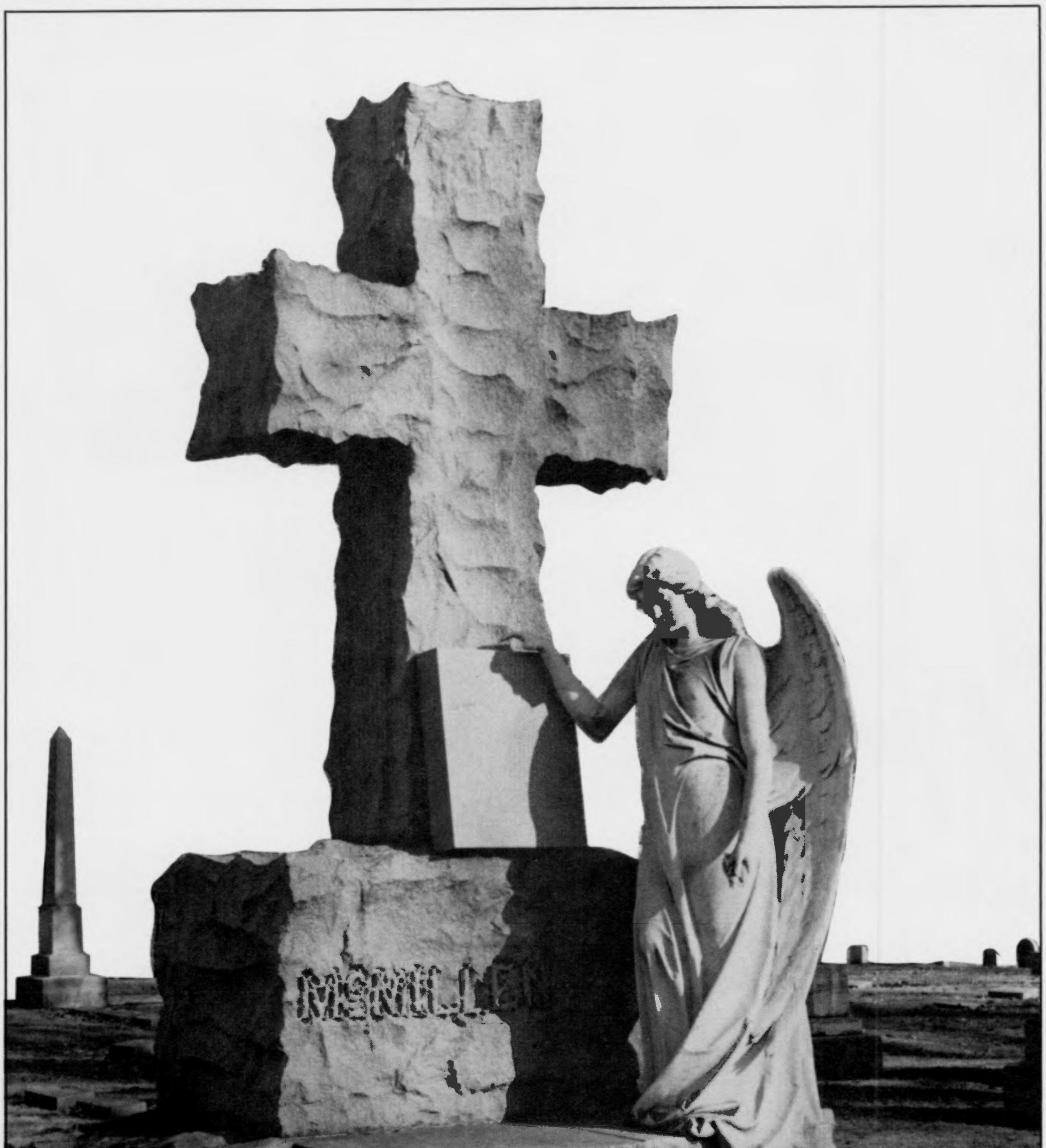
GUIDEBOOK NO. 8

GEOLOGIC GLIMPSES FROM AROUND THE WORLD— THE GEOLOGY OF MONUMENTS IN WOODLAND CEMETERY AND ARBORETUM, DAYTON, OHIO: A SELF-GUIDED TOUR

by Michael R. Sandy



prepared for the 1992 Annual Meeting
of the Geological Society of America

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University of Dayton

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INTRODUCTION

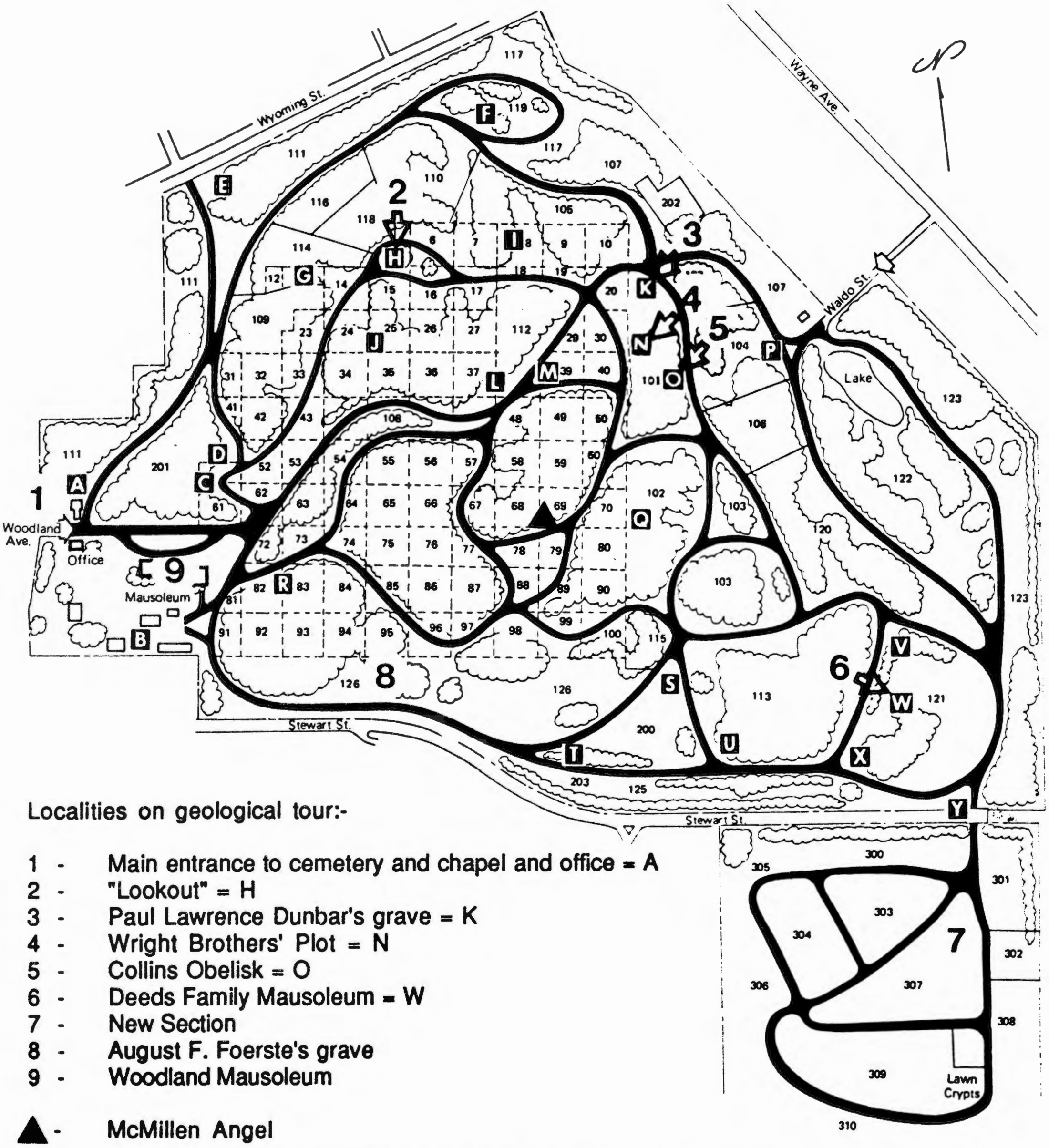
The main purpose of this guidebook is to introduce the wide variety of geology spectacularly displayed in the headstones, obelisks, and other monuments and private family mausoleums of Woodland Cemetery and Arboretum and inside Woodland Mausoleum, a community mausoleum. They comprise many igneous, sedimentary, and metamorphic rocks and provide a glimpse of many different geologic events from around the world. To see these rocks in outcrop in the countries from which they were originally quarried would involve travelling to other continents and spending thousands of dollars in so doing. By using this guidebook and a little imagination, you can travel to many parts of the world, geologically speaking. There is much of geological interest in a cemetery that can be used for those teaching classes at all levels. In addition, there is the potential to add a sense of local, national, and international history, both social and economic.

