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Preliminary analysis of conodont occurrences in
Pennsylvanian strata of Ohio and Kentucky

by

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ABSTRACT

Preliminary analysis of many of the named marine units (principally limestones) of the Pottsville, Allegheny, and Conemaugh Formations in Ohio and equivalent strata in Kentucky may indicate that diagnostic conodont faunas can be used for detailed correlation of Pennsylvanian strata in the central Appalachian basin. These data support earlier analysis of fusulinid foraminifer faunas that correlate the Obryan (southern "Vanport") Member of the Breathitt Formation in Kentucky with the Columbiana Member of the Allegheny Formation. The Obryan Member previously has been correlated with the Vanport Member of the Allegheny Formation in central and northern Ohio.

INTRODUCTION

Marine units, mainly limestones, are relatively persistent and widespread in the Pennsylvanian of the central Appalachian basin. Because most of the macrofauna taxa of these units are stratigraphically long ranging, correlation of marine beds across large parts of the basin has depended on physically tracing the beds from one area to another. Regionally, stratigraphic correlations have depended on the association of several lithologic units such as coal beds, shale beds, and iron ores, commonly in conjunction with several marine beds.

Although studies of fusulinids of the limestones of the Pottsville, Allegheny, and Conemaugh Formations in Ohio (Thompson, 1936; Smyth, 1957, 1974) showed that many marine units contain a distinctive fauna which could be used for regional and inter-regional correlation, the studies were concerned more with the taxonomy of the fusulinids than with the stratigraphy of the limestones. As a result, the fusulinid studies tended to confirm unit identifications previously determined by physical stratigraphy. More recently, however, Douglass (1987) made a comprehensive analysis of fusulinid biostratigraphy of the Pennsylvanian of the central Appalachian basin and suggested an unexpected correlation between the "Vanport" Limestone Member of the Breathitt Formation in Kentucky and the Columbiana Member of the Allegheny Formation in central and northern Ohio and western Pennsylvania. In central and northern Ohio, the Columbiana Member and the underlying Vanport Member of the Allegheny Formation occur together in an area extending from Muskingum County, Ohio, northward and eastward into western Pennsylvania (see Fig. 1). The younger Columbiana Member directly overlies the Lower Kittanning coal bed. The correlation of the Columbiana with the "Vanport" Member of Kentucky therefore has a

EXPLANATION

Conemaugh Formation

A --- Ames Limestone Member
 P --- Portersville Limestone Member
 C --- Cambridge Limestone Member
 UBC --- Upper Brush Creek Limestone Member
 BC --- Brush Creek Limestone Member

Allegheny Formation (Ohio) or Breathitt Formation (Kentucky)

W --- Washingtonville Member
 O --- Obryan Member
 CO --- Columbiana Member
 V --- Vanport Member
 PH --- Putnam Hill Limestone Member

Pottsville Formation (Ohio) or Breathitt Formation (Kentucky)

UM --- Upper Mercer Limestone Member
 LM --- Lower Mercer Limestone Member
 B --- Boggs Member
 PR --- Poverty Run Limestone Member
 L --- Lowellville Limestone Member
 UN --- Unnamed marine zone

