measured from small abandoned mine entry (badly slumped) in the SE¼ NW¼ of section 27, down to road where limestone crops out in road ditch near cement cottage; information given by land owner who took coal out of abandoned mine, verifies thickness, and indicates coal had a persistent sandstone roof and very thin clay bottom; Sugar Creek township (Navarre quadrangle), Wayne County.

Elevation top of section 1193' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		30.9
1. Coal weathered, poorly exposed; TIONESTA COAL, elev. 1192'.	0.9	30.0
2. Covered	28.0	2.0
3. Limestone hard, tough, massive, dark blue; basal contact covered.	2.0	0.0

Elevation base of section 1162'

SECTION # 12651
(28-1)

MEASURED SECTION: section measured in the SW¼ SW¼ of section 28, up creek from road; Sugar Creek township (Navarre quadrangle), Wayne County.

Elevation top of section 1181'

(see following page)

SECTION # 12651
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		43.6
1. Clay shale light brown, thin bedded; basal contact sharp.	1.2	42.4
2. Coal 70 % bright; basal contact sharp; TIONESTA COAL, elev. 1179'.	0.3	42.1
3. Underclay	0.8	41.3
4. Covered	33.0	8.3
5. Limestone hard,2 beds; basal contact sharp; UPPER MERCER LIMESTONE	1.9	6.4
6. Clay shale light gray, firm, hackly, poorly bedded, limonitic; basal contact sharp (especially color change).	4.3	2.1
7. Silty claystone black grading to gray at base; hackly fracture, slickensided, more silty at base; basal contact covered; BEDFORD COAL HORIZON.	2.1	0.0

Elevation base of section 1137'

SECTION # 12652
(6-1)

MEASURED SECTION: section measured along road cut in SE¼ SE¼ of section 6, along east-west road on west slope of hill; Salt Creek township (Millersburg quadrangle), Wayne County.

Elevation top of section 1191' (altimeter)

	Thickness of unit Ft./Tenths	Interval from base Ft/Tenths
		49.0
1. Sandstone gray-white, limonitic stained, 90 % medium-fine, fairly well sorted, sub-rounded to rounded quartz grains in 10 % clay bond; planar cross beds (sets avg. 2 inches with max. 5 inches, sweep avg. 4 feet with max. of 10 feet) yield the following measurements: N 30 W 12 NE, N 2 W 20 NE, N 2 W 21 NE, N 4 W 21 NE, N 8 E 26 SE and N 13 E 16 SE,		

SECTION # 12652
(continued)

1. (continued) sandstone is hard, firm, ridge former; basal contact covered.	17.0	32.0
2. Covered and sandy soil and float	11.0	21.0
3. Shale with coal spars weathered; basal contact sharp.	0.1	20.9
4. Clay soft, plastic; basal contact covered.	0.4	20.5
5. Covered	5.0	15.5
6. Coal weathered, shaly; basal contact sharp; UPPER MERCER ? COAL horizon, elev. 1157'	0.7	14.8
7. Underclay light gray, plastic; basal contact covered	0.4	14.4
8. Covered	4.0	10.4
9. Sandstone gary-white, very fine grained sand in siliceous and clayey matrix; hackly fracture, thin bedded, heavy limonitic staining, common plant frags and vertical joints, joints filled with very fine grain limonitic cemented sand; mica parallel to bedding; 2 prominent ironstone lenses in basal 1/3rd of interval up to ½ inch thick; interval is poor ridge former; basal contact sharp.	7.5	2.9
10. Sandstone white with very heavy limonitic staining and banding; very fine grained sand with local siliceous and limonitic bond, commom plant frags; micas show random orientation; rock appears as one bed with irregular upper and lower surface; tough, ridge former; basal contact sharp.	0.4	2.5
11. MISSISSIPPIAN - PENNSYLVANIAN CONTACT, elev.1145'; ALL NOTED ROCKS BELOW ARE OF MISSISSIPPIAN AGE.		
12. Sandy siltstone grayish white, very fine grained sand in heavy silt matrix; rare mica; no plant frags; thin bedded, crumbly to poorly firm; poor ridge former; basal contact sharp.	1.5	1.0
13. Limonitic siltstone rusty dark brown, thin bedded, hard, with common limonitic pinpoint spots up to 2 mm diameter; basal contact covered.	1.0	0.0

Elevation base ofsection 1142'

SECTION # 12653
(10-1)

MEASURED SECTION: section measured in the NE¼ SW¼ of section 10, just west of road at spring in woods; Salt Creek township (Millersburg quadrangle), Wayne County.

Elevation top of section 1253' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		13.3
1. Sandstone brownish-white, medium-fine, poorly sorted grains in 10% silt bond; medium-thick bedded; basal contact sharp.	11.0	2.3
2. Coal weathered, punky, shaly at top; fair to good hard coal in lower 1/3rd interval; LOWER KITTANNING COAL, elev. 1241'.	1.2	1.1
3. Underclay dark gray, poorly plastic; basal contact covered.	1.1	0.0
Elevation base of section 1240'		

SECTION # 12654
(14-2)

MEASURED SECTION: Section measured in the SW¼ SW¼ of section 14; along south side of creek approximately 1000' east of bridge; Salt Creek township (Millersburg quadrangle), Wayne County.

Elevation top of section 1115' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		22.6
1. Sandstone light brown, very fine grained sand in heavy silt bond; very thin bedded with 1 one inch gray clay seam; basal contact sharp.	2.5	20.1
2. Sandstone dark brown, very fine to fine grains in silty bond; very hard, tough, thick bedded (1 bed); good ridge former; contact at base is sharp.	1.3	18.8
3. Interbedded sandstone and clay shale in very thin beds up to 1 inch thick; SANDSTONE very fine grained, blackish-gray grains in 15 % silt bond; CLAY SHALE black, paper-thin; basal contact sharp.	3.2	15.6

SECTION # 12654
(continued)

4. Coal hard, 33 % bright; VANDUSEN ? COAL horizon, elev. 1108'.	0.6	15.1
5. Underclay dark gray, silty, impure, poorly plastic; basal contact gradational.	1.4	13.7
6. Clay shale grayish-white, limonitic, hard, firm, weathers to a soft white paste; basal contact sharp.	4.0	9.7
7. Limey siltstone light grayish-brown, very hard, tough; basal contact sharp.	0.2	9.5
8. Silty clay shale black, very thin bedded to paper thin shale, mica parallel to bedding; poor slope former; basal contact sharp.	7.4	2.1
9. Clay shale as unit 6 above; basal contact covered	2.1	0.0

Elevation base of section 1093'

SECTION # 12656
(11-1)

MEASURED SECTION; section measured at center of SW¼ section 11; at abandoned sandstone quarry along south side of east-west elongate hill.

Elevation top of section 1177' (topo)

	Thickness of unit Ft/Tenths
1. Sandstone light brown, fine to medium, sub-rounded to sub-angular grains in 5 % clay bond, medium bedded; planar cross beds yield N 60 E 23 NW in upper 1/3rd of interval, and N 35 E 24 NW in lower 2/3rds of interval; hard, firm, to poorly friable; becomes thick bedded to massive in lower 2/3rds interval; basal contact covered; Note: random conglomerate float found amoung talus debris at foot of quarry face.	22.0

Elevation base of section 1155'

SECTION # 12657
(13-1)

MEASURED SECTION: Section measured in the SE¼ NW¼ of section 13, in creek bed just north of bridge; East Union township (Wooster quadrangle) Wooster County.

Elevation top of section 1099'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		15.4
1. Sandstone white, fine to very fine grains in siliceous bond, very hard, tough, medium bedded; basal contact sharp.	2.0	13.4
2. Coal poor, shaly, 40% bright; FLINT RIDGE COAL ? , elev. 1097'.	0.2	13.2
3. Clay brownish-white, hackly fracture, impure; basal contact gradational.	2.0	11.2
4. Silty shale light brown, brittle, firm; basal contact sharp.	2.5	8.7
5. Silty shale black, very thin bedded, brittle; basal contact sharp.	5.4	3.3
6. Coal hard, 95 % bright; basal contact sharp; LOWER MERCER ? COAL, elev. 1087'.	0.2	3.1
7. Sandy shale gray-white, very fine grained sand in heavy clay bond, thin bedded, hard, brittle; basal contact gradational; (upper .3' gets carbonaceous).	1.0	2.1
8. Sandstone gray-white, very fine grained sand in heavy silt bond, medium to thin bedded, hard, tough, local black carbonaceous frags parallel to bedding, micaceous; local white round quartz pebbles up to ½ inch diameter and round limonitic siltstone pebbles up to 2 inches diameter towards base; basal contact covered.	2.1	0.0

Elevation base of section 1084'

SECTION # 12658
(24-4)

MEASURED SECTION: section measured in the SW¼ SE¼ of section 24, along the west slope of the county boundary road in road ditch; Clinton township (Loudenville quadrangle), Wayne County.

