Carbonate Rocks of Cambrian and Ordovician Age in the Lancaster Quadrangle Pennsylvania

By HAROLD MEISLER *and* ALBERT E. BECHER

CONTRIBUTIONS TO STRATIGRAPHY

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CARBONATE ROCKS OF CAMBRIAN AND ORDOVICIAN AGE IN THE LANCASTER QUADRANGLE, PENNSYLVANIA

By HAROLD MEISLER and ALBERT E. BECHER

ABSTRACT

Detailed mapping has shown that the carbonate rocks of Cambrian and Ordovician age in the Lancaster quadrangle, Pennsylvania, can be divided into 14 rock-stratigraphic units. These units are defined primarily by their relative proportions of limestone and dolomite. The oldest units, the Vintage, Kinzers, and Ledger Formations of Cambrian age, and the Conestoga Limestone of Ordovician age are retained in this report. The Zooks Corner Formation, of Cambrian age, a dolomite unit overlying the Ledger Dolomite, is named here for exposures along Conestoga Creek near the village of Zooks Corner.

The Conococheague (Cambrian) and Beekmantown (Ordovician) Limestones, as mapped by earlier workers, have been elevated to group rank and subdivided into formations that are correlated with and named for geologic units in Lebanon and Berks Counties, Pa. These formations, from oldest to youngest, are the Buffalo Springs, Snitz Creek, Millbach, and Richland Formations of the Conococheague Group, and the Stonehenge, Epler, and Ontelaunee Formations of the Beekmantown Group. The Annville and Myerstown Limestones, which are named for lithologically similar units in Dauphin and Lebanon Counties, Pa., overlie the Beekmantown Group in one small area in the quadrangle.

INTRODUCTION

Carbonate rocks of Cambrian and Ordovician age underlie a lowland that occupies most of the Conestoga Valley in southeastern Pennsylvania. Detailed mapping by the authors of the Lancaster quadrangle in the Conestoga Valley (fig. 1) now allow carbonate rocks formerly assigned to the Conococheague and Beekmantown Limestones (Jonas and Stose, 1930) to be more closely subdivided into units defined primarily by their proportions of limestone and dolomite. Most of these units are herein correlated with units in the Great Valley in Lebanon, Berks, and Dauphin Counties, Pa. (Geyer and others, 1958, 1963; Hobson, 1957, 1963; Prouty, 1959). In addition, a newly defined dolomite unit is herein named the Zooks Corner Formation.

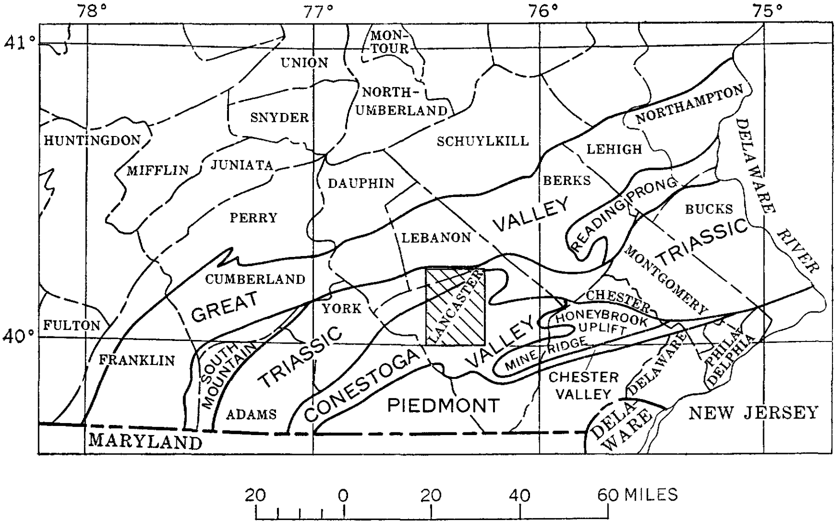


Figure 1.—Location of the Lancaster quadrangle and general physiography of southeastern Pennsylvania.