Aspects of the historical significance and social history of those buried in Woodland Cemetery and Arboretum have been published elsewhere (Hellwig, 1991) and will only be briefly mentioned in this guidebook. Publications produced by the Woodland Cemetery Association include two booklets, one on the monuments of historical and artistic interest (Rogers, 1991), and one on the woody plants of Woodland Cemetery (Thomas and Smith, 1985). In addition, a brochure with map on the trees and monuments (Woodland Cemetery and Arboretum, undated) has been published. A brochure also describes the original stained glass and marble in the Woodland Mausoleum (Woodland Mausoleum, undated).

Woodland Cemetery and Arboretum is the final resting place of such notable Daytonians as the Wright Brothers, Paul Lawrence Dunbar, the paleontologist August F. Foerste, Daniel E. Mead, and John H. Patterson. Charles F. Kettering is interred in Woodland Mausoleum. Because of my interest in paleontology and its importance in geology, I have given more extensive biographical remarks for August F. Foerste.

I have picked out some of the rock types that I have had some success in identifying, with the assistance of employees at Woodland Cemetery and Arboretum, and the comments or writings of geologists and others. I do not claim that this is a comprehensive account of the geology of Woodland Cemetery and Arboretum, which is located at 118 Woodland Avenue, Dayton, Ohio 45409-2892. Telephone: cemetery office (513)228-3221; Woodland Mausoleum office (513)228-1431.

The guidebook is written so that it can be used by anyone interested in finding out more about the geology of the monuments of Woodland Cemetery and Arboretum. It is in the form of a tour which can be carried out on foot or by car. The tour starts at the main entrance to the cemetery (fig. 1), and then goes to the "Lookout" before going to the area of the Wright Brothers' plot. From there the Deeds Mausoleum area is visited. If time permits, the cemetery grounds to the south of Stewart Street (new section) can be visited by going through the underpass. Returning to the main entrance and the Woodland Mausoleum, the grave of paleontologist August F. Foerste is passed, and then the Woodland Mausoleum is described, where a variety of rock types can be seen. This is only a suggested route. You may pick out what you have time to see. To do justice to all of the features listed in the guidebook would probably take at least half a day. You may want to study aspects of the geology over two or three visits. Once you are familiar with the geology of the headstones described in the guidebook you can study many of the other headstones in the cemetery, or take your knowledge to another cemetery or examine building stones in your neighborhood. A number of geological terms are explained in the text. For those wishing to find out more about geology, the *Dictionary of geological terms* by Bates and Jackson (1984) will provide more details on terminology. Introductory geology texts, of which there are many, will provide an introduction to geology.



LANDMARKS AND POINTS OF INTEREST

- A OLD CHAPEL
- B SERVICE BUILDINGS
- C HUFFMAN FAMILY VAULT
- D VETERANS' PLOT
- E OLD PUMP HOUSE
- F STODDARD FAMILY PLOT
- G PATTERSON "KNOLL"
- H "LOOKOUT"
- I VAN CLEVE FAMILY PLOT
- J VALLANDIGHAM PLOT
- K PAUL LAURENCE DUNBAR
- L COTTERILL FAMILY MAUSOLEUM
- M LOWES FAMILY MAUSOLEUM
- N WRIGHT BROTHERS PLOT
- O COLLINS OBELISK
- P DRINKING FOUNTAIN
- Q STANLEY FAMILY PLOT
- R "DOG AND THE BOY"
- S McMILLAN FAMILY MAUSOLEUM
- T GREEK ALTAR
- U PRICE FAMILY MAUSOLEUM
- V DYE FAMILY MAUSOLEUM
- W DEEDS FAMILY MAUSOLEUM
- X HARTMAN FAMILY MAUSOLEUM
- Y UNDERPASS

FIGURE 1.—Map of Woodland Cemetery and Arboretum in Dayton, Ohio, showing locality numbers 1-9 for geological tour and location of McMillen Angel. Other landmarks and points of interest are shown as letters A-Y. Small numbers are section numbers of the cemetery. Map courtesy of Woodland Cemetery Association.

GEOLOGY AND CEMETERIES

The geology of a cemetery may seem an odd topic for a guidebook. I have written it, not because of any morbid obsession on my part, but because there is much of interest to see, both geological and historical. In a consideration of the natural history of cemeteries in Britain, Eric Robinson (*in* Brooks, 1989) makes a number of points about their geology, which appear to be equally relevant to Woodland Cemetery. The following are paraphrased from Robinson's work, with a few of my observations included.

The geological site of a cemetery may be of interest, but the monuments themselves are the main focus of attention—the rock types used, the carving and masonry work, and their weathering characteristics. During and prior to the nineteenth century, the rock type used for monuments was often determined by what was available locally. However, large city cemeteries contain a diverse array of rock types. This diversity reflects the nineteenth-century expansion of the masonry trade and is directly related to the development of transportation. The development of the turnpike, growth of the canal system, and then the spread of the railways (both in Britain and the United States) meant that a wider range of geological materials became available. In 1829 the Miami Canal between Cincinnati and Dayton was completed. A 20-hour journey between the two settlements was considered a rapid trip (Steele and others, 1889). Dayton and Toledo were connected by canal in 1842 (Carillon Park, undated). A number of railroad lines were completed to Dayton in the 1850's (Steele and others, 1889). Marble, gneiss, serpentinite, and polished granite were worked by mid-Victorian masons. In Britain during the second half of the nineteenth century, imports from abroad started to be used for cemetery memorials. This trend continued into the start of the twentieth century. "All major cemeteries contain a number of 'exotics' which are likely to test the experience of any geologist" (Robinson, *in* Brooks, 1989, p. 82). The stones of Woodland Cemetery are no exception!

Not all building stones are necessarily suitable for markers and monuments in cemeteries. However, the materials from which private mausoleums are constructed can be considered building stones. The 1860's saw the development of mirror-smooth polished surfaces on granite memorials, which may still defy weathering today. "Such polished surfaces make the urban cemetery an open-air museum of practical geology, perfectly revealing mineralogy and textural characteristics" (Robinson, *in* Brooks, 1989, p. 82). Rock textures may be more clearly seen than in natural outcrop. Disadvantages include not being able to see rock outcrops in a cemetery, although in Lake View Cemetery in Cleveland rock was quarried until the mid-1930's, and there are other outcrops too (Hannibal and Schmidt, 1988a). Another disadvantage is not being able to obtain samples for further study, although a helpful stone mason or supplier could be invaluable in providing samples.

A study of the weathering of monuments in cemeteries is scientifically important because the process of weathering is difficult to investigate solely in a laboratory. Comparative rates of decay can be assessed because memorials are dated (although headstones may be erected prior to, or replaced after, death). The marker for Henry Young is a notable exception in Woodland Cemetery; it was placed on his grave in 1981, as a result of genealogical research, 135 years after his death (Hellwig, 1991, p. 54). Doe (1989) has given an interesting account of pollution, structural, and other kinds of damage to stone monuments, memorials, and buildings of downtown Washington, D.C. Such information on weathering rates is directly relevant to the modern built (urban) environment.

If you find a "problem rock" that is difficult to identify, cemetery staff or cemetery records may provide the answer. Geologists at a local museum, university, or state geological survey may be able to assist. "A guide to selected sources of information on stone used for buildings, monuments, and works of art" is a recently published bibliography (Hannibal and Park, 1992) that is a valuable source of additional information for those wishing to find out more about the use and identification of stone.