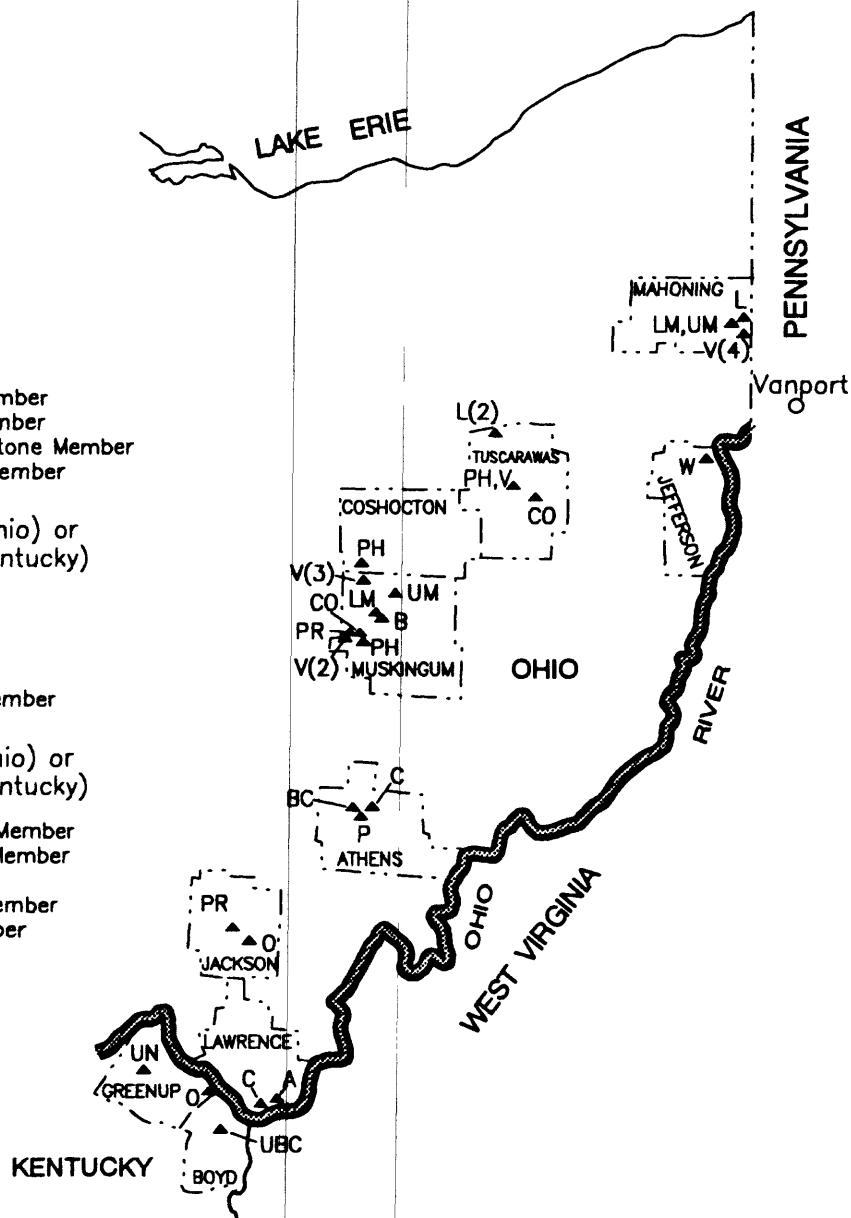


Figure 1. Regional map showing locations of counties in Ohio and Kentucky where samples of marine units (indicated by triangles) were collected for this conodont study. Samples of several units were collected at the same localities, and several samples of the same unit (number shown in parentheses) were collected in places because of the thickness of fossil bearing beds. See appendix for detailed descriptions of sample localities.

significant impact on the identification and correlation of many coal beds traditionally associated with the "Vanport" Member in Kentucky and equivalent strata in adjacent parts of southern Ohio.

The "Vanport" Limestone Member of the Breathitt Formation (or Vanport Limestone Member as used by Phalen, 1912) extends in an outcrop belt northward from northeastern Kentucky to an area just beyond the northern boundary of Jackson County, Ohio (see Fig. 1). This unit is as much as 9 ft (3 m) thick. In that region in Ohio and Kentucky, it is an important marker bed for the Pennsylvanian and an important commercial source of limestone. Because it occurs in only a limited part of southern Ohio, it commonly has been described as the "southern" Vanport. In order to avoid further confusion about the identity of the limestone unit in northern Kentucky and southern Ohio, the unit has been renamed the Obryan Member of both the Breathitt Formation in Kentucky and the Allegheny Formation in Ohio (Rice and others, in press).

In a study of conodonts of the marine units of the Allegheny Formation in Ohio and Pennsylvania, Merrill (1968) also suggested that the Vanport of Ohio was two distinct but closely related limestones, a younger "northern" Vanport and an older "southern" Vanport (the Obryan Member). Note that Merrill's assignment of relative position of those two units is the opposite of the relation suggested by Douglass (1987). Merrill (1968) based his conclusions on the occurrence of a greater number of primitive species of *Gnathodus* in the southern Vanport than in the northern Vanport. But, in a different part of his study, Merrill indicated that the ratios of

Streptognathodus to *Idiognathodus* should steadily increase upward in the Allegheny Formation. Of the five marine units that Merrill analyzed by this method, the two most conforming ratios were the southern Vanport (the Obryan) and the Columbiana, 1:10 and 1:8, respectively; the northern Vanport has a ratio of 1:200, indicating (by the criterion of increasing upward ratios) that it is older than the other two units. Thus these data appear to be conflicting, and the relation of the southern Vanport to the northern Vanport and to the Columbiana remained unclear.