Elevation top of section 1122' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		5.4
1. Sandstone grayish-white, very fine grained sand in 15 % silt bond, thin bedded; basal contact covered.	0.6	4.8
2. Covered	0.4	4.4
3. Coal hard, locally shaly; LOWER MERCER ? COAL, elev. 1121'.	0.4	4.0
4. Underclay light gray, plastic.	4.0	0.0
Elevation base of section 1117'		

SECTION # 12659
(24-3)

MEASURED SECTION: section measured in the SE¼ SE¼ of section 24, on east slope of county line road along road ditch; Clinton township (Loudenville quadrangle), Wayne County.

Elevation top of section 1104' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		10.6
1. Sandy shale dark brown, very fine grained sand in heavy silt bond, thin bedded to very thin bedded; carbonaceous plant frags and mica parallel to bedding; basal contact gradational.	1.1	9.5
2. Sandstone brownish-white, very fine to fine grains in 25 % silt bond; thin bedded, common mica parallel to bedding; basal contact sharp.	0.2	9.3
3. Sandy shale dark gray very fine grained sand in heavy clay bond, hard, tough, thin to very thin bedded, firm to crumbly, micas parallel to bedding; basal contact sharp.	0.3	9.0

SECTION # 12659
(continued)

4. Coal weathered with local fine bright bands; VANDUSEN ? COAL, elev. 1102'.	0.2	8.8
5. Sandstone grayish-white, very fine grained sand in silty and siliceous bond; hard, tough, one bed, very common unoriented plant frags and mica; basal contact sharp.	0.2	8.7
6. Clay medium-light gray, impure, silty, poorly plastic to locally plastic, common carbonaceous frags (unoriented), locally shaly in thin beds.	3.2	5.5
7. Silty shale rusty brown, very thin bedded, heavy limonitic staining, poorly brittle; basal contact sharp.	5.0	0.5
8. Sandstone grayish-white, very fine to fine grains in 15 % clay bond, locally limonitic, common unoriented plant frags and micas; basal contact covered.	0.5	0.0

Elevation base of section 1093'

SECTION # 12850
(24-1)

MEASURED SECTION: section measured in the SW¼ SW¼ of section 24, on the south slope of east-west trending county line road in road ditch; Clinton township (Loudenville quadrangle), Wayne County.

Elevation top of section 1099'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		59.2
1. Sandy shale dark brown, very fine grained sand in heavy silt matrix; thin bedded, hard, brittle, limonitic; basal contact gradational.	5.0	54.2
2. Silty shale highly limonitic, dark brown, with local hard .1' thick siltstone beds; basal contact covered.	10.0	44.2
3. Covered	22.3	21.9
4. (see following page)		

4. Sandstone brownish-white, very coarse to fine grained, poorly sorted to well sorted, round to subrounded grains in 10-15% clay bond; medium to thin bedded, local coal frags parallel to bedding; poorly developed planar cross-bedding with sets up to 3 inches and maximum sweep 5 inches, the one determinable cross bedding direction yielded N-S 40 W; common limonitic ore band and vugs (often filled with coarse sand grains) up to ½ inch wide parallel and inclined to bedding; local conglomeratic bands up to 3 inches thick contain rounded white quartz pebbles up to 3/4ths of an inch diameter; basal contact gradational.	5.0	16.9
5. Ferrugineous sandstone dark brown, locally mottled, very fine to very coarse, poorly sorted (locally well sorted) sand in very heavy limonitic silt bond; common black iron bands up to ½ inch thick parallel and inclined to bedding; local rounded white quartz pebbles up to ½ inch diameter; weatheres to irregular "vuggy" surface; basal contact sharp.	1.5	15.4
6. Coal weathered with rare bright vein; basal contact sharp.	0.4	15.0
7. Iron ore thin bedded, vuggy; basal contact sharp.	0.4	14.6
8. Coal as in unit 6 above; basal contact sharp; QUAKERTOWN COAL HORIZON ?, elev. 1055'.	0.2	14.4
9. Iron ore one thick .1' bed with thin shaly beds above and below; basal contact sharp.	0.2	14.2
10. MISSISSIPPIAN-PENNSYLVANIAN CONTACT elev. 1054'; ALL BEDS NAMED BELOW ARE OF MISSISSIPPIAN AGE.		
11. Clay yellow and gray mottled, silty; basal contact sharp.	2.2	12.0
12. Sandy siltstone brownish-yellow, very fine grained sand in heavy silt matrix; thin bedded, hard, firm; basal contact covered.	12.0	0.0

Elevation base of section 1040'

SECTION # 12851
(11-3)

MEASURED SECTION: Section measured in the SW¼ NE¼ of section 11, south from farm buildings in field and along deep gully southeast from farm buildings, Clinton township (Loudenville quadrangle), Wayne County.

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
Elevation top of section 1086' (altimeter)		61.2
1. Sandstone light brown, medium to very fine, poorly sorted grains in 0 - 5 % clay bond; medium bedded, hard; basal contact covered.	1.0	60.2
2. Covered	20.0	40.2
3. Sandstone as in 1 above; basal contact covered.	2.0	38.2
4. Covered	31.5	6.7
5. Conglomeratic sandstone brownish-white, fine to very coarse, poorly sorted grains in 5 % silt bond; medium bedded with round white quartz pebbles up to 1½ inch longest demensions and fossiliferous weathered chert pebbles up to 3 inches diameter containing brachiopod frags; basal contact covered.	2.0	4.7
6. Covered	1.5	3.2
7. MISSISSIPPIAN-PENNSYLVANIAN CONTACT, elev. 1028'. ALL BEDS BELOW ARE OF MISSISSIPPIAN AGE.		
8. Siltstone pale brown, thin bedded, platy, finely laminated; basal contact covered.	3.2	0.0
Elevation base of section 1025'		

SECTION # 12852
(11-1)

MEASURED SECTION: section measured in the east central NW¼ of section 11, along west side of road going down south slope of hill; Clinton township (Loudenville quadrangle), Wayne County.

(see following page)

SECTION # 12852
(continued)

Elevation top of section 1097' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		23.7
1. Sandstone light brown, very fine to fine grained sand in 15 % clay bond, hard, tough; basal contact covered.	10.0	13.7
2. Coaly clay shale black, thin to paper thin bedded, basal .1' has rare bright coal spars; basal contact sharp; BEAR RUN COAL HORIZON? elev. 1082'.	5.0	8.7
3. Clay brown, impure; basal contact sharp.	0.2	8.5
4. Sandstone yellow-white, medium to fine, round to subrounded, poorly sorted grains in 5 % clay bond; medium bedded; common carbonaceous frags and clay frags parallel to bedding appear interbedded with 2 inch beds of medium to fine poorly sorted yellow sandstone without carbonaceous frags or clay pods; basal contact covered; Note- sandstone gets generally more fine grained and thinner bedded towards top of interval.	8.5	0.0
Elevation base of section 1073'		

SECTION # 12853
(10-3)

MEASURED SECTION: section measured in the SE¼ SW¼ of section 10, southwest from house and barns down creek bed; Clinton township (Loudenville quadrangle), Wayne County.

Elevation top of section 1110' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		34.5
1. Coaly black shale black, clay shale, thin bedded with rare bright coal spars at base; VANDUSEN COAL HORIZON ? elev. 1100'	1.2	33.3
2. Underclay light gray, impure, silty; basal contact covered.	2.0	31.3

(continued on following page)

SECTION # 12853
(continued)

3. Covered	20.0	11.3
4. Black shale with rare bright coal spars at base; very thin to thin bedded; one .1' thick limy bed, hard, dense; BEAR RUN COAL HORIZON ? elev. 1080'	6.0	5.3
5. Covered	1.0	4.3
6. Clay gray, plastic with coal frags at top.	3.1	1.2
7. Sandstone grayish-white, very fine grained sand, hard, tough.	1.2	0.0

8. MISSISSIPPIAN-PENNSYLVANIAN CONTACT, elev. 1075'; all beds below are of Mississippian age.

9. Siltstone orange-brown, hard, tough.

Elevation base of section 1075'

SECTION # 12854
(3-1)

MEASURED SECTION: section measured in the NW¼ NE¼ of section 3; at bottom of lane leading from barn in the NE¼ NE¼ section 3; Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1096'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		42.2
1. Coal poor, shaly, with thin bright veins; basal contact sharp.	0.4	41.8
2. Clay light gray, pure, plastic (Note: a clay of "ceramic quality" according to local farmer).	5.0	36.8
3. Coal poor, shaly with thin bright veins; BEAR RUN ? COAL HORIZON, elev. 1091'.	0.3	36.5
4. Covered	28.0	8.5
5. Black shale thin to very thin bedded, clayey, poor slope former; basal contact gradational.	1.2	7.3

(continued on next page)

SECTION # 12854
(continued)