Table 1.—*Stratigraphic section of the carbonate rocks of the Lancaster quadrangle used by Jonas and Stose (1930) and in this report*

System	Jonas and Stose (1930)		This report		
ORDOVICIAN	Conestoga Limestone (age uncertain)	Cocalico Shale		Cocalico Shale	
				Myerstown Limestone	
		Cocalico basal limestone		Annville Limestone	?
	Beekmantown Limestone		Beekmantown Group	Ontelaunee Formation	Conestoga Limestone (In southern part of quadrangle)
				Epler Formation	?
				Stonehenge Formation	?
CAMBRIAN	Conococheague Limestone		Conococheague Group	Richland Formation	
				Millbach Formation	
				Snitz Creek Formation	
				Buffalo Springs Formation	
		Elbrook Limestone		Zooks Corner Formation	
	Ledger Dolomite			Ledger Dolomite	
	Kinzers Formation			Kinzers Formation	
	Vintage Dolomite			Vintage Dolomite	

TABLE 2.—*Generalized section of the carbonate rocks of Cambrian and Ordovician age in the Lancaster quadrangle, Pennsylvania*

System	Group	Formation	Thickness (feet)	Character
Ordovician		Myerstown Limestone	200±	Limestone, dark-gray, coarsely crystalline, thinly bedded; abundant pelmatozoan stem plates.
		Annville Limestone	200±	Limestone, gray, finely crystalline, partly laminated.
	Beekmantown Group	Ontelaunee Formation	0-600±	Dolomite, gray, very finely to finely crystalline; finely laminated in part.
		Epler Formation	2,000-2,500	Limestone and dolomite, interbedded, gray; abundant white beds in lower part, calcarenite beds, pelmatozoan stem plates, coiled gastropods.
		Stonehenge Formation	500-1,000	Limestone, gray; shaly laminae, calcarenite beds, pelmatozoan stem plates.
Cambrian	Conococheague Group	Richland Formation	0-500±	Limestone and dolomite, interbedded, gray; beds of fine conglomerate and calcarenite, rare cryptozoon.
		Millbach Formation	1,200-2,000	Limestone, white to pinkish-gray and gray; scattered beds and laminae of gray dolomite.
		Snitz Creek Formation	300-400	Dolomite, gray, argillaceous, silty, sandy.
		Buffalo Springs Formation	1,500-3,800	Limestone and dolomite, interbedded, white to pinkish-gray and gray. Dolomite is commonly argillaceous, silty, sandy; scattered sandstone beds, cross laminae, ripple marks, rare cryptozoon.
		Zooks Corner Formation	1,600±	Dolomite, gray, commonly silty and sandy; little gray limestone, cross laminae, ripple marks.
		Ledger Dolomite	1,000±	Dolomite, light gray, mostly coarsely crystalline, sparkling, partly mottled.
		Kinzers Formation	300-600	Shale, gray, rusty weathering; white to gray limestone commonly containing reticulated argillaceous and silty laminae; some dark-gray earthy dolomite.
		Vintage Dolomite	350-550	Dolomite, gray, very finely to coarsely crystalline; locally contains interbedded limestone.
In southern part of quadrangle				
Ordovician		Conestoga Limestone	Unknown	Limestone, gray, finely to coarsely crystalline, schistose in part; limestone conglomerate near base.

The stratigraphic nomenclature used by Jonas and Stose (1930) and that used in this report are both given in table 1. A summary of the character and thickness of each formation is given in table 2.

A generalized preliminary geologic map of the Lancaster quadrangle (fig. 2) shows a separation of the area underlain by carbonate rocks into three east-west trending belts. The Lititz belt is separated from the Mount Joy belt by a ridge of shale of the Cocalico. The Mount Joy belt is separated from the Lancaster belt by discontinuous