THE GEOLOGY OF THE SITE OF WOODLAND CEMETERY

The wooded hill on which Woodland Cemetery and Arboretum is situated is part of the more widely distributed moraine deposits of Wisconsinan age found in western and northern Ohio and beyond. These sedimentary deposits were formed by glaciers, or ice sheets, that once covered this region during the Pleistocene and melted approximately 20,000 to 17,000 years ago. The ice was not "clean"—it was carrying clay, sand, gravel, and boulders within its mass. Some of the smaller sediment particles were carried away by meltwater to form outwash deposits of clay, sand, and gravel. Some material was deposited directly in place by the ice as it melted. Moraine is typically an example of this type of deposit. It is poorly sorted, containing a variety of sediment sizes from clay to gravel. According to Norris and Spieker (1966) the moraine in the vicinity of Woodland Cemetery is on the order of 100 feet (30 m) thick (fig. 2). However, outcrops in the cemetery (at one time there was a gravel pit on the south side of Stewart Street) and the University of Dayton grounds (excavations for a new humanities building, 1992) indicate stratified sands and gravels are present.

Glacial outwash deposits are very important in the Dayton area because a number of deep valleys have been infilled with such deposits (valley train deposits). The sands and gravels of these outwash deposits act as aquifers (that is, they contain water), which supply the City of Dayton with its water. The buried valleys were eroded in bedrock probably before modification to the drainage patterns that resulted during latest Pleistocene glaciation. The form of the deepened valley can be seen in figure 2.

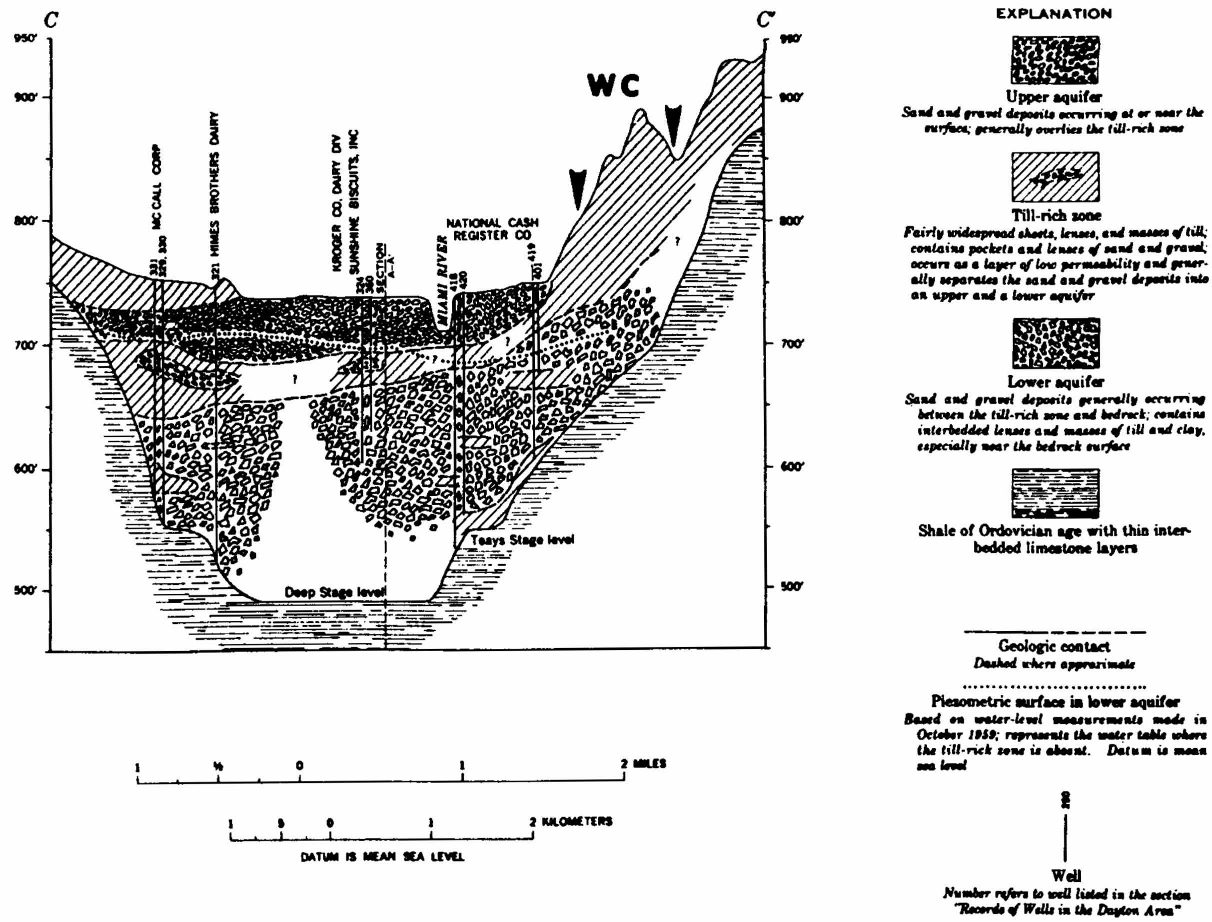


FIGURE 2.—Geologic cross section across the Miami River valley showing the form of the buried river valley eroded into Ordovician bedrock and infilled with glacial and alluvial sediments. Location of Woodland Cemetery is indicated by arrows and letters WC. (Modified from Norris and Spieker, 1966, pl. 3.)

ROCK TYPES USED IN WOODLAND CEMETERY—SOME INTRODUCTORY REMARKS

Representatives of each of the three major rock types—igneous, sedimentary, and metamorphic—can be seen in Woodland Cemetery and Arboretum. Igneous rocks form from the cooling of a hot liquid; for example, a lava flow or intrusion of hot liquid rock (magma) within the Earth's crust. Igneous rocks identified in Woodland Cemetery include diabase, gabbro, granite, granodiorite, quartz monzonite, and syenite. Sedimentary rocks are composed of fragments of pre-existing rocks, and may contain the fossil remains of animals and plants. Conglomerate, dolomite, limestone, and sandstone are types of sedimentary rocks that have been identified in Woodland Cemetery. Metamorphic rocks form from the heating and/or squeezing of pre-existing rocks (the pre-existing rocks can be igneous, sedimentary, or metamorphic). Metamorphic rocks identified in Woodland Cemetery and Arboretum include marble and serpentinite. Table 1 gives the geologic ages for some of the rocks discussed, and figure 3 indicates their origins.

It is important to distinguish between geological rock names used by geologists and trade names used by stone merchants, stone masons, and stone traders to describe the rock in nongeological terms. Two names in particular, granite and marble, are used extensively by geologists and by stone merchants to describe certain rocks. Granite and marble have different meanings to both, so it is necessary to define how geologists and stone merchants use the terms. Granite to a geologist is a coarse-grained (minerals clearly visible with the naked eye) igneous rock containing the minerals quartz (glassy), feldspar (white and/or pink), mica (reflective, platy flakes) and hornblende (black). When a granitic rock has 20 percent or more quartz and the white plagioclase feldspars are more common than the pink alkali feldspars, geologists call the rock granodiorite. The stone merchant uses the term granite to describe a rock that is hard and can take a polish and includes a wide range of igneous rocks that are not granite in the geologist's sense. In this guidebook, rock names in italics, such as *Rockville granite,* indicate the use of a stone traders' term or an informal, nongeological name. Therefore, *Rockville granite* is not necessarily a true granite in the geological sense—to the geologist it is in fact quartz monzonite. Geological names for rocks are given in normal typeface. Marble to a geologist is a metamorphosed limestone (originally a sedimentary