6. Coaly black shale very thin bedded to paper-thin, thin bright coal veins in 10% of interval; basal contact gradational.	1.1	6.2
7. Black shale as in unit 5 above; base QUAKERTOWN ? COAL HORIZON, elev. 1059'.	0.8	5.4
8. Sandy clay dark gray, impure, very fine grained sand and silt in heavy clay bond; massive, hackly fracture; basal contact gradational.	0.8	4.6
9. Sandstone gray-white, thin bedded, very fine grained sand in 20 % clay bond; mica parallel to bedding, limonitic staining common; common unoriented plant stem?molds and carities up to 1 inch long and ½ inch diameter; fair to good ridge former; basal contact gradational.	1.4	3.2
10. Sandstone yellow-white, very coarse to medium, poorly sorted, rounded grains in 15 % white clay bond; medium bedded with local cut-outs in bedding; common coal frags pafallel to bedding; crumbly; basal contact sharp; Note-this appears to be a channel sand.	0.8	2.4
11. Silty clay shale black, thin bedded, firm; basal contact sharp.	1.4	1.0
12. Sandy clay shale orange-brown 5 % coarse to fine very poorly sorted sand in clay bond; local limonitic seams and staining; firm to poorly crumbly; basal contact covered.	1.0	0.0

Elevation base of section 1054'

SECTION # 12855
(3-2)

MEASURED SECTION: section measured in the SW¼ NE¼ of section 3, along creek bottom and walls of valley; Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1084' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		63.35

(see following page)

SECTION # 12855
(continued)

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
1. Sandstone dark brown, very fine grained sand in 25 % clay bond; thin bedded, micas and plant frags parallel to bedding; firm, brittle; basal contact covered.	7.5	55.85
2. Sandstone brownish-white, fine to medium sand in 10 % clay bond, hard, tough, common plant casts and carbonaceous frags; massive to thick bedded.	3.5	52.35
3. Covered	6.0	46.35
4. Carbonaceous sandstone gray black, fine to very fine grain sand in 30 % clay and carbonaceous bond; thin bedded, micas parallel to bedding; hard tough; basal contact sharp.	0.4	45.95
4. Silty clay shale black, thin bedded, firm; basal contact charp.	0.3	45.65
5. Coal hard, bright; basal contact sharp.	0.1	45.55
6. Clay shale light gray, thin bedded, common black carbonaceous frags, micas parallel to bedding; silty; basal contact covered.	4.2	41.35
7. Covered	2.0	39.35
8. Silty shale black, thin bedded.	1.0	38.35
9. Covered	3.5	34.85
10. Coal 90% dull 10% bright, hard, tough; base QUAKERTOWN COAL ? , elev. 1055'	1.2	33.65
11. Sandy clay shale grayish-white, very fine sand in heavy silt-clay bond; common plant frags, mica parallel to bedding; basal contact covered.	3.0	30.65
12. Covered	13.0	17.65
13. Silty shale black, thin bedded with local thin limonitic seams; basal contact gradational.	5.0	12.65

(continued on next page)

SECTION # 12855
(continued)

14. Coal hard, 35 % bright, 65 % dull; basal contact sharp; ANTHONY ? COAL, elev. 1033'	1.0	11.65
15. Clay shale dark gray, silty, thin bedded, hackly; basal contact sharp.	0.6	11.05
16. Sandstone grayish-white, very fine grained to fine grained sand in 10 % clay bond, hard, firm, poorly friable, local cut and fill structures, massive; weathers to thin irregular beds; micas and black plant frags parallel to bedding; basal contact sharp.	3.2	7.85
17. Silty shale dark olive brown, thin bedded, hackly fracture; basal contact gradational.	0.3	7.55
18. Silty shale dark gray, thin to paper thin shale, hard, brittle, with local round ironstone nodules throughout; basal contact gradational.	1.6	5.95
19. Ironstone nodule zone subrounded to rounded nodules; basal contact sharp.	0.1	5.85
20. Coaly shale black, hard, thin bedded; 10 % bright coal spars; basal contact sharp.	0.05	5.8
21. MISSISSIPPIAN-PENNSYLVANIAN CONTACT, elev. 1027'; ALL BEDS BELOW ARE OF MISSISSIPPIAN AGE		
22. Siltstone dark gray, very fine grained sand in heavy silt matrix; hard, tough, hackly fracture;	1.8	4.0
23. Silty shale olive drab, hackly fracture.	4.0	0.0

Elevation base of section 1021'

SECTION # 12857
(9-1)

MEASURED SECTION: section measured in the center NW¼ of section 9, along road just south of Moorland; Franklin township (Millersburg quadrangle), Wayne County.

(continued on next page)

SECTION # 12857
(continued)

Elevation top of section 1109' (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		8.8
1. Sandstone brownish-white, fine to medium, subangular, poorly sorted grains in 5 % clay bond; medium to thick bedded, hard, firm, good ridge former; common clay concretions, mica parallel to bedding; one cross beds gives N 18 E 10 NW direction; basal contact sharp.	1.0	7.8
2. Sandstone light brown, very fine to medium, poorly sorted grains in 10 % clay bond; very thin to thin bedded; common coaly plant frags parallel to bedding; slope former; basal contact covered.	1.2	6.6
3. Clay shale dark gray, very thin bedded; basal contact sharp.	2.1	4.5
4. Coal poor, shaly and weathered with few good, bright, coal veins; basal contact sharp.	0.2	4.3
5. Clay dark gray, impure, crumbly, grades into clay shale in lower ½ interval, gray shale is very thin bedded and clayey; basal contact sharp.	3.5	0.8
6. Sandstone grayish-black, very fine grained sand in 25 % silty-clay carbonaceous bond; very hard, tough; basal contact sharp.	0.1	0.7
7. Clay shale dark brownish-black, highly limonitic, crumbly; basal contact sharp.	0.1	0.6
8. Coal poor, shaly with 2 or 3 fine bright veins only; basal contact sharp, BEAR RUN COAL ?, elev. 1100'	0.2	0.4
9. Clay shale light brown, crumbly; basal contact covered.	0.4	0.0
Elevation base of section 1100'		

SECTION # 12859
(10-3)

MEASURED SECTION: section measured in the SW¼ SW¼ of section 10, up ravine approximately 500' from the SW corner of section; Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1038' (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		10.7
1. Red clay (reported by farmer-miner)	1.0	9.7
2. Coal weathered, 50 % bright*; ANTHONY ? COAL, elev. 1035'.	1.9	7.8
3. Underclay gray, poorly exposed.	0.2	7.6
4. Covered	2.0	5.6
5. Sandstone grayish-white, very fine sand in 25 % silty clay bond; firm to poorly friable, thin bedded at top interval grading to medium bedded at base; rare mica parallel to bedding; locally limonitic; basal contact sharp.	1.5	4.1
6. Sandy iron ore dark brown, hard, tough, 15 % sand, one bed, local black staining; basal contact sharp.	0.1	4.0
7. MISSISSIPPIAN-PENNSYLVANIAN CONTACT, elev. 1031'; ALL BEDS LISTED BELOW ARE OF MISSISSIPPIAN AGE.		
8. Sandy siltstone grayish-white, very fine grained sand in heavy silt matrix; thin bedded, flaggy; siltstone gets less sandy and more silty with increase in limonitic pinpoint mottling towards base of interval; basal contact covered.	4.0	0.0

Elevation base of section 1027'

* According to farmer-miner who owns land at above section site, this coal was mined for 500' under the hill towards the southeast from the entry (at coal crop above); no roof and dip towards the the southeast with consequent water trouble was the cause of the abandonment of this drift.

SECTION # 12860
(10-4)

MEASURED SECTION: section listed below was described (including thicknesses) by A.A.Wright in 1882 (listed in the files of the Ohio Geological Survey, # 7646) as in section 10, Franklin township (Millersburg quadrangle), Wayne County. The section was not located by the present author but tentative correlations and elevations have been added below by the present author.