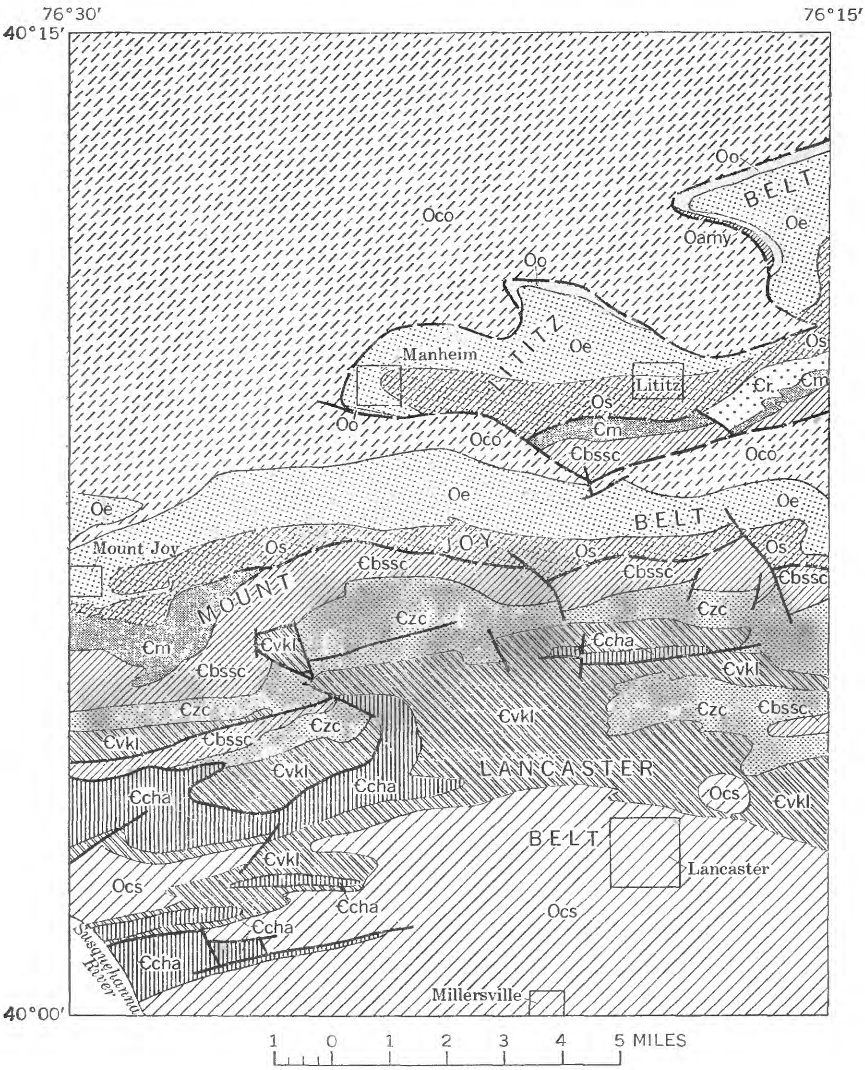
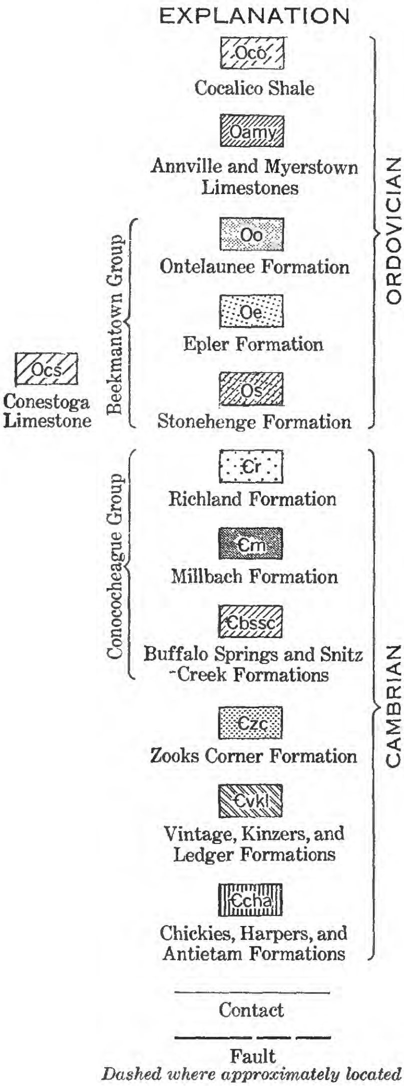


FIGURE 2.—Generalized geologic

ridges of Lower Cambrian quartzites and phyllites. Stratigraphic differences between these belts are discussed in subsequent sections of this paper.