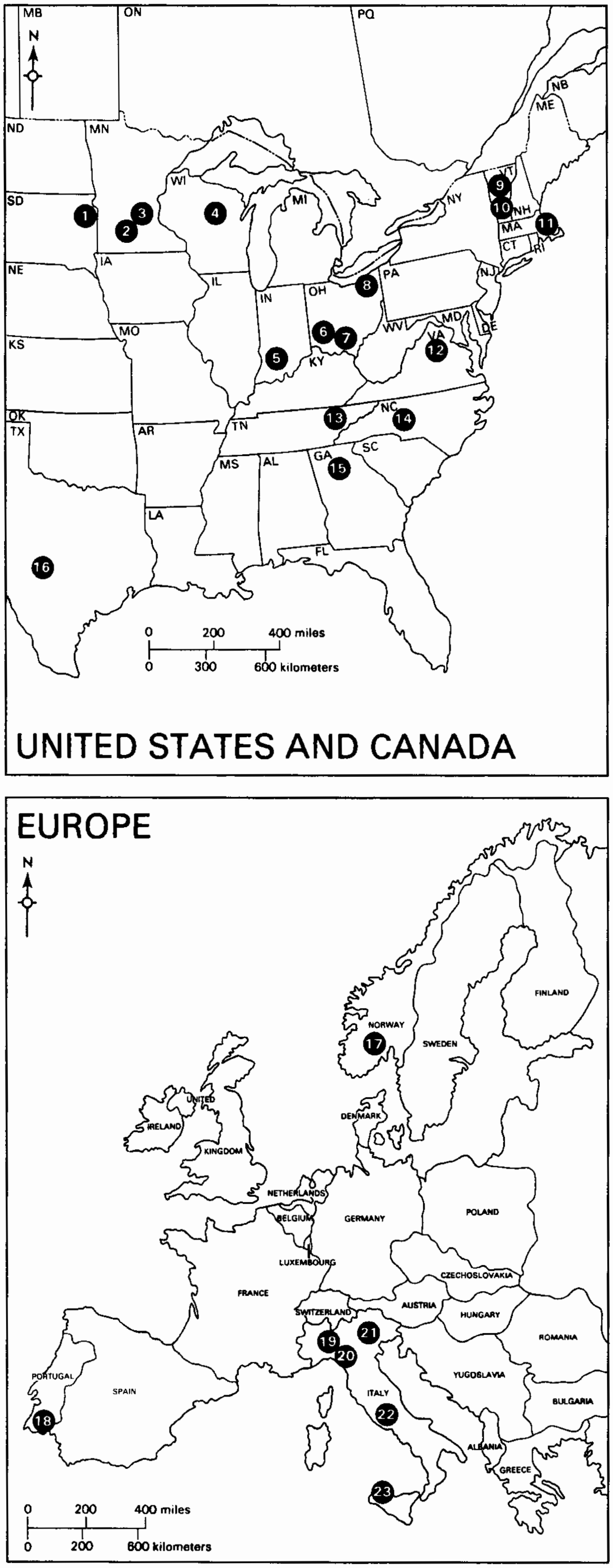
TABLE 1.—*Simplified geologic time scale showing the geologic periods during which some rock types used in Woodland Cemetery and Mausoleum were deposited or formed.*

ERA	Age	Millions of years ago	Rock name	Rock type	Source
CENOZOIC	Quaternary	1.6	*Roman travertine*	travertine	Italy
	Tertiary	66.4			
MESOZOIC	Cretaceous	144	*Dolcetto Perlato*	limestone	Sicily, Italy
			St. Florient Rose	limestone	Portugal
			Sierra White	granite	Raymond, California
	Jurassic	208	*Botticino*	limestone	Italy
			Brecha Lioz	limestone	Portugal
			Verde Issorie	serpentinite	Italy
	Triassic	245	*Italian Cremo*	brecciated marble	Carrara, Italy
PALEOZOIC	Permian	286	*Blue Pearl granite*	syenite	Larvik, Norway
	Pennsylvanian	320	Buena Vista sandstone	sandstone	southern Ohio
			Sharon conglomerate	conglomerate	northeastern Ohio
	Mississippian	360	Salem Limestone	limestone	Salem, Indiana
	Devonian	408	*Barre granite*	granodiorite	Barre, Vermont
			Fior de Pesco Carnico	brecciated limestone	northeast Italy
			Woodbury Granite	granite	Woodbury, Vermont
	Silurian	438	Brassfield Formation	limestone	Dayton area, Ohio
			Dayton Formation	limestone	Dayton area, Ohio
	Ordovician	505	*Pavonazzo White*	marble	Danby, Vermont
			Quincy Granite	granite	Quincy, Massachusetts
			Tennessee marble	limestone	Tennessee
			Verde Antique	serpentinite	Rochester, Vermont
	Cambrian	570	*Rosa Aurora*	marble	Portugal
PRECAMBRIAN	Precambrian		*Diamond Pearl*	granite	Mason, Texas
			Diamond Pink	granite	St. Cloud, Minnesota
			Impala Black	gabbro	Transvaal, South Africa
			Jet Black	gabbro	Transvaal, South Africa
			Lake Superior Sandstone	sandstone	Wisconsin
			Minnesota Rainbow	migmatite	Morton, Minnesota
			Mount Rushmore Mahogany	granite	Milbank, South Dakota
			Rockville granite	quartz monzonite	Rockville, Minnesota
			Rockville White	granite	Rockville, Minnesota
			Salisbury Pink	granite	Salisbury, North Carolina
			Wausau Red granite	syenite	Wausau, Wisconsin

Dates for the time scale are from Palmer (1983).

rock). In the stone trade the term marble is used for a soft rock that will take and retain a polish. The stone-trade definition can include igneous, sedimentary, and metamorphic rocks, so it is quite different from the strict geological definition. In addition, geologists define formal rock-unit names such as the Dayton Formation. A rock unit is named after the place where it is well-developed, in this instance, Dayton. The Dayton limestone is the building stone that has been quarried from the Dayton Formation. Names of fossils, such as the coral *Favosites*, also appear in italics because it is standard practice to indicate such names by italics in publications.

Memorials can be small or large. In Woodland Cemetery they range from small tablets (or a die) on a base, to private mausoleums, to obelisks. Stone for memorials is placed into one of four grades, 1, 2, 3, and 4, with 4 being the highest quality. Grade 4 would be suitable for tablets, and 3 or 2 for bases (Larry Young, Woodland Mausoleum, personal communication). Because of their resistance to weathering, igneous rocks are used today for tablets in the cemetery. They are commonly called *granite*, but include a variety of other igneous rocks. Many of the tablets and bases, obelisks, and private mausoleums are made of igneous rock, although sedimentary or metamorphic rocks also are used. Higher transportation costs mean that imported stone will, not surprisingly, cost more than domestic stone. There are a variety of finishes available for memorial stone. The finish affects the appearance and clarity of some of the textures in the rock. From coarsest to finest, these finishes are sawed, satintone, velvet, and polished. Steeled finish is intermediate between sawed and satintone. Engraved lettering on monuments can be painted white (highlighting) or a variety of other colors (*e.g.*, black, brown, gray) by lithochrome. Flashing is a finish in which a polished surface is masked and sand-blasted to produce an inscription. Inscriptions on older monuments were hand carved with hammer and chisel.



1) *Mount Rushmore Mahogany*, Milbank, South Dakota

2) *Minnesota Rainbow*, Morton, Minnesota

3) *Diamond Pink*, St. Cloud, Minnesota; *Rockville granite* and *Rockville White*, Rockville, Minnesota

4) *Wausau Red granite*, Wausau, Wisconsin

5) Salem Limestone, Bloomington-Bedford, Indiana

6) Dayton Formation, and Brassfield Formation, Dayton area, Ohio

7) Buena Vista sandstone, Buena Vista, Ohio

8) Sharon conglomerate, northeastern Ohio

9) *Barre granite*, Barre, Vermont; Woodbury Granite, Woodbury, Vermont

10) *Verde Antique*, Rochester, Vermont; *Pavonazzo White*, Danby, Vermont

11) Quincy Granite, Quincy, Massachusetts

12) *Ebony Mist*, Culpeper, Virginia

13) *Tennessee marble*, Knoxville area, Tennessee

14) *Salisbury Pink*, Salisbury, North Carolina

15) *Georgia marble*, Tate area, Georgia

16) *Diamond Pearl*, Mason, Texas

17) *Blue Pearl granite*, Larvik, Norway

18) *Brecha Lioz*, Olhao, Portugal

19) *Botticino*, Lombardy, Italy

20) *Italian Cremo* and *Cippolino Vert Apoana*, Carrara, Italy

21) *Casino Rose*, Vicenza, Italy

22) *Roman travertine*, Tivoli, Italy

23) *Dolcetto Perlato*, Sicily, Italy

FIGURE 3.—Sources of some of the rock types used in Woodland Cemetery and Mausoleum. Dots may indicate more than one location.