Elevation top of section 1217'	Thickness of unit Ft/Inches	Interval from base Ft/Inches
		139.3
1. "Gray limestone" (PUTNAM HILL)	8.0	131.3
2. "Coal" (BROOKVILLE COAL, elev. 1207')2 ft. to	2.6 ft.	128.7
3. "Interval"	17.5	111.2
4. "Clay and coal streaks" (TIONESTA COAL, elev. 1189'.)	0.2	111.0
5. "Interval"	42.0	69.0
6. "Coal reported" (MIDDLE MERCER ? COAL, elev. 1144')	3.0	66.0
7. "Interval"	66.0	0.0
8. "Sandstone"	-	-
9. "Clay"	-	-

SECTION # 12863
(15-1)

MEASURED SECTION: section measured in the SE¼ SE¼ of section 15, at spring by shed just east of house; Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1204'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		11.4
1. Limestone medium to thin bedded; basal contact sharp; PUTNAM HILL	5.0	6.4
2. Coal hard, good; basal contact sharp; BROOKVILLE COAL, elev. 1198'.	1.6	4.8

(continued on next page)

SECTION # 12863
(continued)

3. Clay very dark gray, impure; basal contact gradational.	1.8	3.0
4. Sandstone white, very fine grained sand in 30 % clay bond; mica parallel to bedding; basal contact covered.	3.0	0.0

Elevation base of section 1193'

SECTION # 12864
(18-1)

MEASURED SECTION: section measured in the SW¼ SW¼ of section 18, along the NW side of hill in road ditch and road cut; coal blossoms out in field approximately 400' SW from the Mississippian-Pennsylvanian contact; Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1007' (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		37.0
1. Coal weathered, rare bright veins; SHARON ? COAL HORIZON, elev. 1007'.	0.4	36.6
2. Underclay dark gray, plastic; basal contact covered.	0.4	36.2
3. Covered	22.0	14.2
4. Interbedded conglomerate, conglomeratic sandstone and sandstone in alternating and lenticular beds showing both gradational and sharp contacts with each other; CONGLOMERATE at least 3 distinct zones up to 2.' maximum thickness, sub-rounded to rounded quartz pebbles and rock frags (fine grained sandstone, weathered cherty limestone, iron ore) up to 2 inches longest demension, showing no alignment or distinct pebble bands although elongate pebbles are usually parallel to bedding; pebbles are in poorly sorted fine to very coarse sand matrix with up to 10 % clay bond; CONGLOMERATIC SANDSTONE at least 2 zones up to 1.5' maximum thickness, pebbles and rock frags as above in 50 % or more sandstone matrix; SANDSTONE at least 2 beds up to 1.5' maximum thickness, medium to fine, subrounded, well sorted		

(continued on following page)

SECTION # 12864
(continued)

4. (continued) yellowish-white sand in 5 % clay bond; sandstone is best ridge former of the 3 rock types; basal contact of interval is sharp with conglomerate on siltstone; SHARON CONGLOMERATIC SANDSTONE, CONGLOMERATE AND SANDSTONE.	13.0	1.2
5. MISSISSIPPIAN-PENNSYLVANIAN CONTACT, elev. 972'; ALL ROCKS LISTED BELOW ARE OF MISSISSIPPIAN AGE.		
6. Siltstone dark brown, very fine grained sand in very heavy silt matrix; thin bedded, hard, tough; basal contact covered.	1.2	0.0

Elevation base of section 970'

SECTION # 12865
(23-5)

MEASURED SECTION: section measured in road cut going east over hill in the NW¼ SE¼ of section 23, Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1159' (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		55.1
1. Sandstone brownish-white, medium to fine grains in 10 % clay bond, medium to thin bedded, firm-friable, good ridge former; basal contact covered.	12.0	43.1
2. Covered	19.7	23.4
3. Coal weathered; LOWER KITTANNING COAL, elev. 1126'.	1.1	22.3
4. Clay yellowish-gray-white, poor, impure.	3.0	19.3
5. Covered	2.0	17.3
6. Sandstone grayish-white, very fine grained sand in heavy silt-clay bond, 70 % sand and 30% clay-silt; mica parallel to bedding, very thin bedded; basal contact covered.	17.3	0.0

Elevation base of section 1104'

SECTION # 12866
(24-2)

MEASURED SECTION: section measured from the 1214' T-road intersection eastward and down toward bottom of hill, section 24, Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1214'	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		151.3
1. Covered	32.0	119.3
2. Coal poor, shaly; BROOKVILLE COAL, elev. 1181' (Note: Putnam Hill limestone crops out at an elevation of 1177' nearby).	1.1	118.2
3. Clay poor, dark gray, poorly plastic, impure; basal contact covered.	1.0	117.2
4. Covered	30.0	87.2
5. Coal ½ to ¾ inch streaks of bright coal in dull shaly coal bed;	1.0	86.2
6. Clay dark gray, poorly exposed.	3.0	83.2
7. Covered	2.0	81.2
8. Coal poor, shaly in lower portions; basal contact sharp; BEDFORD ? COAL, elev. 1143'	1.2	80.0
9. Clay dark gray with plant frags, impure.	3.0	77.0
10. Clay shale light brown, thin bedded, mica parallel to bedding; basal contact sharp.	1.2	75.8
11. Sandstone grayish-white, very fine grained sand in 20 % silty-clay bond; mica parallel to bedding, locally limonitic with some faint limonite bands parallel to bedding; .2' shale zones at last (unit 10) above occur in upper 1/3rd of interval and one iron nodule zone occurs 11.5' from top of sandstone interval; basal contact gradational.	14.8	61.0
12. Interbedded silty shale and very fine grained silty sandstone dark brown, very thin bedded, micaceous, common ironstone nodules; basal contact covered.	14.0	47.0

(continued on next page)

SECTION # 12866
(continued)

13. Covered	43.5	3.5
14. Sandstone light gray, medium to coarse, rounded, poorly sorted to fairly well sorted grains in clay bond; sand grains are commonly stained with limonite; basal contact sharp with .2' iron stained zone at base.	3.2	0.3
15. Clay shale dark gray, silty, thin bedded; basal contact sharp.	0.3	0.0
16. MISSISSIPPIAN-PENNSYLVANIAN CONTACT, elev. 1063', contact shows relief of 5' in 50' lateral feet; ALL ROCKS LISTED BELOW ARE OF MISSISSIPPIAN AGE.		
17. Siltstone tan, thin bedded, very common limonitic pin point specks or mottling up to 2 mm diameter; basal contact covered		

SECTION # 12868
(21-1)

MEASURED SECTION: section measured in the SW¼ SE¼ of section 21, along road going downhill and down into gully on south side bottom of hill; Putnam Hill limestone from entry west central section 22; NOTE: elevations of limestones appear abnormally low in this area due to proximity of regional syncline; intervals are normal; Franklin township (Millersburg quadrangle), Wayne County.

Elevation top of section 1171' (H.L.)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		152.5
1. Limestone medium to dark gray; basal contact sharp; PUTNAM HILL LIMESTONE.	4.8	147.7
2. Coal weathered, poorly exposed; BROOKVILLE COAL, elev. 1163'	2.6	145.1
3. Covered	43.0	102.1

(continued on next page)

4.	Limestone dark blue, in 2 beds approximately 1.' thick which weather into thinner plates 1 inch thick, very hard, tough, crinoidal; basal contact sharp; contains Fusulinella iowensis; UPPER MERCER LIMESTONE.	2.0	100.1
5.	Clay shale black, very thin bedded to paper thin shale, poorly brittle to plastic getting more plastic in upper 1/3rd interval; basal contact covered; approximate base of BEDFORD COAL HORIZON, elev. 1110'.	8.0	92.1
6.	Covered	27.3	64.8
7.	Coaly shale thin coal spars in poorly exposed weathered shale; LOWER MERCER ? coal horizon, elev. 1083'.	0.1	64.7
8.	Underclay plastic,light gray; basal contact covered.	1.0	63.7
9.	Covered	11.7	52.0
10.	Sandstone brownish-white, very fine to fine, poorly sorted grains in 15 % silt bond; medium to thin bedded, micas parallel to bedding; common plant frags and local limonitic staining; ridge former; basal contact gradational through 1.' zone.	2.6	49.4
11.	Clay white,silty, poorly plastic; basal contact sharp.	6.9	42.5
12.	Coal thin, poor, 25% bright; VANDUSEN ? COAL, elev. 1060'.	0.1	42.4
13.	Underclay light gray, plastic.	1.0	41.4
14.	Covered	26.9	14.5
15.	Sandy siltstone light gray-brown, very fine grained sand in heavy silt matrix; heavy limonitic staining, hard, tough, thin bedded; basal contact gradational.	6.5	8.0
16.	Clay shale olive drab, very thin bedded, platy, limonitic,thin ¼ inch plates at base; basal contact sharp.	2.0	6.0

(continued on following page)

SECTION # 12868
(continued)

17. MISSISSIPPIAN - PENNSYLVANIAN CONTACT ?
elev. 1024'; Rocks listed below are of probable Mississippian age.

18. Siltstone light gray, thin to medium bedded, with 1 mm limonitic pin point specks common.	6.0	0.0

Elevation base of section 1018'

SECTION # 12870
(23-2)

WELL RECORD: (from recovered drill cuttings) from water well drilled on property of Mose S. Miller; location of well approximately 2000' west and 450' south of the NE corner of section 23, Salt Creek township (Millersburg quadrangle), Wayne County.

Ground elevation of well 1237' (altimeter)

TOP	BOTTOM	DESCRIPTION	THICKNESS
0	39	Wash	39
39	41	Coal (BROOKVILLE COAL, elev. 1196')*	2
41	49	Sandy clay	8
49	60	Gray shale	11
60	62	Black slate (TIONESTA COAL horizon, elev. 1175')*	2
62	67	Clay	5
67	76	Gray shale	9

T.D. 1161' *(ADDED BY H.G.MULTER)

SECTION # 12873
(34-1)

MEASURED SECTION: section located in the central NE¼ of section 34, in bank of gully near lane (Note: only coal blossom was seen and dug out - remainder of lithology and thicknesses were given by farmer who has recently made a farm pond out of gully; most of blossom is currently under water); Sugar Creek township (Navarre quadrangle), Wayne County.