CURRENT STUDY

As a part of the U.S. Geological Survey project to map the Ironton 30 X 60 minute quadrangle (Ohio, Kentucky, and West Virginia), a series of marine limestone samples was collected from the Pennsylvanian strata of Ohio and Kentucky to establish, if possible, a biostratigraphic zonation of conodonts for this part of the Appalachian basin. A preliminary collection of 32 marine samples was made of 15 different marine units extending from an unnamed marine unit in northeastern Kentucky in strata equivalent to the lower part of the Pottsville Formation up to the Ames Limestone Member of the Conemaugh Formation (see Fig. 2). Fourteen samples were collected from the closely related Putnam Hill, Vanport, Obryan, and Columbiana marine units (all of the Allegheny Formation) to determine if those units contained distinctive populations of conodonts. This initial collection was designed to obtain several samples of each unit from widely spaced outcrops to determine both the faunas of the units and the areal consistency of

their conodont populations.

A preliminary analysis of the conodont occurrences in the 16 marine units from Ohio and northeastern Kentucky is shown in Figure 2. As illustrated in Figure 2, many of the marine units, even at this early stage of analysis, have diagnostic faunas that can be distinguished from those of other units and which can be used for regional correlation. The unnamed marine unit from northeastern Kentucky and the correlative Lowellville Limestone and Poverty Run Limestone Members of the Pottsville Formation all have essentially the same fauna. The fauna of the single sample of the Boggs Member of the Pottsville Formation is different from underlying marine units with the introduction of *Neognathodus* and *Diplognathodus* species. The Lower and Upper Mercer Limestone Members of the Pottsville Formation have a different species of *Neognathodus* than the Boggs Member and possibly can be differentiated from each other by subtle differences in the *Idiopriioniodus* species that they contain.

Figure 2 shows that the closely related Putnam Hill and Vanport Members of the Allegheny Formation contain different species of *Idiognathodus* and *Neognathodus*, which distinguishes them from underlying and overlying marine units. The Putnam Hill is reported either to pinch out against the base of the overlying Vanport limestone in northeastern Ohio (Merrill, 1968) or, conversely, the two units may join to form a single unit in northeastern Ohio and western Pennsylvania. The Putnam Hill has not been identified in western Pennsylvania or in northeastern Ohio within 30 mi (50 km) of the border of

Pennsylvania. Preliminary analysis suggests that the Putnam Hill and the Vanport have a similar variability of faunas and may represent parts of the same marine unit.

As shown on Figure 2, the Columbiana and Obryan Members of the Allegheny Formation appear to be correlatives of one another. They contain a new species of *Hindeodus* as well as a different species of *Neognathodus* from that of the underlying Vanport Member. The overlying Washingtonville Member of the Allegheny Formation, a calcareous shale, did not yield much of a fauna, but it is similar to that of the Columbiana and Obryan Members.

The overlying marine members of the Conemaugh Formation contain a succession of *Streptognathodus* species that, for the most part, distinguish individual units. Different species of *Streptognathodus* are diagnostic of the Brush Creek Limestone Member, of both the Upper Brush Creek Limestone Member and Cambridge Limestone Member, of the Portersville Limestone Member, and of the Ames Limestone Member.

CONCLUSIONS

Preliminary analysis of the conodonts of the Pennsylvanian marine limestones of the northern part of the central Appalachian basin suggests that many of those units of the middle and upper parts of the Pottsville Formation and most of the marine units of the Allegheny and Conemaugh Formations contain diagnostic faunas that can be used for regional correlation. The analysis also strongly confirms the correlation of the Columbiana and