Throughout the older parts of the cemetery much use is made of *gray granite* for headstones. This stone is in many cases *Barre granite*, which is geologically a granodiorite. It can also be considered a *Northern Gray granite*. The Rock of Ages Quarry at Barre, Vermont, is a major quarry for the extraction of *Barre granite*. Plates 1.1, 1.3, 4.1, 4.2, and 4.6 illustrate examples that may possibly all be this rock type. This granodiorite, quarried in the Green Mountains, is a Middle Devonian intrusive associated with the Acadian Orogeny (Richter, 1987), resulting from crustal collisions along the eastern margin of the North American continent. Many of the monuments identified as *gray granite* may prove to be *Barre granite*. Woodbury Granite is similar in appearance to *Barre granite* and is quarried approximately 20 miles (32 km) north of Barre. It is possible to distinguish *Barre granite* from others (see below). However, there are *granites* from New England and Canada that closely resemble *Barre granite*, and detailed petrographic analysis or reliable archives may be needed to be certain as to the origin of a rock material.

Another *gray granite* used extensively for memorials in the United States can be considered a *Southern Gray granite* (pl. 1.2, 1.4). Like *Barre granite*, it too is geologically a granodiorite. These two granodiorites can generally be distinguished after a little time looking at examples of each type. Typically, *Barre granite* is darker in color and coarser grained. *Southern Gray granites* come from a variety of sources including Texas, Alabama, Oklahoma, and North and South Carolina. However, a major source of such rock is Elberton, Georgia, which produces over 250,000 granite memorials each year (David Norman, Elberton Granite Association, personal communication). *Sierra White* from Raymond, California, is lighter in color than *Southern Gray granite*. It is of Cretaceous age.

The 1920's and 1930's saw the opening of many quarries in *Southern granites*. Many closed during the Second World War. *Southern Gray granites* used for tablets tend to discolor more readily than *Northern Gray granites* (Larry Young, Woodland Mausoleum, personal communication). This tendency may be a reflection of the finer grain size and greater mineral surface area for attack by weathering, or mineralogical differences (*i.e.*, the presence of biotite in the *Southern Gray granites*). Rose- and pink-colored *granites* in monuments from this time may be difficult to link to their source. During the past 10 to 15 years other *granites* have become very common for use in monuments. Granites that contain large grains (phenocrysts) of red- to pink-colored feldspars are termed *Mahoganys* in the stone trade. *Northern Mahogany* (pl. 1.7) comes from Milbank, northeast South Dakota. It is a Precambrian granite and is also known as *Mount Rushmore Mahogany* and *American Mahogany*. The name *Carnelian* is used for a lighter colored variation from Milbank. *Diamond Pink* is a Precambrian-age granite from St. Cloud, Minnesota (pl. 1.5), cut and finished by the Cold Spring Granite Company, Cold Spring, Minnesota. It has pink feldspar phenocrysts. There are many similar looking Precambrian granites with pink and white feldspar phenocrysts including *Rockville White* and *Rockville Beige*, from Rockville, Minnesota; *Diamond Pearl* from Mason, Texas; *Texas Pearl* and *Sunset Beige* from Marble Falls, Texas; and *Mosaic Rose* or *Carolina Mahogany* from Kershaw, South Carolina. *Wausau Red granite* is quarried from part of the Wausau syenite complex in Wisconsin, and is geologically a syenite (pl. 1.6). These intrusions and the associated Wolf River batholith have been dated between 1.8 to 1.0 billion years old (Myers and others, 1984). *Salisbury Pink* is a lighter colored Precambrian *granite*, quarried in Salisbury, North Carolina.

Migmatite is a striking rock. It typically has a swirling texture, indicating the hot and near-fluid state of the rock, close to melting and becoming a magma. *Minnesota Rainbow* (pl. 1.8) is the trade name for one migmatite commonly used for headstones and as a facing stone for buildings (such as the lower portion of The Museum Center at Cincinnati Union Terminal). This Precambrian rock comes from Morton, Minnesota, and is over 3.5 billion years old. Another migmatite that can appear very similar to *Minnesota Rainbow* is *Stony Creek granite* from Stony Creek, Connecticut. It tends to have a lighter color with more white and orange shades than the rock from Minnesota, which has more black minerals present.

Rocks termed *black granite* are generally geologically identified as gabbro, which is an igneous rock that lacks the light-colored quartz and feldspars found in granite. *Impala Black* (pl. 1.14, 1.15) is a Precambrian gabbro from the Transvaal of South Africa and is approximately 3.5 billion years old. A totally black variety of gabbro from South Africa is known as *Jet Black*. *Impala Black* shows a light mottling that *Jet Black* lacks. *India Black* is another gabbro (pl. 1.13) and comes from India. It is typically darker than *Impala Black*. These black gabbros may not be easy to distinguish from each other. In addition, there are other sources of *black granites* that include gabbros and related rocks, for example, *Academy Black* from California. *Ebony Mist* is a gabbro from Culpeper, Virginia, that typically displays light wisps or variegation (pl. 1.11, 1.12). Another variegated black gabbro very similar in appearance is *French Creek* or *Fox Hill Black granite* from the French Creek area, Pennsylvania. *French Creek* gabbro typically has more horizontal lines running across it rather than the wisps that characterize *Ebony Mist*. Quincy Granite (pl. 1.9) is a coarse-grained rock from Quincy, Massachusetts. A number of color varieties have been identified (Dale, 1923), although the rock has a distinctive speckled appearance from the dark mafic minerals. The rock is Ordovician-Silurian in age. An igneous rock that is dark in color but contains large white feldspar phenocrysts is *Rockville granite* from Rockville, Minnesota. Geologically this rock is a Precambrian-age quartz monzonite. This rock has probably been used for some markers in Woodland Cemetery.

An igneous rock called *Blue Pearl granite* has been used in the cemetery (pl. 1.10). Geologically, it is a syenite and is also known as larvikite, after Larvik, Norway, where it is quarried. The rock comprises iridescent dark-blue plagioclase called labradorite, and black mafic (iron-rich) minerals. The rock is of Permian age, approximately 280 million years old.

White *Georgia marble*, a true marble in the geological sense (a metamorphosed limestone), is used for some of the older monuments (pl. 4.8). Three white marbles which may show various amounts of green streaky coloration are commonly used throughout the United States. These are *Alabama, Georgia,* and *Vermont marbles*. *Georgia marble* tends to be coarse grained, typically coarser than the other two marbles. *Alabama marble* and *Vermont marble* may appear identical, and perhaps only additional research into archives will determine the source of the stone (Don Burns, Pluess-Staufer

PLATE 1.—Examples of some of the *gray, red,* and *black granites* used in Woodland Cemetery.

1.1. *Barre granite*, a granodiorite, from Barre, Vermont, polished finish. White feldspar, glassy quartz, black mafic minerals. Detail from Lee tablet (shown in 1.3), section 307. Scale in centimeters (2.5 cm = 1 inch).

1.2. *Southern Gray granite*, possibly from Elberton, Georgia, polished finish. White feldspar, glassy quartz, black mafic minerals. Detail from Davidson tablet (shown in 1.4), section 307. Scale in centimeters (2.5 cm = 1 inch).

1.3. *Barre granite*, a granodiorite, from Barre, Vermont, polished finish with flashing where engraved and inscribed. Lee tablet (detail shown in 1.1), section 307. Height of tallest lettering 7.5 cm (3 inches).

1.4. *Southern Gray granite*, polished finish around edge, flashing in center. Davidson tablet (detail shown in 1.2), section 307. Height of tallest lettering 5.0 cm (2 inches).

1.5. *Diamond Pink*, a granite from Minnesota, polished finish. Pink feldspar phenocrysts. Detail from the wall of the Garden of the Soaring Spirit, Lawn Crypts, section 307. Width of field of view approximately 12 cm (4.8 inches).

1.6. *Wausau Red granite*, a syenite from Wausau, Wisconsin, polished finish. Pink and white feldpars, gray quartz. Detail from Wortham tablet, section 307. Scale in centimeters (2.5 cm = 1 inch).

1.7. *Mount Rushmore Mahogany*, a granite from Milbank, South Dakota, polished and flashed finishes. Pink to red feldspar phenocrysts, glassy quartz, black mafic minerals. Detail from K. R. Davidson tablet, section 307.

1.8. *Minnesota Rainbow*, a migmatite from Minnesota, polished and engraved surface. Swirling texture of pink, feldspar-rich veins in contrast to dark, mafic-rich lenses. Buhl tablet, section 126.

1.9. Quincy Granite, a granite from Quincy, Massachusetts, polished finish. Mead Obelisk, section 101. Letter height 4.5 cm (1.8 inches).