(see following page)

SECTION # 12873
(continued)

Elevation of top of section 1125' (altimeter)	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
		1.9
1. White sticky clay	0.5	1.4
2. Coal	0.1	1.3
3. Shale, gray	0.2	1.1
4. Coal ; base UPPER MERCER COAL HORIZON, elev.1123'	1.1	0.0

Elevation base of section 1123'

SECTION # 12875
(36-6)

MEASURED SECTION DATA: Information given below represents verbal description given by owner of abandoned mine; lithology represents that cut by the 115 foot shaft to the Massillon (#1) coal; lithology below coal represents results of drill test within 200 feet of shaft. Location of shaft is approximately 3700' east and 600' north of the SW corner of section 36, Sugar Creek township (Navarre quadrangle), Wayne County.

Elevation of shaft at ground level 1012' (altimeter)

	Thickness of unit Ft/Tenths	Interval from base
1. Surface	70	-
2. Blue shale	?	-
3. Gray slate	?	-
4. Coal "good"; base MASSILLON COAL, elev. 892'.	3.0	15.0
5. Underclay	11.0	4.0
6. Conglomeratic sandstone*	4.0	0.0
7. MISSISSIPPIAN-PENNSYLVANIAN CONTACT ? elev.877'		
8. "Cuyahoga shale"		

* pieces of this rock found on gob pile

SECTION # 12877
(21-1)

MEASURED SECTION: section measured in the SE¼ NE¼ of section 21, from T-road intersection 1021 westward along road ditch; augments section # 10064 in files of the Ohio Geological Survey; Baughman township (Massillon quadrangle), Wayne County.

	Thickness of unit Ft/Tenths	Interval from base Ft/Tenths
Elevation top of section 1099' (H.L.)		77.7
1. Sandstone (coaly) white, fine to very fine grains in 5 % clay bond; firm, hard, common carbonaceous plant and bright coal frags; basal contact sharp; base VANDUSEN ? coal horizon elev. 1094'.	4.0	73.7
2. Underclay medium to dark gray, plastic, local bright coal frags in upper 1/3rd of interval; basal contact covered.	5.9	67.8
3. Covered	23.6	44.2
4. Coal weathered, 50 % bright; base QUAKERTOWN COAL, elev. 1064'.	0.9	43.3
5. Underclay light gray, poorly plastic, siliceous	2.0	41.3
6. Covered	9.3	32.0
7. Shale dark, poorly exposed	2.0	30.0
8. Covered	17.0	13.0
9. Sandstone poorly exposed	3.0	10.0
10. Interval	10.0	0.0
11. Sharon coal*, elev. 1021' (approximately)	?	-
Elevation base of section 1021'		

* Conrey (1921, p.99) in describing this section notes that the road corner (T-road corner, elev: 1021') is "the approximate level of the Sharon or No. 1 coal" here.

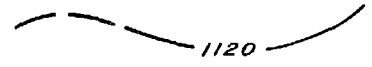
AUTOBIOGRAPHY

I, Harold Gray Multer, was born in Syracuse, N.Y., July 7, 1926. I received my secondary school education in the public schools of Arkport, New York. For the following two years I served in the U.S. Navy in the Pacific theater. My undergraduate training was obtained at Alfred and Syracuse Universities, New York. I received the degree of Bachelor of Arts (Geology) from Syracuse University in June 1949. I also received the degree of Master of Science (Geology) in January 1951, from Syracuse University; while in residence at the University I acted in the capacity of Graduate Assistant. Following graduation I was employed as a geologist for a major oil company in California. In September 1952 I started graduate studies at The Ohio State University serving the first year as a Graduate Assistant and the following two years as Research Fellow, in the Department of Geology.

PLATES II and III and IV

DISTRIBUTION AND STRUCTURAL RELATIONSHIPS OF MISSISSIPPIAN AND PENNSYLVANIAN ROCKS IN WAYNE COUNTY, OHIO

Subsurface structure contours on top of the Mississippian BEREA sandstone



Structure contours on top of the MISSISSIPPIAN — PENNSYLVANIAN DISCONFORMABLE SURFACE

ALL ELEVATIONS ABOVE MEAN SEA LEVEL

ALL CONTOUR INTERVALS 20 FEET

PENNSYLVANIAN

Pottsville and Allegheny

MISSISSIPPIAN (after Conrey, 1921)

Logan

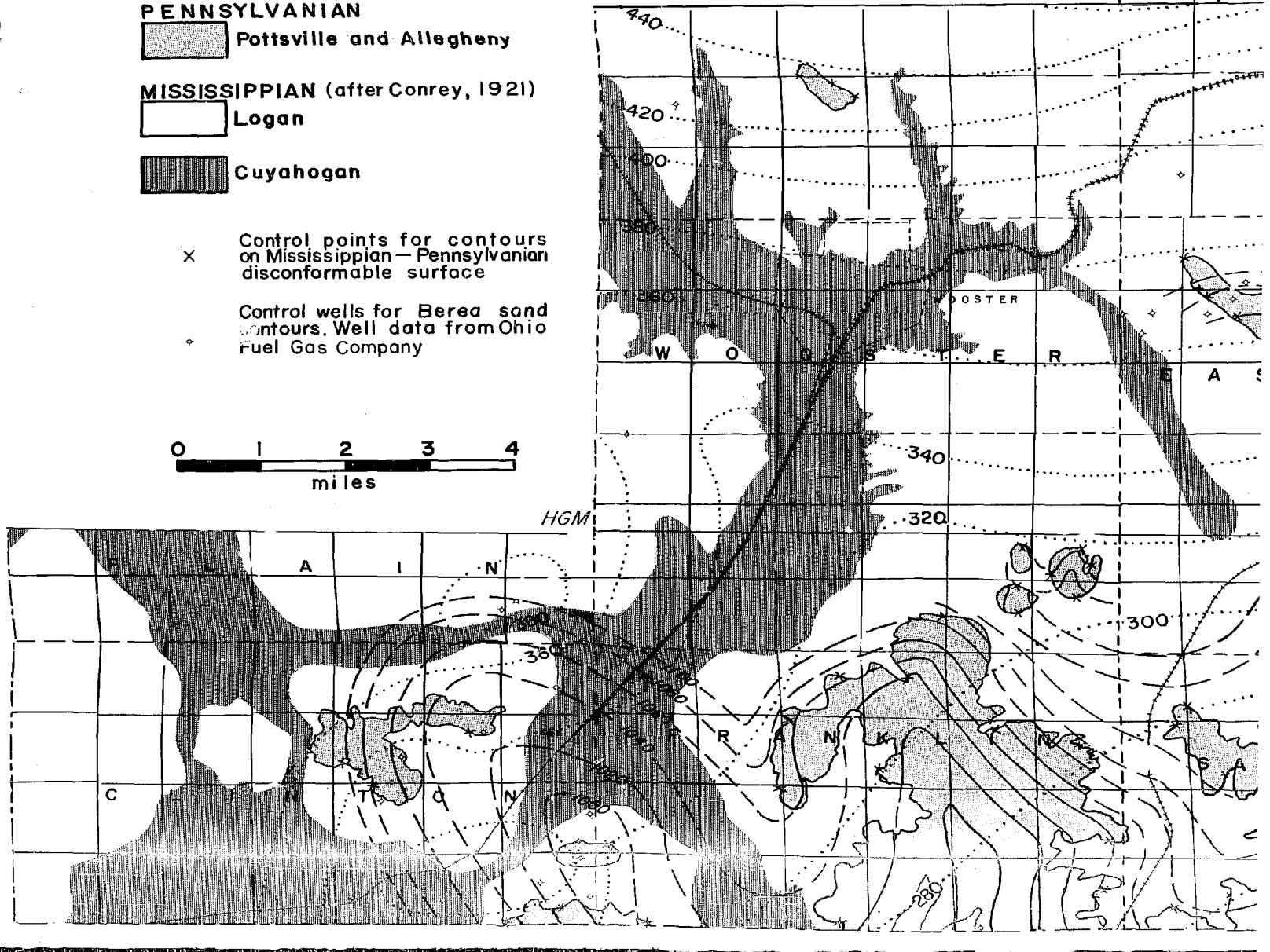
Cuyahogan

× Control points for contours on Mississippian — Pennsylvanian disconformable surface