		Conemaugh Formation										
		Member										
		Adeognathodus levitus (Gunnell) Declinognathodus nodiferus (Ellison and Graves) Diplopynathodus orphanus Merrill Hindeodus coloradensis (Murray and Graves) Hindeodus sp. 2 (of Wardlaw and Stumm) Idiognathodus sp. 3 (of Wardlaw and Stumm) Idiognathodus claviformis Gunnell Idiognathodus sp. 1 Idiognathodus sp. 2 Idiognathodus amphifrons Lambert? Idiopynathodus sinuatus Harris and Hollingsworth Idiopynathodus conjunctus (Gunnell) Neognathodus sp. 1 Neognathodus sp. 2 Neognathodus stictoanesis Neognathodus sp. A of Lambert Neognathodus mediterraneus Merrill Neognathodus caudatus? Lambert? Streptognathodus cancellatus (Gunnell) Streptognathodus opulus Ellison Streptognathodus sp. 1 Streptognathodus sp. 2 Sweetina confusa (Ellison)										
Conemaugh Formation		Ames	*	*							*	
		Portersville		*								
		Cambridge, Sample 1	*	*							?	
		Sample 2	*	*							?	
		Upper Brush Creek	*	*							*	
		Brush Creek		*							*	
		Washingtonville (shale)		*	*							
		Obryan, Sample 1	*	*	*						*	
		Sample 2		*	*						*	
		Columbiana, Sample 1		*	*						*	
		Sample 2	*	*	*							
Allegheny Formation		Vanport, Sample 1	*	*		?						
		Sample 2	*	*		?						
		Sample 3		*	*	?						
		Sample 4A (top)		*	*	*						
		4B		*	*	*						
		4C		*	*	*						
		4D (bottom)		*	*	*					?	
		Putnam Hill, Sample 1		*		*	*	*	*	*	*	
		Sample 2	*	*	*	*		*	*	*		
		Sample 3	*	*	*	*		*	*	*		
Pottsville Formation		Upper Mercer, Sample 1	*	*	*	*		*	*			
		Sample 2		?	?			?				
		Lower Mercer, Sample 1	*	*	*	*		*	*			
		Sample 2	*	*	*	*		*	*			
		Boggs (Blunt Run)	*	*	*		*	*				
		Poverty Run, Sample 1	?									
		Sample 2	*	*	*		*	*				
		Lowellville, Sample 1	*	*	*		*	?				
		Sample 2	*	*	*		*	*				
		Sample 3	*	*	?		*	?				
		Unnamed marine zone	*	*	*		*	?				

Figure 2. Chart showing the occurrence of conodonts in a preliminary analysis of 16 marine units collected from the Pottsville and Allegheny Formations in Ohio and from equivalent strata of the Breathitt Formation in Kentucky, and from the Conemaugh Formation in both states. All lithologies are limestone unless otherwise indicated. Dashed line denotes major change in fauna.

Obryan Members as suggested by Douglass (1987). Sweet (1988) states that there are no widely recognized conodont zones from the Atokan through the Virgilian Series, representing a period of time including deposition of most of the strata of the Pottsville Formation, and all of the Allegheny and Conemaugh Formations. Sweet suggests that the unsolved problem of conodont taxonomy for this part of the stratigraphic section will require careful biometric studies of collections from rock sequences that represent long-continued stability of depositional conditions. Although the limestones sampled for this study represent the rapid marine transgressions of Pennsylvanian cyclic deposits, they do appear to contain distinctive conodont faunas of great biostratigraphic significance at least for this part of the central Appalachian basin. A more complete report is anticipated including the taxonomy of the conodonts, their biometrics, and the collection and analysis of additional samples of limestones from the Pottsville, Allegheny, and Conemaugh Formations of Ohio and equivalent strata from Pennsylvania and Kentucky.

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APPENDIX

Description of sample locations:

Unnamed marine zone (Breathitt Formation, approximately equivalent to Betsie Shale Member): $38^{\circ}37.83'N$, $82^{\circ}59.27'W$, approximately 100 ft (30 m) below and 200 ft (61 m) west of Howland Lookout Tower, on southern access to new highway, southwest corner of Portsmouth (7.5-min.) quadrangle, Greenup County, Kentucky. Small dark-gray limestone nodules.

Lowellville Limestone Member (Pottsville Formation):

Sample 1: $41^{\circ}02.03'N$, $80^{\circ}32.50'W$, crops out in creek bed about 300 ft (91 m) above pond in Grindstone Run, Campbell (7.5-min.) quadrangle, Mahoning County, Ohio. Dark-gray argillaceous limestone. Locality 22 of Morningstar (1922).