1.10. *Blue Pearl granite*, a syenite called larvikite from Norway, polished finish. Large crystals of labradorite feldspar are common. Vandenbrock tablet, section 307. Width of field of view approximately 6 cm (2.4 inches).

1.11. *Ebony Mist*, a gabbro from Virginia, polished, engraved, and flashed finishes. Detail from McGee tablet, section 307. Height of Scales of Justice approximately 15 cm (6 inches).

1.12. *Ebony Mist* (see 1.11), polished and flashed finishes. Lager tablet, section 307.

1.13. *India Black*, a gabbro from India, polished, engraved, and flashed finishes, with lithography on letters. Blackmon tablet, section 307. Height of lettering 8.8 cm (3.5 inches).

1.14. *Impala Black*, a gabbro from South Africa, polished and flashed finishes. Fortson tablet (detail shown in 1.15), section 307. Height of tallest lettering 8.2 cm (3.3 inches).

1.15. *Impala Black* (see 1.14), polished and flashed finishes. Detail from Fortson tablet, section 307. Height of letter 8.2 cm (3.3 inches).


METRIC 1 2 3 4 5 6 7 8
1
METRIC 1 2 3 4 5 6 7 8
2
LEE
JAMES L.
"BUSTER"
OPAL MA
3
Father
DORLAND
DAVIDSO
JULY 21, 192
4
5
METRIC 1 2 3 4 5 6 7 8 9 10
6
AND
DAVIDS
7
BUHL
8
9
10
11
LAGER
VERNON G
FEB. 13, 1919
APR. 30,
12
B
L
13
FORTSON
ARLES H.
LOIS BURN
32 1989
1932
14
O
15

PLATE 2.—Examples of rocks used inside Woodland Mausoleum. All rocks have a polished finish. Height of tallest lettering in all photographs is 48 mm (1.9 inches).

2.1. *Fior di Pesco Carnico*, a brecciated limestone from Carnia, Dolomite Mountains, northeast Italy, Devonian age.
2.2. *Italian Cremo*, a brecciated marble from Carrara, Italy, Triassic age.
2.3. *St. Florient Rose*, a fossiliferous limestone from Pero Pinheiro, Portugal, Cretaceous age. Contains rudist bivalves.
2.4. *Andejura*, a travertine (limestone) from Spain, ?Cenozoic age.
2.5. *French Escalope*, a limestone from France, probably Mesozoic age.
2.6. *Pavonazzo White*, a marble from Danby, Vermont, Ordovician age.
2.7. *Brecha Lioz*, a fossiliferous limestone from Portugal, Jurassic age.
2.8. *Botticino*, a limestone from Lombardy, Italy, Lower Jurassic (Lias) age.
2.9. *Dolcetto Perlato*, a fossiliferous limestone from Mount Erice, Sicily, Italy, Cretaceous age.
2.10. *Casino Rose*, a brecciated limestone from Vicenza, Italy, ?Mesozoic age.
2.11. *St. Sylvester*, a brecciated limestone from Italy, ?Mesozoic age.
2.12. *Norwegian Rose*, a metamorphosed conglomerate from Norway, Paleozoic age.

Industries Inc., personal communication). *Tennessee marble* (pl. 4.5) is geologically a limestone. This light-gray limestone is Middle Ordovician in age and contains fossils. It has been widely used as a building stone, for example, the National Gallery of Art, Washington, D.C. (Withington, 1975). Some Italian *Carrara marble*, a true marble, was used earlier this century for sculptures in the cemetery, for example, the "McMillen Angel" (front cover and pl. 5.3) on the grave of Asa McMillen (1797-1855) in section 69.

The sedimentary rock sandstone is used for older monuments (pre-1840) that were moved to Woodland Cemetery from the earlier Dayton Cemetery at Third and Main Streets.

Examples of these include the Barnett truncated obelisk in section 61 (pl. 5.2, 5.4) and the Towner obelisk in section 69 (pl. 5.5, 5.6). The sandstone is of fine to medium grain size and has a tan color. It is probably Pennsylvanian-age Buena Vista sandstone from southern Ohio. Another commonly used sandstone in Ohio is the Berea Sandstone, of Devonian-Mississippian age, from northern Ohio. The Berea typically has a coarser grain size than that seen in these memorials. Weathering has led to blackening of the surface of the Buena Vista sandstone in places. An interesting example of differential weathering rates can be seen between the easterly facing (pl. 5.4) and southerly facing (pl. 5.6) inscriptions from the two monuments. The southerly facing inscription faces the predominant direction of incoming weather systems and presumably rainfall. It shows a higher degree and presumably faster rate of weathering. A distinctive quartz-pebble conglomerate (pl. 4.3), is found in one part of the cemetery (locality 5). This sedimentary rock may be Pennsylvanian-age Sharon conglomerate, transported by glaciers from northeastern Ohio (Fullerton, 1986), where the rock crops out. Another conglomerate known in glacial deposits—a red jasper conglomerate—is known to crop out north of Lake Huron, Canada (Hannibal and others, 1991). The stone is used in Westwood Cemetery, Oberlin, Ohio, for the monument and markers of glacial geologist G. Frederick Wright and family. Wright was a theologian and geologist at Oberlin College (Hannibal and others, 1991).

WOODLAND CEMETERY AND ARBORETUM

ORIGINS OF WOODLAND CEMETERY AND ARBORETUM

Woodland Cemetery was founded in 1841 by John Whitten Van Cleve (1801-1858), who is buried in the cemetery (fig. 1, I). The name Woodland Cemetery was chosen because the site was originally a wooded hill located outside of the City of Dayton. Today Woodland Cemetery maintains its wooded aspect with over 3,000 trees; many fine specimens are present within its grounds. There are approximately 100,000 monuments in the cemetery, which covers 247 acres. It is estimated that the cemetery has burial space for at least another 150 years. To the southwest of the cemetery grounds lies the campus of the University of Dayton, and surrounding on all other sides are residential properties (see fig. 8). During 1991, Woodland Cemetery celebrated its 150th anniversary. During that year the Woodland Cemetery chapel was restored and a history of Woodland Cemetery and Arboretum was written (Hellwig, 1991).

GEOLOGY OF THE HEADSTONES AND MEMORIALS IN THE CEMETERY

Localities 1 to 9 are shown on figure 1 and on the back cover.

Locality 1 - Main entrance to cemetery, office, and chapel

The Woodland Cemetery office and chapel were both constructed in 1887. Plaques on both buildings indicate that they were placed on the National Register of Historic Places in 1979. The main gate, office, and chapel are constructed of sedimentary rocks—the white limestone of the Dayton Formation and red sandstone trim (pl. 3.1-3.3). The red sandstone is most likely Precambrian-age Lake Superior Sandstone, or *brownstone*, from Wisconsin. The chapel features a fine stained-glass window commissioned in 1904 from Louis


THOMAS F MC GLADE
1
JONES
ISAAC H
MILDRED E
2
EMMONS
C DALE
CHARLOTTE B
3
BAKER
LEONARD P
PEARL R
4
LAUGHTER
CECIL M
LELIA E
5
KETTERING
CHARLES FRANKLIN
1876
6
HARLOW
FERGUSON
7
MOEHLMAN
BERNARD E
EDNA M
1897
8
J BARRY O'BRIEN
CATHERINE
1914
9
FLORIDIS
GREGORY G
ANGELA
1912
10
GEIGER
HALL
ALOYS H
KATHRYN E
WILBUR W
11
YAHREIS
SACHS
MARGARET
CHARLES A
1927
12

Tiffany of New York (Hellwig, 1991).

The Dayton Formation is laid parallel to its original layering or bedding in the wall by the main entrance to the cemetery. In some private mausoleums, large bedding-plane slabs mounted vertically or inclined are used for walls. The Dayton Formation is a limestone, with variable amounts of dolomite and some shaly horizons. In the Dayton area it generally ranges between 4 and 5 feet thick (1.2 and 1.5 m) (Horvath and Sparling, 1967). Fossil remains of brachiopods, corals, cephalopods, bryozoans, and crinoids have been recorded from the Dayton Formation (Foerste, 1935; Ausich, 1987). Flat, laminar corals up to 1 foot (30 cm) across can be seen in the wall by the entrance to the cemetery. Some of these corals can be identified in the cemetery as the colonial tabulate coral *Favosites* (pl. 6.1). Trace fossils are generally conspicuous. These trace fossils were formed by animals burrowing through loose unconsolidated sediment on the sea floor before it was lithified (solidified) into solid rock. The horizontal burrows (pl. 5.1) are referable to *Palaeophycus* or *Planolites* (Joseph T. Hannibal, personal communication).