Control wells for Berea sand contours. Well data from Ohio Fuel Gas Company

0 1 2 3 4 miles

HGM



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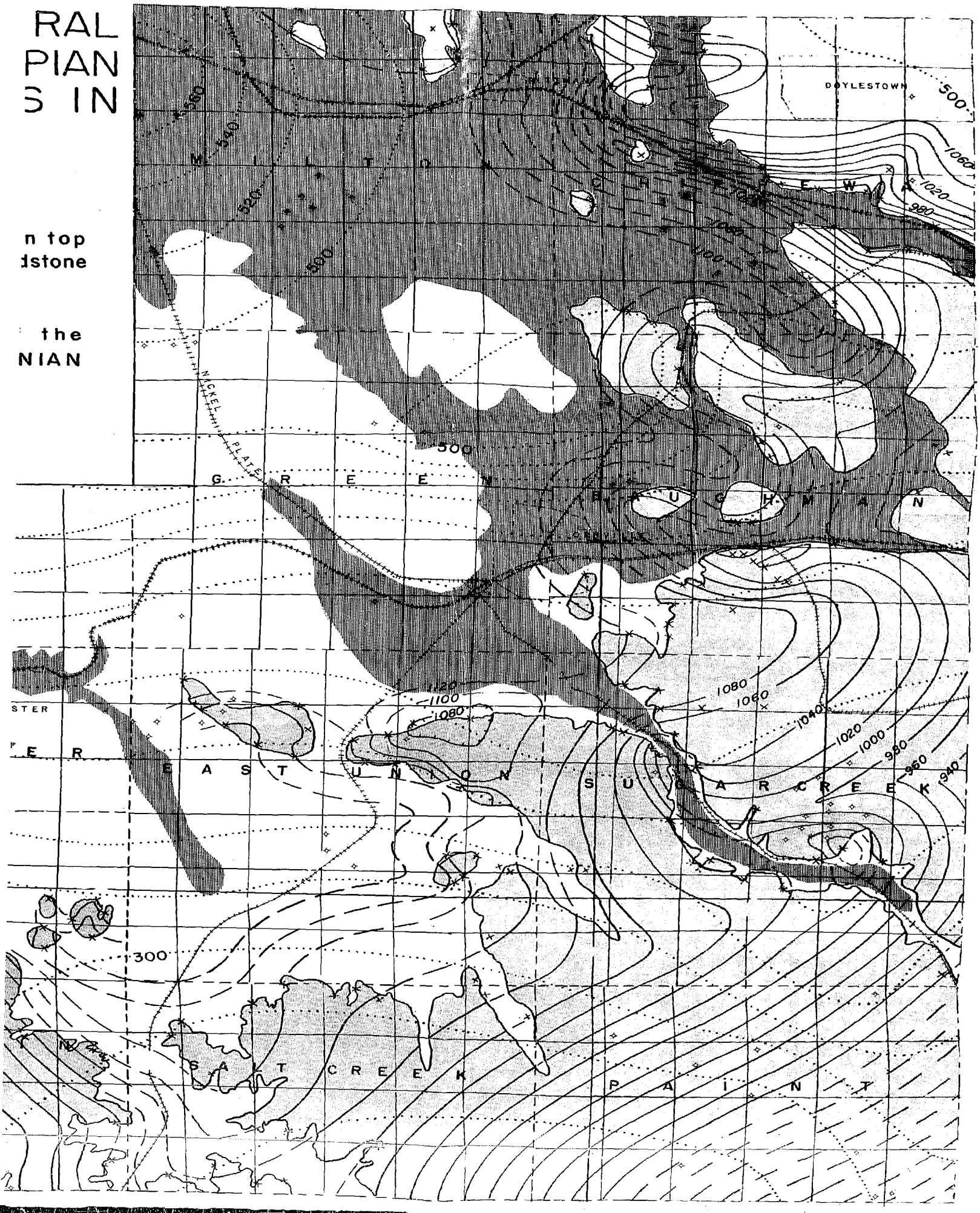
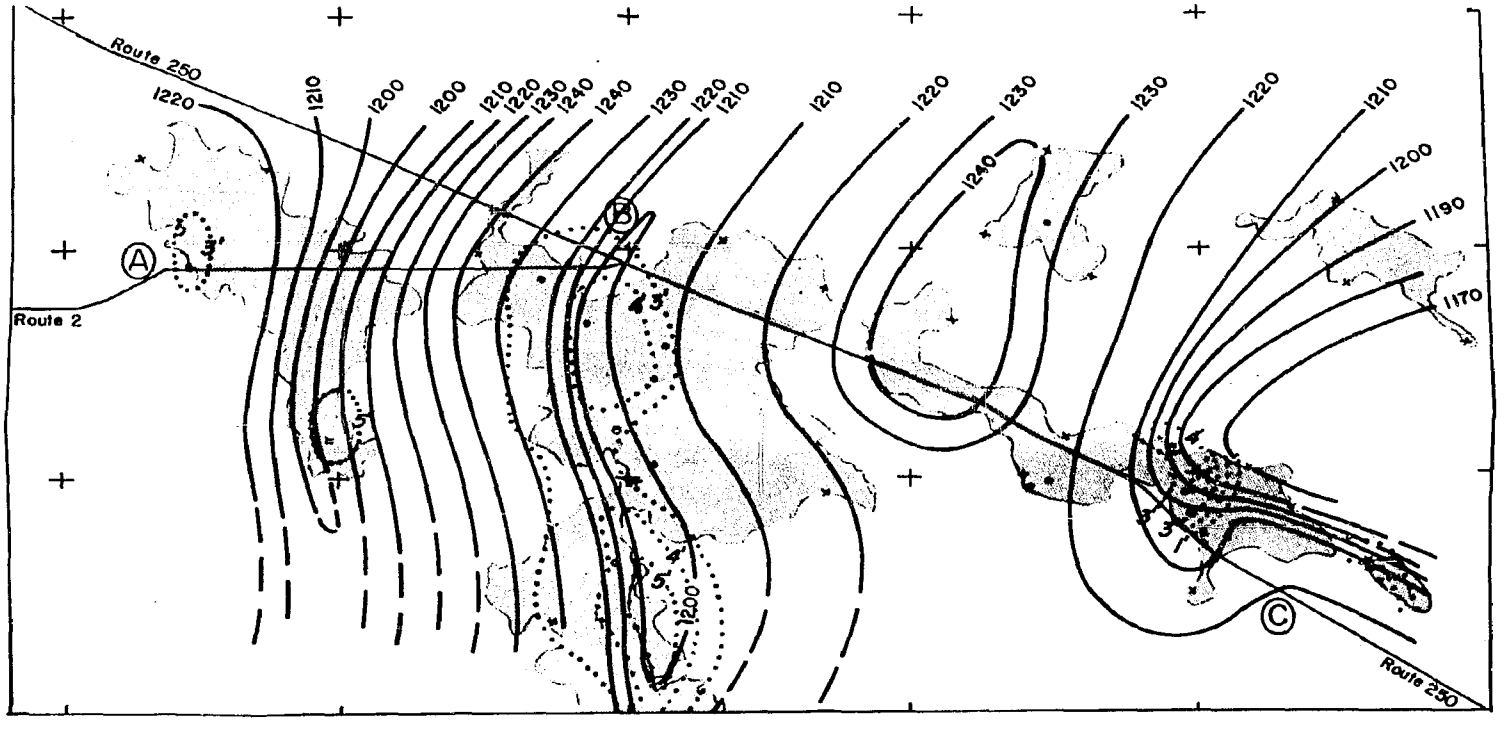
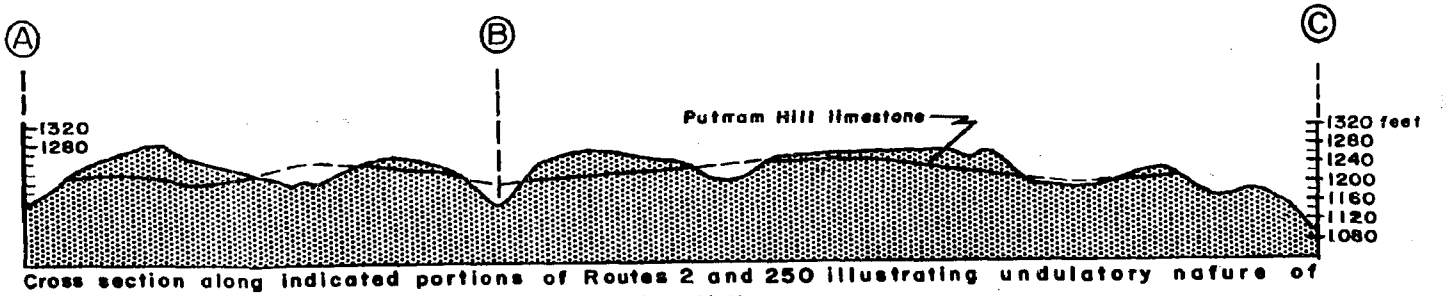


DISTRIBUTION, STRUCTURE AND LOCAL THICKNESS OF THE PUTNAM HILL LIMESTONE IN PAINT TOWNSHIP





Cross section along indicated portions of Routes 2 and 250 illustrating undulatory nature of the Putnam Hill limestone. Vertical exaggeration 11 X.