Sample 2: $40^{\circ}38.12'N$, $82^{\circ}59.27'W$, on south side of spillway for Beach City Reservoir, Navarre (7.5-min.) quadrangle, Tuscarawas County, Ohio. Large medium-gray limestone nodules about 8 ft (2.5 m) above water level.

Sample 3: same location as above. Black limestone at water level.

Poverty Run Limestone Member (Pottsville Formation):

Sample 1: $39^{\circ}58.57'N$, $82^{\circ}09.23'W$, in bed of branch of Poverty Run about 2200 ft (670 m) east of elevation 1044 on road between Mt. Sterling and Mt. Olive Church, Gratiot (7.5-min.) quadrangle, Muskingum County, Ohio. Limestone is dark gray, discontinuous and is only 6-8 in (15-20 cm) thick; contains plant roots.

Sample 2: $39^{\circ}03.25'N$, $82^{\circ}37.07'W$, on east side in road cut about 110 ft (34 m) above road level, Wellston (7.5-min.) quadrangle, Jackson County, Ohio. Large limestone concretions.

Boggs (Blunt Run) Limestone Member (Pottsville Formation): $40^{\circ}01.92'N$, $82^{\circ}00.07'W$, limestone ledge, which crosses bed of Blunt Run, Dresden (7.5-min.) quadrangle, Muskingum County, Ohio. Locality 27 of Morningstar (1922); locality 28 of Smyth (1957); locality 74 of Douglass (1987).

Lower Mercer Limestone Member (Pottsville Formation):

Sample 1: $41^{\circ}01.95'N$, $80^{\circ}32.65'W$, ledge in Grindstone Run, about 100 ft (30 m) below road on old railroad grade which crosses near head of run, Campbell (7.5-min.) quadrangle, Mahoning County, Ohio. Locality 22 of Morningstar (1922).

Sample 2: $40^{\circ}02.03'N$, $82^{\circ}00.23'W$, ledge in bed of Blunt Run, Dresden (7.5-min.) quadrangle, Muskingum County, Ohio. Locality 27 of Morningstar (1922); locality 74 of Douglass (1987).

Upper Mercer Limestone Member (Pottsville Formation):

Sample 1: $41^{\circ}01.93'N$, $80^{\circ}32.65'W$, ledge in Grindstone Run, about 25 ft (8 m) above Lower Mercer limestone, about 100 ft (30 m) below and east of road on old railroad grade which crosses near head of run, Campbell (7.5-min.) quadrangle, Mahoning County, Ohio. Locality 22 of Morningstar (1922).

Sample 2: $40^{\circ}05.28'N$, $81^{\circ}57.05'W$, ledge in creek bed of small eastern tributary of the north Branch of Symmes Creek about 0.25 mi (0.4 km) north of the crossroads (Stoner Cemetery), Madison Township, Adamsville (7.5-min.) quadrangle, Muskingum County, Ohio. Locality 68 of Morningstar (1922).

Putnam Hill Limestone Member (Allegheny Formation):

Sample 1: 40°29.35'N, 81°28.50'W, ledge about 35 ft (11 m) above road level in cut on southwest side of U.S. Highway 250, across from New Philadelphia, Tuscarawas County, Ohio. Stop 8 of Merrill (1974).

Sample 2: 40°11.13'N, 82°05.73'W, limestone on east side of road between Graham Corners and BM 906, elevation 1036, section 20, Pike Township, Coshocton County, Ohio. Locality 54 of Smyth (1957); locality 79 of Douglass (1987).

Sample 3: 39°56.85'N, 82°04.03'W, in underpass on north side of U.S. Highway I-70 about 1 mi (1.6 km) west of Zanesville, Muskingum County, Ohio. Locality 71 of Douglass (1987), misidentified as the Vanport Limestone Member of the Allegheny Formation.

Vanport Limestone Member (Allegheny Formation):

Sample 1: 40°29.35'N, 81°28.50'W, in roadcut on southwest side of U.S. Highway 250, across from New Philadelphia, Tuscarawas County, Ohio, 27 ft (8.2 m) above Putnam Hill limestone (Sample 1 above). Stop 8 of Merrill (1974).

Sample 2: 39°57.05'N, 82°10.33'W, on north side of U.S. Highway I-70, at top of roadcut above thick "Clarion" coal and underlay sequence, just south-southwest of Hopewell, Gratiot (7.5-min.) quadrangle, Hopewell Township, Muskingum County, Ohio.