The Dayton Formation is approximately 430 million years old and was deposited during the Silurian Period. In the vicinity of Dayton, Silurian rocks are exposed in the gorge cut by the Little Miami River in John Bryan State Park, approximately 20 miles (32 km) east of Dayton (Kleffner and Ausich, 1988). Additional notes on the importance of the Dayton Formation in the Dayton area as a building stone are given on pages 22-27.

From the cemetery entrance follow the suggested route to the "Lookout." Pass the Woodland Mausoleum (funeral services tend to be in the morning, so you may wish to plan your visit inside so as to not disturb any formal proceedings). For details on the exterior and interior of this building see locality 9.

Continuing up the main drive from the entrance of the cemetery on the left is the Huffman family vault. As you turn left along the first road close to the end of the main entrance drive, note the two mausoleums on your right. The Gagel Mausoleum is constructed of Dayton limestone and has *red granite* columns. Large slabs of Dayton Formation limestone also are used for the adjacent unnamed mausoleum, the City Vault, built to receive caskets that could not be interred immediately—for example, when frozen ground during winter would result in delays in interment (Hellwig, 1991). Meanders of trace fossils can be distinguished in the Dayton limestone of both of these buildings (pl. 5.1). Proceed towards the "Lookout" by bearing sharply left on the first road to the left. On the left is an obelisk (Burrowes) of *Georgia marble* on a Dayton limestone base. On the right is the Hamman plot, with markers of *gray granite*; the adjacent Dodds marker is of Quincy Granite. A number of tablets and obelisks of white *Georgia marble* are visible here, as well as monuments of fine-grained, tan-colored sandstone that weathers dark brown to black. It is probably Buena Vista sandstone. As you continue, on the left is the Huffman family vault, with walls of Dayton limestone surmounted by a monument of *Georgia marble*. Immediately opposite on the right is the Anderton tablet of Quincy Granite. Many of the tablets in the Veterans' plot are likely *Georgia marble*. The Barnett marker close to the Veterans' plot in section 61 is probably of Buena Vista sandstone (pl. 5.2, 5.4). Continue to the "Lookout."

Locality 2 - The "Lookout"

Around the base of the "Lookout" are a number of glacial erratics including migmatites, gneisses, and granites. The steps up to the top of the "Lookout" are Dayton limestone. Fossils, including a colonial coral, stromatoporoids (spongelike mounds), and trace fossils, are visible in the steps. The seat at the top and the tablet for Mayne are of migmatite. Adjacent is a tablet (Locke) of medium-grained pink-red granite and one (Kirscher) of *Mount Rushmore Mahogany*. A number of rock types are visible from the "Lookout," including *gray granites*, darker Quincy Granite, some *red granites*, as well as white *Georgia marble*. The "Lookout" also gives a view of Dayton, including downtown. During the summer this view may be somewhat obscured by the trees in leaf. Looking northward towards the downtown area, one can see the valley of the Great Miami River. The most notorious flood in this valley was that of 1913, when over 300 people lost their lives (fig. 4). The Mad River flows from the east (right) to join the Great Miami River in the downtown area. As a result of the 1913 flood the Miami Conservancy District was established. Channel improvements were undertaken and levees and walls were constructed. The most visible act of the Miami Conservancy District was the construction of five dams in the drainage basin—Englewood, Germantown, Huffman, Lockington, and Taylorsville Dams (fig. 5). The dams were innovative and controversial because they were to act as retarding basins at times of high runoff, and not for the permanent storage of water. The chief engineer of the construction project was Arthur E. Morgan. He later became President of Antioch College in Yellow Springs (20 miles/32 km east of Dayton).

Huffman Prairie, where the Wright Brothers had their first permanent flying school (Johnson, 1986), is

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PLATE 3

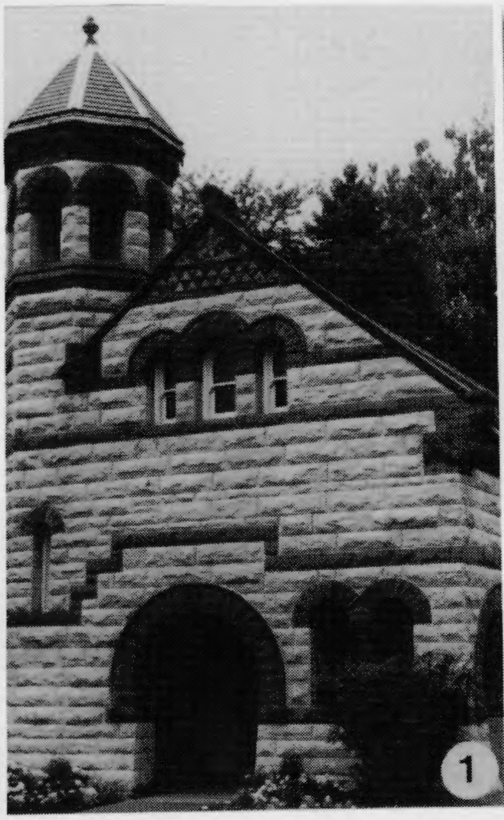
3.1. Woodland Cemetery chapel, of Dayton limestone with Lake Superior Sandstone (*brownstone*) trim.

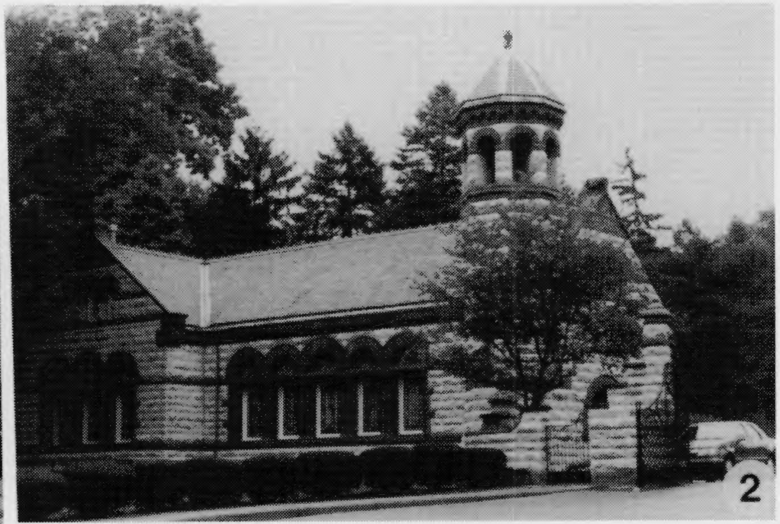
3.2. Woodland Cemetery chapel and main gate, of Dayton limestone with Lake Superior Sandstone (*brownstone*) trim.

3.3. Detail of Woodland Cemetery chapel windows showing Dayton limestone and carved Lake Superior Sandstone (*brownstone*) trim.

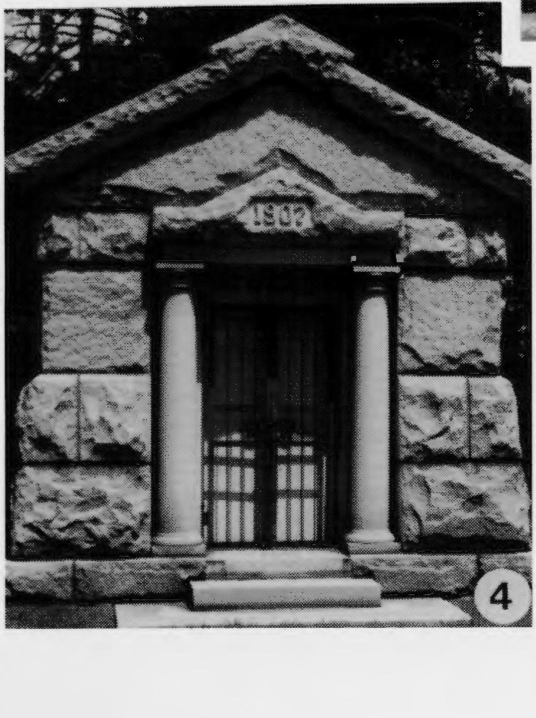
3.4. De Weese Mausoleum, of *gray granite*, section 107.