Area of Putnam Hill limestone

x Outcrop control

o Well control

SCALE

0 1 2

miles

ALL ELEVATIONS ABOVE MEAN SEA LEVEL

1210 Structure contours

4 Local isopach contours

NOTE: thickness data for remainder of area are either inadequate for contouring or the limestone is less than one foot thick

HGM

GEOLOGIC MAP OF THE PENNSYLVANIAN ROCKS IN WAYNE COUNTY, OHIO

By H. Gray Multer

1955

Scale $\frac{1}{62500}$

1 ½ 0 1 2 3 4 Miles

1000 500 0 1000 2000 3000 4000 5000 6000 7000 Yards

1000 0 3000 6000 9000 12000 15000 18000 Feet

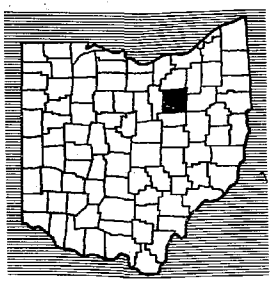
Contour interval 20 feet

Datum is mean sea level

PENNSYLVANIAN SYSTEM

Allegheny Group

Pottsville Group



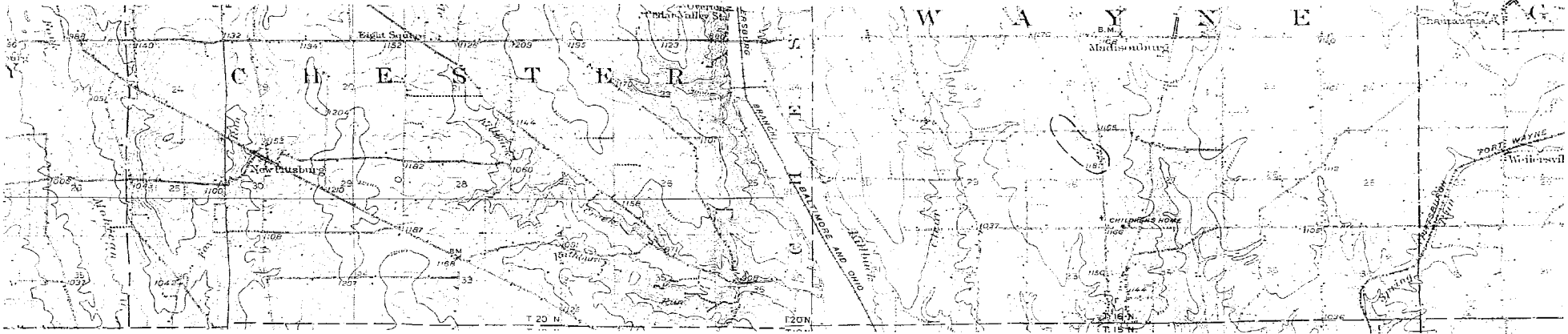
Location of Wayne County, Ohio

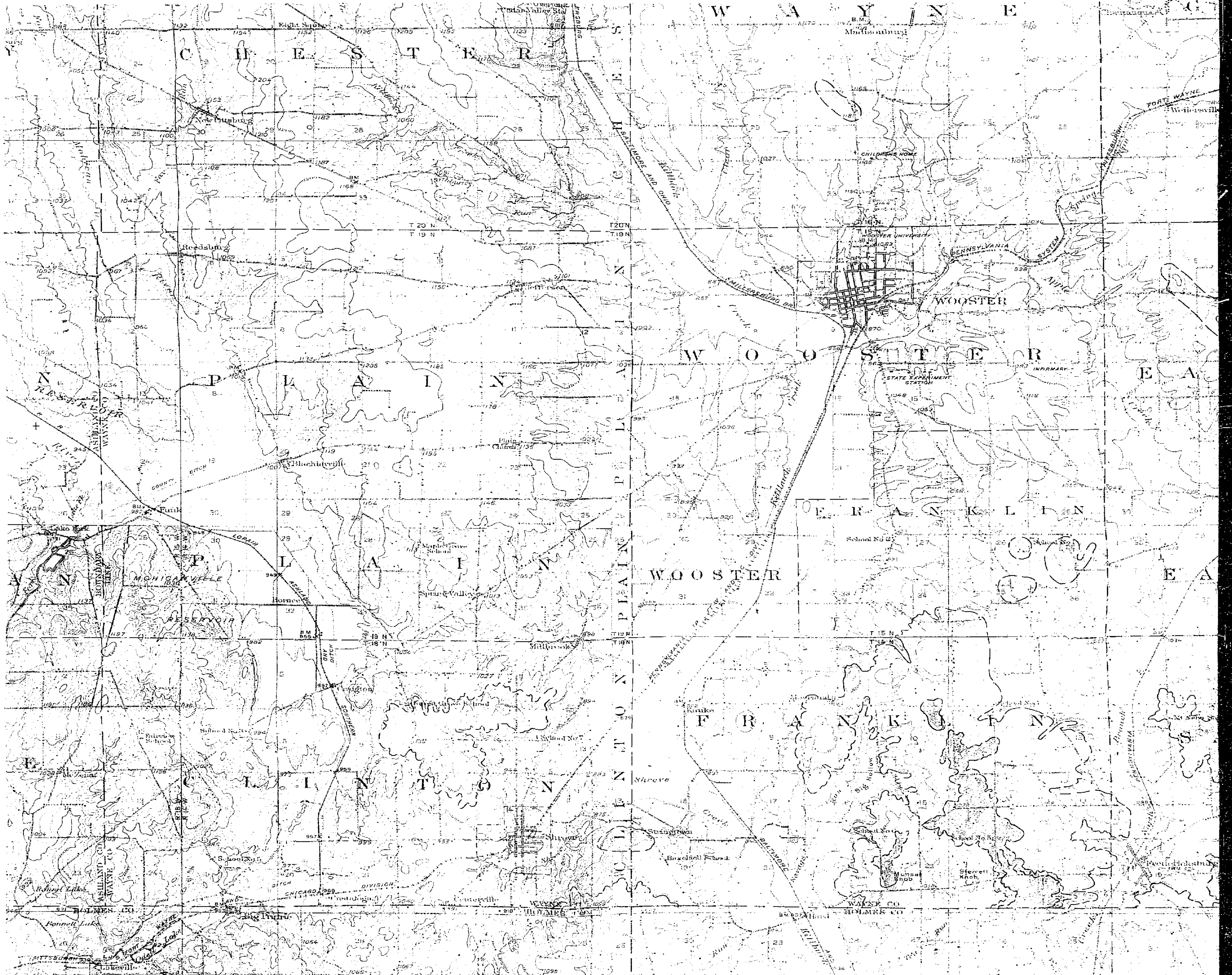
MISSISSIPPIAN SYSTEM

Logan and Cuyahoga Formation (*undifferentiated*)

M Outcrop of Middle Kittanning coal

L Outcrop of Lower Kittanning coal




WAYNE
CHESTER
WOOSTER
PLAIN
FRANKLIN
CLINTON
WOOSTER
WOOSTER
PLAIN
FRANKLIN
CLINTON
Madisonburg
Reedsburg
New Pittsburg
Blachleyville
Millbrook
Shreve
Big Prairie
Fredericksburg
BALTIMORE AND OHIO
PENNSYLVANIA SYSTEM
FORT WAYNE
STATE EXPERIMENT STATION
INFIRMARY
CHILDRENS HOME
WOOSTER UNIVERSITY
RESERVOIR
MOHICANVILLE
ASHLAND CO
WAYNE CO
HOLMES CO