This report is a product of the hydrogeologic investigation of carbonate rocks in the Lancaster quadrangle by the U.S. Geological Survey in cooperation with the Pennsylvania Geological Survey.



map of the Lancaster quadrangle.

CAMBRIAN SYSTEM

VINTAGE, KINZERS, AND LEDGER FORMATIONS

The definition and use of the names “Vintage,” “Kinzers,” and “Ledger” in this report follow that of Jonas and Stose (1930). These formations crop out only in the Mount Joy and Lancaster belts shown in figure 2.

ZOOKS CORNER FORMATION

The Zooks Corner Formation is a dolomite sequence that is here named for exposures along Conestoga Creek, half a mile west of the village of Zooks Corner (fig. 3). At this location, 700 feet of the total measured thickness of 1,550–1,650 feet and the upper and lower contacts are exposed. At the contact with the underlying Ledger Dolomite, the two formations interfinger. The contact with the overlying Buffalo Springs Formation is defined as the base of the lowest thick limestone of an interbedded limestone and dolomite sequence.

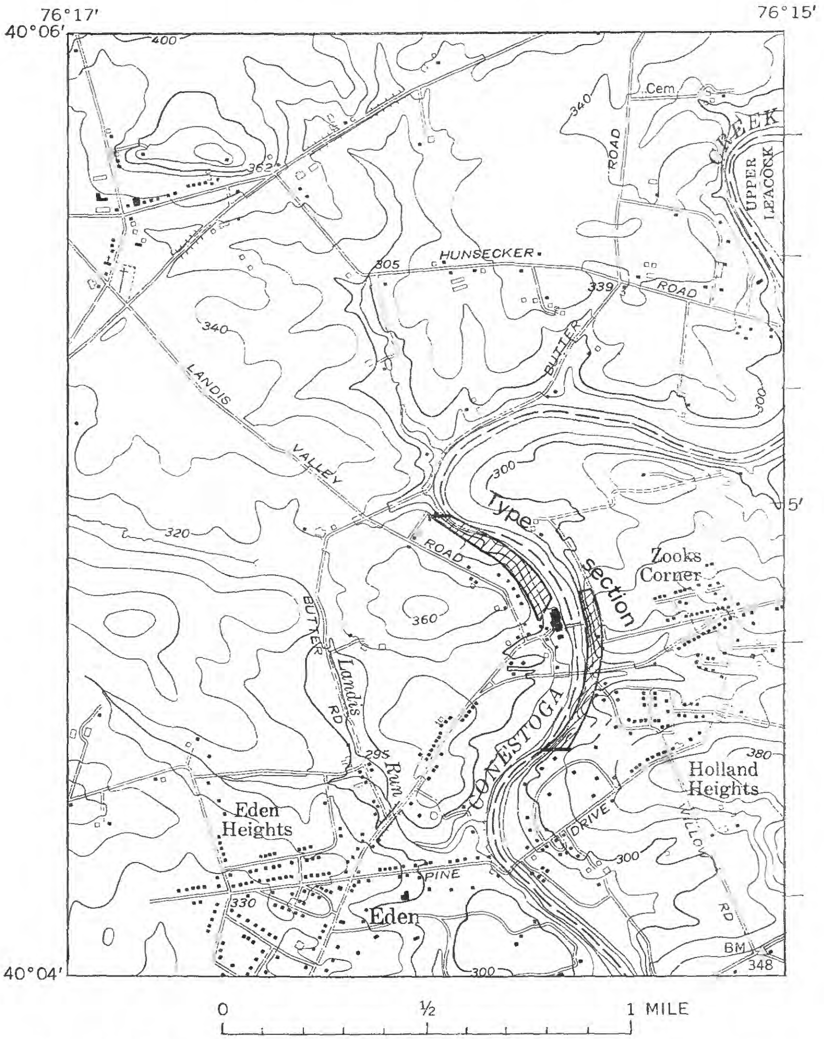


FIGURE 3.—Location of the type section of the Zooks Corner Formation.