Sample 3: 40°07.32'N, 82°04.22'W, on north side of road on The Highlands, north-central part of Dresden (7.5-min.) quadrangle, Cass Township, Muskingum County, Ohio. Locality 40 of Smyth (1957); locality 78 of Douglass (1987).

Sample 4A: 40°59.35'N, 80°31.60'W, 0.5-1.0 ft (0.15-0.3 m) from top of south face of limestone quarry northern part of New Middletown (7.5-min.) quadrangle about 2 mi (3 km) west of Pennsylvania State border, Mahoning County, Ohio.

Sample 4B: location same as above, 9.5-10 ft (2.9-3 m) above base.

Sample 4C: location same as above, 8 ft (2.4 m) above base.

Sample 4D: location same as above, 0.5-1.0 ft (0.15-0.3 m) from base of limestone.

Columbiana Member (Allegheny Formation):

Sample 1: 40°25.87'N, 81°29.43'W, road side dump of blocks of 2-2.5 ft (0.6-0.8 m) thick limestone taken from just above the No. 5 or Lower Kittanning coal bed in a coal strip-mining operation, New Philadelphia (7.5-min.) quadrangle, Tuscarawas County, Ohio.

Sample 2: 39°58.62'N, 82°06.30'W, large, 4-5-ft-long (1.2-1.5-m-long) limestone concretion at northwest corner of intersection 983, section 11, Hopewell Township, Muskingum County, Ohio. Near locality 75 of Smyth (1957) for the "Hamden" limestone, now called the Columbiana.

Obryan Member (Allegheny Formation, Ohio, or Breathitt Formation, Kentucky):

Sample 1: 38°59.05'N, 82°31.75'W, in roadcut on southwest side of U.S. Highway 35, in southwest part of section 20, Bloomfield Township, Oak Hill (7.5-min.) quadrangle, Jackson County, Ohio.

Sample 2: 38°30.42'N, 82°40.82'W, limestone outcrop along powerline on bluff

overlooking Ohio River, just north of Ashland Coal Company office in Riverview area, south-central Ironton (7.5-min.) quadrangle, Greenup County, Kentucky. Type locality of Obryan Member; locality 61 of Douglass (1987).

Washingtonville Member: 40°33.80'N, 80°39.93'W, roadcut along Ohio Route 213 south of Yellow Creek, 0.25 mi (0.4 km) above its mouth, Saline Township, Wellsville (7.5-min.) quadrangle, Jefferson County, Ohio. Stop 5 of Merrill (1974).

Brush Creek Limestone Member (Conemaugh Formation): 39°23.02'N, 82°08.17'W, in roadcut just northeast of junction of U.S. Highway 33 and Ohio Route 682, just south of Beaumont, southeastern corner Nelsonville (7.5-min.) quadrangle, Athens County, Ohio.

Upper Brush Creek Limestone Member (Conemaugh Formation): 38°22.85'N, 82°39.58'W, in roadcut on north side of U.S. Highway I-64 about 2 mi (3.2 km) west of intersection with U.S. Highway 23, Boyd County, Kentucky.

Cambridge Limestone Member (Conemaugh Formation):

Sample 1: 38°25.38'N, 82°29.47'W, nodular limestone bed in drainage ditch between divided highway just southwest of northbound exit ramp of bridge across Ohio River on U.S. Highway 52, Lawrence County, Ohio.

Sample 2: 39°23.48'N, 82°04.30'W, small nodules of limestone in road bank just south of 710 on U.S. Highway 550, 0.70 mi (1.1 km) north of Sugar Creek, Jacksonville (7.5-min.) quadrangle, Athens County, Ohio.

Portersville Limestone Member (Conemaugh Formation): 39°20.80'N, 82°05.70'W, large flat limestone concretions along U.S. Highway 550 (behind roadside buildings) just east of Armitage, Athens (7.5-min.) quadrangle, Athens County, Ohio.

Ames Limestone Member (Conemaugh Formation): 38°25.70'N, 82°27.32'W, fossiliferous calcareous shale with 4-in.-thick (10-cm-thick) biomicrite layer at eye level just above carbonaceous shale on north side of road just east of Chesapeake on Ohio Route 7, Lawrence County, Ohio.