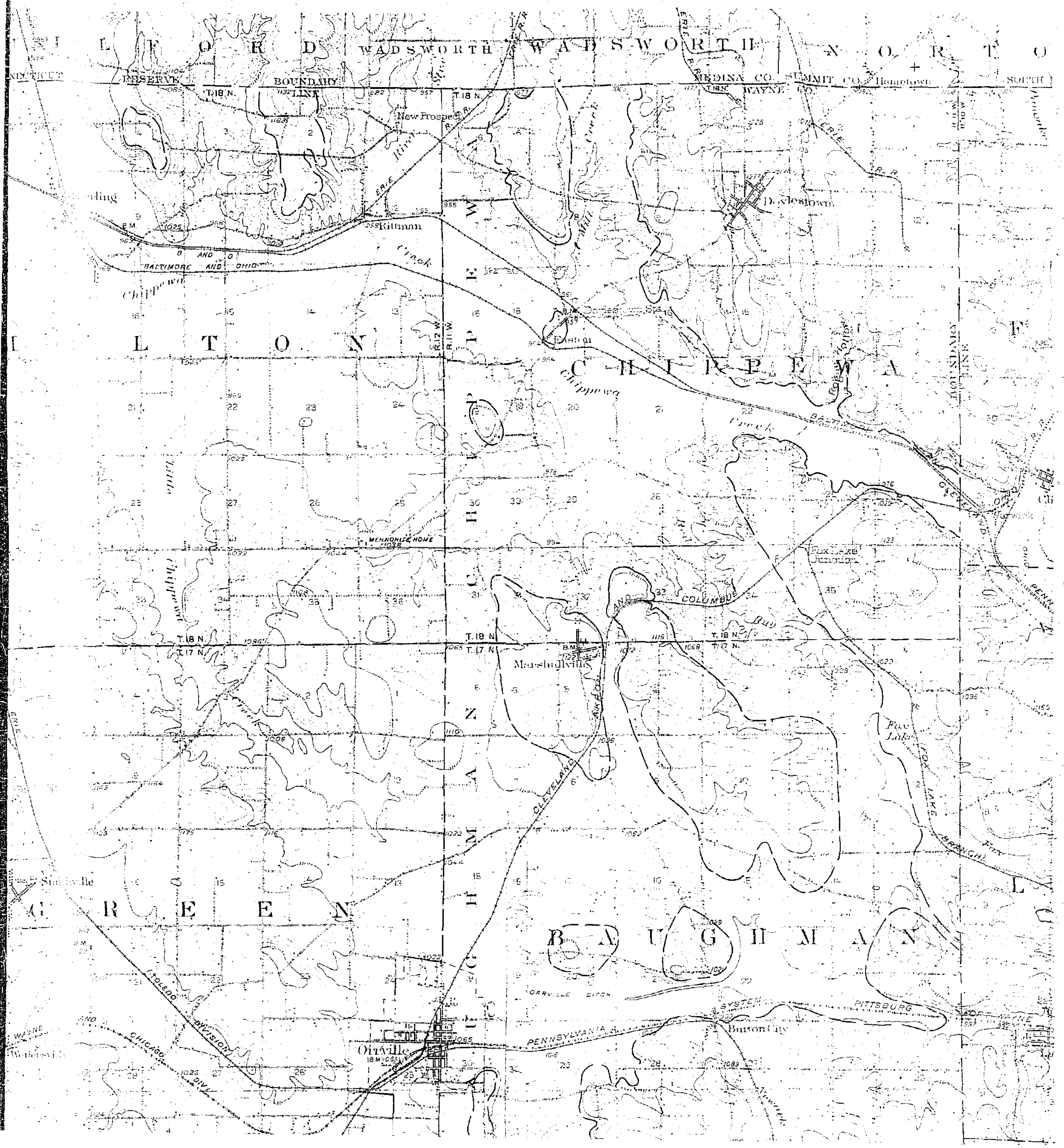
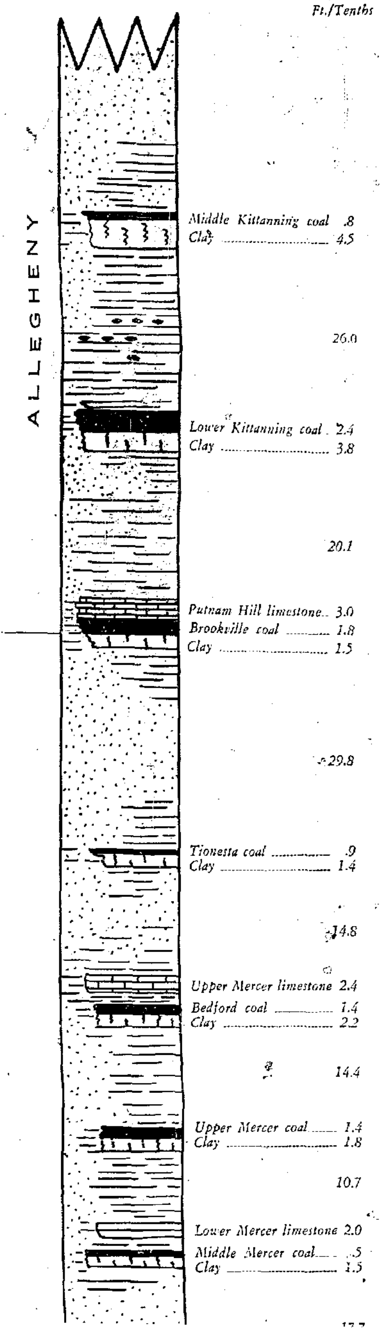
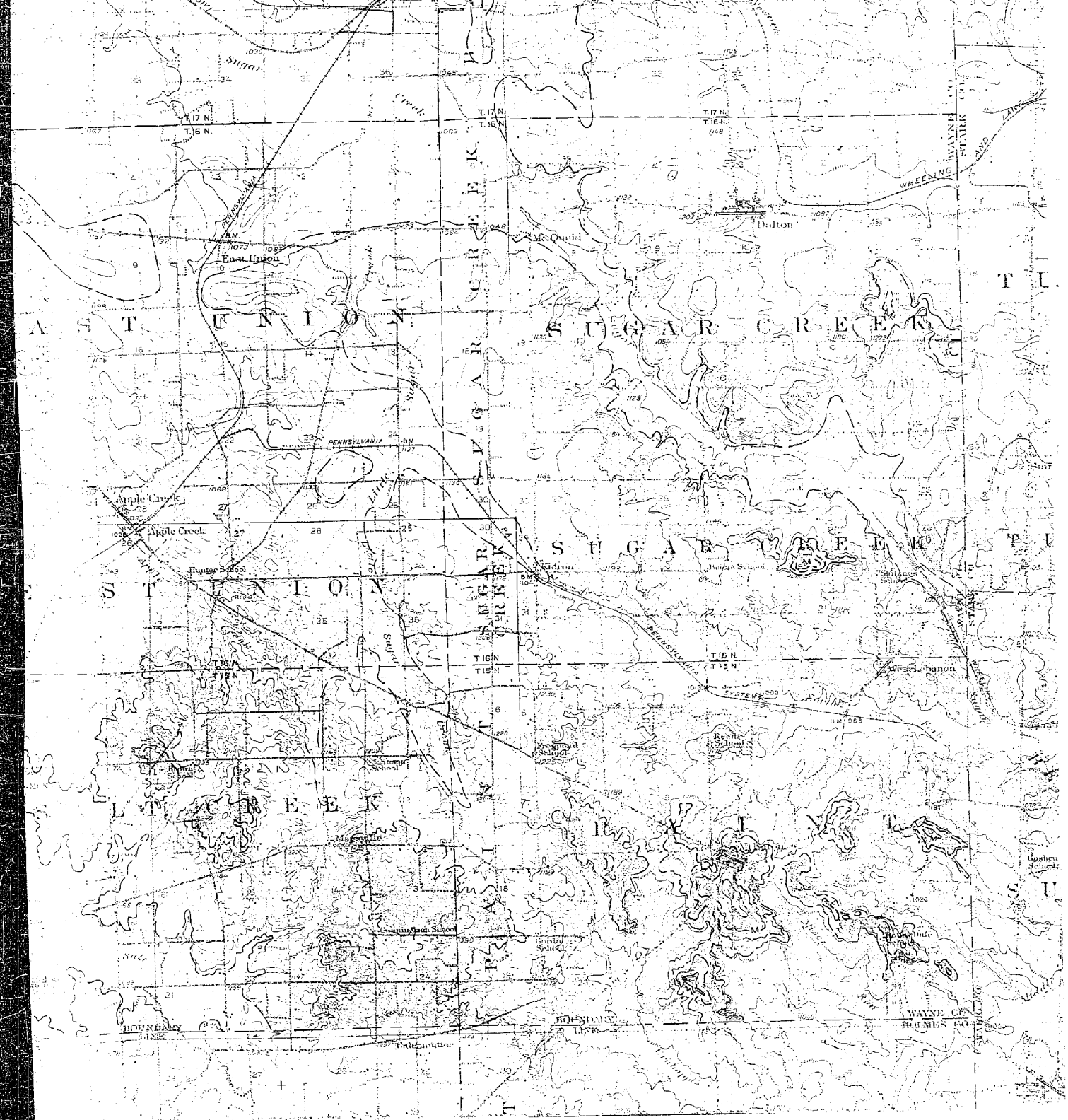


PLATE IV

AVERAGE SECTION





POTTSVILLE

Middle Mercer coal		.9
Clay		1.5
		17.7
Flint Ridge coal		.8
Clay		4.0
		14.0
Lower Mercer coal		1.0
Clay		2.3
		20.2
Vandusen coal		.5
Clay		1.7
		25.7
Bear Run coal		.6
Clay		1.8
		28.2
Quakertown coal		1.9
Clay		5.0
		14.2
Anthony coal		2.8
Clay		1.8
		30.2
Sharon ("Massillon coal")		5.1
Clay		3.1
		21.8
Sharon Conglomeratic Sandstone		
Harrison ore		1"

MISS.