The predominant lithology of the Zooks Corner Formation is medium-gray dolomite, but beds of lighter and darker gray dolomite are common. Much of the dolomite is silty and sandy and contains scattered interbeds of dolomitic sandstone. Very light gray to medium-gray limestones are present, but they constitute only about 5 percent of the measured thickness. The formation contains many sedimentary structures such as laminae, cross laminae, and ripple marks, but no fossils have been found.

The rocks that constitute the Zooks Corner Formation were mapped by Jonas and Stose (1930) as Elbrook Limestone and Conococheague Limestone. The contact between the latter two units lies within the Zooks Corner Formation. In the western part of the Lancaster quadrangle, where Jonas and Stose (1930, p. 33) did not recognize Elbrook Limestone, the Zooks Corner Formation coincides with the lower part of their Conococheague Limestone.

The present authors believe that Elbrook is not an appropriate stratigraphic name in the Lancaster quadrangle. In the section of the Elbrook referred to by Jonas and Stose (1930, p. 32) in the Lancaster quadrangle, the overwhelmingly dolomitic rocks bear little resemblance to the Elbrook Limestone at its type locality in Franklin County, Pa. Rocks that were mapped as Elbrook Limestone elsewhere in the quadrangle by Jonas and Stose (1930) and that do resemble the Elbrook in its type locality have been mapped by the present writers as part of the Buffalo Springs Formation.

The Zooks Corner Formation crops out in the Lancaster and Mount Joy belts (fig. 2) but is absent from the Lititz belt where the lowest unit exposed is the Buffalo Springs Formation.

CONOCOCHEAGUE GROUP

The sequence of limestones and dolomites previously mapped as Conococheague Limestone (Jonas and Stose, 1930) can be separated on the basis of lithology into four rock-stratigraphic units. These units, the Buffalo Springs, Snitz Creek, Millbach, and Richland Formations, are here correlated on the basis of stratigraphic position and lithologic similarity with units in the Great Valley in Lebanon County, Pa. (table 3).

The Conococheague in Lebanon County was divided by Gray and others (1958) into five members. Geyer and others (1963, p. 29) subsequently raised these members to formation rank and raised the Conococheague to group rank; also (p. 29) they separated the Buffalo Springs Formation from the Conococheague Group by correlating the Buffalo Springs Formation with the Elbrook Formation at its type locality in Franklin County, Pa., and by correlating the overlying

TABLE 3.—*Correlation of the Conococheague Group in the Lancaster quadrangle and Lebanon and Berks Counties, Pa.*

<table>
<tr><th colspan="2">Lebanon County
(Gray and others, 1958)</th><th colspan="2">Berks County
(Geyer and others, 1963)</th><th colspan="2">Lancaster quadrangle
(This report)</th></tr>
<tr><td rowspan="5">Conococheague Formation</td><td>Richland Member</td><td rowspan="4">Conococheague Group</td><td>Richland Formation</td><td rowspan="5">Conococheague Group</td><td>Richland Formation</td></tr>
<tr><td>Millbach Member</td><td rowspan="2">Millbach Formation</td><td rowspan="2">Millbach Formation</td></tr>
<tr><td>Schaefferstown Member</td></tr>
<tr><td>Snitz Creek Member</td><td>Snitz Creek Formation</td><td>Snitz Creek Formation</td></tr>
<tr><td>Buffalo Springs Member</td><td colspan="2">Buffalo Springs Formation</td><td>Buffalo Springs Formation</td></tr>
</table>

Snitz Creek Formation with the basal Big Spring Station Member of the Conococheague Limestone in Maryland (Wilson, 1952, p. 307–308).

This report retains the group rank of the Conococheague in the Lancaster quadrangle. In addition, the authors include the Buffalo Springs Formation within the Conococheague Group for the following reasons:

1. Most of the Buffalo Springs Formation was mapped as Conococheague Limestone by Jonas and Stose (1930). The lower contact of their Conococheague Limestone either coincides generally with the lower contact of the Buffalo Springs or is within or at the base of the underlying Zooks Corner Formation.
2. The lower contact of the Buffalo Springs Formation is the best defined and most readily traceable contact within the Cambrian carbonate sequence.
3. The Snitz Creek Formation is not separable from the Buffalo Springs Formation everywhere in the Lancaster quadrangle.
4. Lithologies in the Buffalo Springs Formation are similar to lithologies of other formations in the Conococheague. Dolomites in the Buffalo Springs are similar to those of the Snitz Creek Formation and limestones in the Buffalo Springs are similar to those in the Millbach Formation.
5. The conspicuous beds of sandstone in the Snitz Creek Formation are important factors in considering this unit as basal Conococheague in the Lebanon Valley. In the Lancaster quadrangle, however, beds of sandstone are also common in the underlying Zooks Corner and Buffalo Springs Formations.
6. Correlation of the Snitz Creek Formation with the Big Spring Station Member of Wilson (1952) in Maryland is highly tenuous, as the latter unit cannot be traced northeastward from Maryland across Franklin County, Pa. (Root, 1967).

The authors recognize the possibility that other limits could be placed on the Conococheague Group in the Lancaster quadrangle. They believe, however, that the original limits established by Jonas and Stose (1930) in the Lancaster quadrangle should be maintained as nearly as possible until more detailed mapping in adjacent areas provides clear evidence for correlation with the type area of the Conococheague in Franklin County, Pa.

BUFFALO SPRINGS FORMATION

The Buffalo Springs Formation is an interbedded limestone and dolomite sequence that overlies the Zooks Corner Formation. The lower contact is defined as the base of the lowest thick limestone of an interbedded limestone and dolomite sequence.

The Buffalo Springs Formation consists of white to very light pinkish-gray and medium- to medium-dark-gray limestones interbedded with very light pinkish-gray and yellowish-gray to medium-dark-gray dolomites. The limestones commonly contain laminae, patches, and stringers of dolomite. The dolomites are commonly argillaceous, silty, or sandy and contain sedimentary features such as cross laminae and ripple marks. Cryptozoa are rare, but they occur in both limestone and dolomite. Thick silty and sandy lenses of dolomite as much as 700 feet thick, similar lithologically to the overlying Snitz Creek Formation, occur within the Buffalo Springs Formation in the west half of the Mount Joy belt (fig. 2).

SNITZ CREEK FORMATION

The Snitz Creek Formation is a dolomite sequence that overlies the Buffalo Springs Formation. It consists of light-gray to dark-gray very finely to finely crystalline dolomite. Much of the dolomite is argillaceous, silty, or sandy. No fossils have been found in this formation.

The Snitz Creek Formation is traceable along its strike for approximately 2 miles in the western part of the Mount Joy belt (fig. 2) and for an equal distance in the eastern part of the Lititz belt. Elsewhere, the formation either cannot be readily separated from the Buffalo Springs Formation or is concealed beneath a thrust sheet of older rocks.

MILLBACH FORMATION

The Millbach Formation is a predominantly limestone sequence that overlies the Snitz Creek Formation. Where the Snitz Creek cannot be distinguished, the Millbach overlies the undivided Buffalo Springs and Snitz Creek Formations.

The Millbach Formation consists of white to light-pinkish-gray limestone containing some laminae or thin beds of light-gray dolomite, and medium-gray limestone containing scattered beds of light- to medium-gray dolomite.

The Millbach Formation is mappable across the Lititz belt and the western one-third of the Mount Joy belt (fig. 2). In the eastern two-thirds of the Mount Joy belt, the Millbach Formation is probably concealed beneath a thrust sheet of older rocks, but possibly Millbach sediments were never deposited in this area.

RICHLAND FORMATION

The Richland Formation is defined as an interbedded limestone and dolomite unit that overlies the Millbach Formation. The Richland Formation in the Lancaster quadrangle differs considerably from the type section of this formation in Lebanon County (Gray and others, 1958). In Lebanon County the Richland Formation is predominantly dolomite, whereas in the Lancaster quadrangle it is approximately two-thirds limestone.

The Richland Formation consists of medium-gray to medium-dark-gray, finely crystalline, interbedded limestone and dolomite. The limestones commonly contain disseminated grains, patches, or laminae of dolomite and some beds of fine conglomerate and calcarenite. Cryptozoa rarely occur in the Richland Formation.

In the Lancaster quadrangle, the Richland Formation is exposed only in a small area at the east end of the Lititz belt (fig. 2), but it can be traced for several miles to the east and northeast in the adjacent quadrangle. Westward, exposures of the Richland end abruptly, as the unit is probably concealed beneath a thrust plate. In the Mount Joy belt there is no evidence to indicate the presence of the Richland Formation; it may underlie the same thrust plate that conceals the Millbach Formation through most of this belt. At the west end of the Mount Joy belt the Richland Formation probably does not occur in the stratigraphic section.

ORDOVICIAN SYSTEM

CONESTOGA LIMESTONE

The definition and use of the term Conestoga in this report follow that of Jonas and Stose (1930). The formation, which is in the southern part of the quadrangle, consists of medium-gray finely to coarsely crystalline limestone. Much of the limestone is graphitic and micaceous and, hence, is schistose in appearance. The base of the formation usually contains pebble and boulder conglomerates and coarsely crystalline silty and sandy limestones.

The Conestoga Limestone is considered to be Early Ordovician in age. The Conestoga unconformably overlaps the Ledger, Kinzers, and Vintage Formations and, hence, is younger than the Ledger. The problem of the age and correlation of the Conestoga is discussed by Jonas and Stose (1930, p. 44–47) and Stose and Stose (1944, p. 37–38).

BEEKMANTOWN GROUP

Detailed mapping in the Lancaster quadrangle by the authors has shown that strata mapped as Beekmantown Limestone by Jonas and Stose (1930) can be divided into three geologic units—the Stonehenge, Epler, and Ontelaunee Formations. On the basis of stratigraphic position and lithologic similarity, these units are here correlated with and named for units of the Beekmantown Group (Hobson, 1957) in Berks County, Pa. A fourth unit in Berks and Lebanon Counties, the Rickenbach Formation, between the Stonehenge and Epler Formations, is not present in the Lancaster quadrangle.

STONEHENGE FORMATION

The Stonehenge Formation is defined as a limestone sequence that overlies the Richland Formation. The Stonehenge Formation is in contact with the Richland Formation, however, only at the east end of the Lititz belt. Elsewhere in the Lititz and Mount Joy belts the Richland Formation is absent and the Stonehenge is probably in fault contact with the Millbach or Buffalo Springs Formations. At the west end of the Mount Joy belt (fig. 2) the Richland Formation probably does not occur in the stratigraphic section. The sequence of Stonehenge overlying Millbach here, therefore, may be a normal stratigraphic relationship.

Although the nature of the contact of the Stonehenge Formation with the Conococheague Group is not clear everywhere, a sharp contrast in lithologies makes this contact one of the most easily traced in the Lancaster quadrangle. The contact is defined as the base of a sequence of medium-gray limestones that contain abundant shale laminae and beds of calcarenite containing fragments of pelmatozoan stem plates and other fossil detritus. The authors have been unable to find pelmatozoan stem plates in any strata lower than the Stonehenge.

EPLER FORMATION

The Epler Formation is defined as an interbedded limestone and dolomite sequence that overlies the Stonehenge Formation. It has the most varied lithology of any formation in the Beekmantown Group in the Lancaster quadrangle. It consists mainly of medium- to medium-dark-gray interbedded limestone and dolomite, but the limestones are generally more abundant. The formation contains scattered beds of calcarenite, fossil detritus containing pelmatozoan stem plates, and a few coiled gastropods. Commonly, the dolomites are calcareous, and all gradations between pure dolomite and pure limestone are present. In the lower part of the formation, white to light-pinkish-gray rocks are conspicuous. In the Lititz belt (fig. 2), the Epler Formation appears to consist predominantly of limestone that is virtually indistinguishable from the Stonehenge Formation, except near the base, where some dolomite and white limestone occur.

The contact between the Epler Formation and the underlying Stonehenge Formation is placed at the base of the lowest dolomite of a sequence of interbedded limestones and dolomites. The contact is difficult to trace in the field because of the scarcity of outcrops; consequently, in some places the contact is placed between white limestones of the Epler Formation and gray limestones of the Stonehenge Formation.

The Epler Formation is overlain stratigraphically by the Ontelaunee Formation. In the Mount Joy belt and part of the Lititz belt (fig. 2), the Ontelaunee, Annville, and Myerstown Formations are missing, and the Cocalico Formation unconformably overlies the Epler. Faulting probably accounts for some ofthe missing section in the Lititz belt.

ONTELAUNEE FORMATION

The Ontelaunee Formation is a dolomite sequence that overlies the Epler Formation. It consists of medium-gray very finely to finely crystalline dolomite and is, in part, finely laminated.

The contact between the Ontelaunee Formation and the underlying Epler Formation in the Lancaster quadrangle is defined as the top of the highest limestone of an interbedded limestone and dolomite sequence beneath the dolomite sequence of the Ontelaunee. This definition differs from that in Berks County, where according to Hobson (1963, p. 17) "the contact between the Epler Formation and the overlying Ontelaunee Formation in central Berks County is placed at the top of the highest limestone bed beneath a prominent zone of chert beds in the Ontelaunee." This chert zone is not recognizable in the Lancaster quadrangle.

The Ontelaunee Formation is exposed only in the Lititz belt (fig. 2) where it is stratigraphically overlain by the Annville Formation. Where the Annville and Myerstown Formations are missing, the Ontelaunee Formation is either overlain unconformably by or is in fault contact with the Cocalico Formation.

ANNVILLE LIMESTONE

The Annville Limestone in the Lancaster quadrangle is defined as a limestone sequence that overlies the Ontelaunee Formation. It is here correlated on the basis of lithologic similarity and stratigraphic position with the Annville Limestone of the type section in Dauphin County (Prouty, 1959). The Annville Limestone consists of light-gray to medium-dark-gray finely crystalline partly laminated limestone. Its weathered surface is conspicuously fluted.

The Annville Limestone is exposed in the Lancaster quadrangle only in a small area 3–5 miles north-northeast of Lititz in the Lititz belt (fig. 2). It is overlain stratigraphically by the Myerstown Limestone. Where the Myerstown is missing, the Annville is either in fault contact with or is overlain unconformably by the Cocalico Shale.

MYERSTOWN LIMESTONE

The Myerstown Limestone overlies the Annville Limestone. It is here correlated on the basis of stratigraphic position and lithologic similarity with the Myerstown Limestone in the type section in Dauphin County (Prouty, 1959).

The Myerstown Limestone underlies an extremely small area approximately 3 miles north-northeast of Lititz in the Lititz belt (fig. 2). The exposure is limited to two outcrops that contain, respectively, dark-gray coarsely crystalline thinly bedded limestone and dark-gray shaly limestone. Fossil detritus, including pelmatozoan stem plates, is abundant.

In Dauphin County the Myerstown Limestone is overlain by the Hershey Limestone. In the Lancaster quadrangle, there is no evidence to indicate the presence of the Hershey Limestone. The Cocalico Shale overlies the Myerstown Limestone in the Lancaster quadrangle, but no exposure of the contact between these two formations has been observed.

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CONTRIBUTIONS TO STRATIGRAPHY

"Contributions to stratigraphy" in the Geological Survey's Bulletin series, consists of reports dealing primarily with stratigraphy, including those defining changes in stratigraphic nomenclature in reports of the Geological Survey. About 40 short reports pertaining to one or several stratigraphic units have been published or are in press. Like other Survey publications, these are announced in the monthly "New publications of the U.S. Geological Survey." In addition to reports on specific problems, an annual report within the series lists all changes in stratigraphic nomenclature such as (1) new names, (2) previously used names now adopted, (3) revised names, (4) changes in age designations, and (5) abandoned names. The age of the unit, the area in which the name is employed, the title of the pertinent report, and the publication in which the change is described are given. Thus far, the following reports dealing with annual compilations of changes in stratigraphic nomenclature have been published:

Bulletin 1194-A (for 1963). 20c
Bulletin 1224-A (for 1964). 30c
Bulletin 1244-A (for 1965). 25c
Bulletin 1254-A (for 1966). 20c