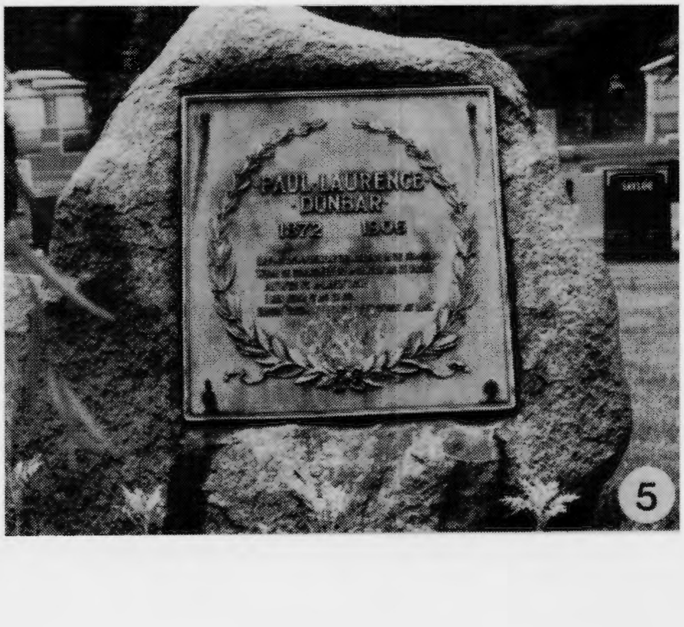
3.5. Grave marker of Paul Lawrence Dunbar (1872-1906), a glacial erratic of granitic composition, section 101.


1


2


3


4


PAUL LAURENCE
DUNBAR
1872 1906
5

located a few miles east, on valley train deposits along the Mad River. Huffman Prairie is now part of Wright-Patterson Air Force Base, but is visible from the Wright Brothers' Memorial, located above the Baltimore and Ohio Railroad cut parallel to Ohio Route 444 in Dayton and Huffman Dam. The shaft and base of the Wright Brothers' Memorial are said to be made of *marble* quarried near Kitty Hawk, North Carolina (Johnson, 1986). They are, in fact, constructed of granite. Orville Wright made the first flight at Kitty Hawk on December 17, 1903.

Excavations in Ordovician bedrock for the outlet tunnel of Huffman Dam in 1919 led to the discovery of a large trilobite specimen measuring 14.5 inches (36.8 cm) long by 10.25 inches (26 cm) wide, belonging to the genus *Isotelus* (Hansen, 1985). The workers who uncovered the specimen brought it to the attention of Arthur Morgan. The trilobite was given to his son, Ernest, for his school's museum. The specimen was soon taken to the paleontologist August Foerste. Foerste's long-standing research ties with the Smithsonian Institution, Washington D.C., resulted in the specimen going to the Smithsonian, where it is still on display. This specimen of *Isotelus* was particularly significant in providing inspiration for two Dayton-area elementary school classes and their teachers to make *Isotelus* the official state fossil of Ohio. The legislation was passed in June 1985 (Hansen, 1985). Subsequently, amateur paleontologist Tom Johnson has collected Ohio's largest intact specimen of *Isotelus* from Ordovician strata of Montgomery County (Babcock, 1989).

On the east side of the "Lookout," the marker for P. P. Lowe is of Quincy Granite on a base of *gray granite*, the Wilson marker is of *Georgia marble*, and the Weinman marker, across the road, is of Quincy Granite. Continuing downhill along the road, on the left the marker for Tate, an urn covered with a shroud, is of white *Georgia marble* on a Dayton limestone base. Opposite this, on the right, is the Sachs marker of a medium- to coarse-grained *gray granite*. A little farther down the hill on the left are markers for Aulabaugh, of migmatite, and Maetke, consisting of an urn with an engraved caduceus (indicating a physician—Dr. Hugo Maetke), of a light *gray granite* (possibly *Barre granite*). Then on the right is a marker for Blind of Quincy Granite. Note the difference in color between the polished areas and the lighter, unpolished base.

At the four-way road intersection, bear left. Larger mausoleums are present in this area, including Schantz, possibly of Woodbury Granite, on the right. The tablet for Oelman close to Schantz shows the difference in color between a polished finish and where the rock has been inscribed. The De Weese Mausoleum (pl. 3.4) is on the left at the next intersection. These monuments are all of *gray granite*, all possibly from Vermont. On the corner opposite De Weese is an obelisk (Harries) of Quincy Granite. Bear right at the next four-way intersection. On the right, almost immediately, is the grave of the poet Paul Lawrence Dunbar.

Locality 3 - Paul Lawrence Dunbar's grave

Paul Lawrence Dunbar (1872-1906) is acknowledged as the first black writer to receive international literary acclaim. He and Orville Wright were classmates in the 1890 class of Dayton's Central High School (now demolished), on the southwest corner of Fourth and Wilkinson Streets (Johnson, 1986). Dunbar's grave marker (pl. 3.5) is a glacial erratic of granitic composition and has cross-cutting veins. This rock was probably eroded from the area of ancient Precambrian igneous and metamorphic rocks to the north known as the Canadian Shield. Many thousands of these erratics were eroded from the Canadian Shield, transported by glacial ice, and then deposited as the Pleistocene glaciers melted and retreated from Ohio and adjacent North America.

Looking from the road towards Dunbar's grave, many *granite* tablets are visible including *gray granite* (Heiss) and, immediately to the left, Quincy Granite (Kimmel). Proceeding behind Dunbar's marker, two tablets, Saylor and Beattie, are probably of *Ebony Mist*, a gabbro, showing some of the light-colored veins or variegation typical of this rock. Close by is the Steffen-Brown tablet, of migmatite. Behind this tablet is that of Anderson of black gabbro. The Smith obelisk is of a dark-red granite with large feldspar crystals. From the tablet for Beattie turn left (south) and then walk towards the Wright Brothers' plot.

Locality 4 - Wright Brothers' plot

A large marker with the family name on its west face marks the Wright Brothers' plot. The larger marker and the smaller tablets marking the graves in the Wright family plot are of *Barre granite* (granodiorite). The Wright Brothers, Wilbur and Orville, are world famous for developing and performing the first powered flight in 1903. Buried in the family plot are Wilbur Wright (1867-1912), Orville Wright (1871-1948; pl. 4.1), their father, Bishop Milton Wright (1828-1917), their mother, Susan Koerner Wright (1831-1889), and their sister, Katharine Wright Haskell (1874-1929). There were two other brothers, Reuchlin (1861-1920) and Lorin (1862-1939). They were not buried in the family plot, although Lorin is in Woodland Cemetery (section 122). From the Wright plot it is possible to see a tall obelisk close by, the Collins Obelisk. A nearby marker for J. M. Wallace is of Quincy Granite.

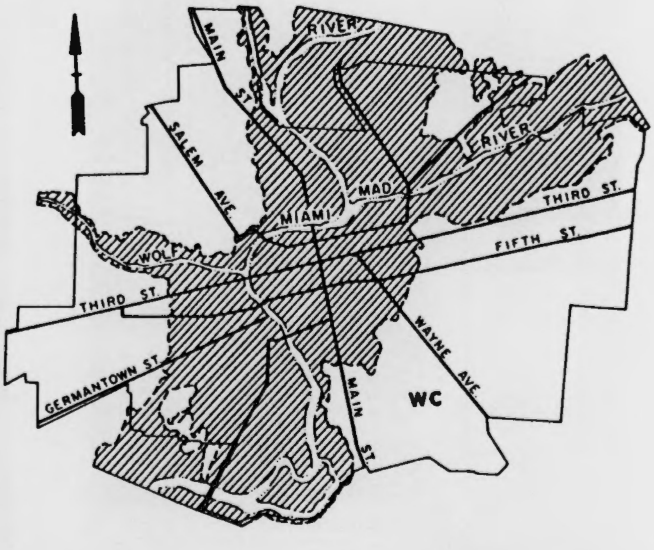


FIGURE 4.—Map of Dayton showing area (diagonal pattern) of the city flooded in 1913. Location of Woodland Cemetery indicated by WC. (Modified from Becker and Nolan, 1988.)

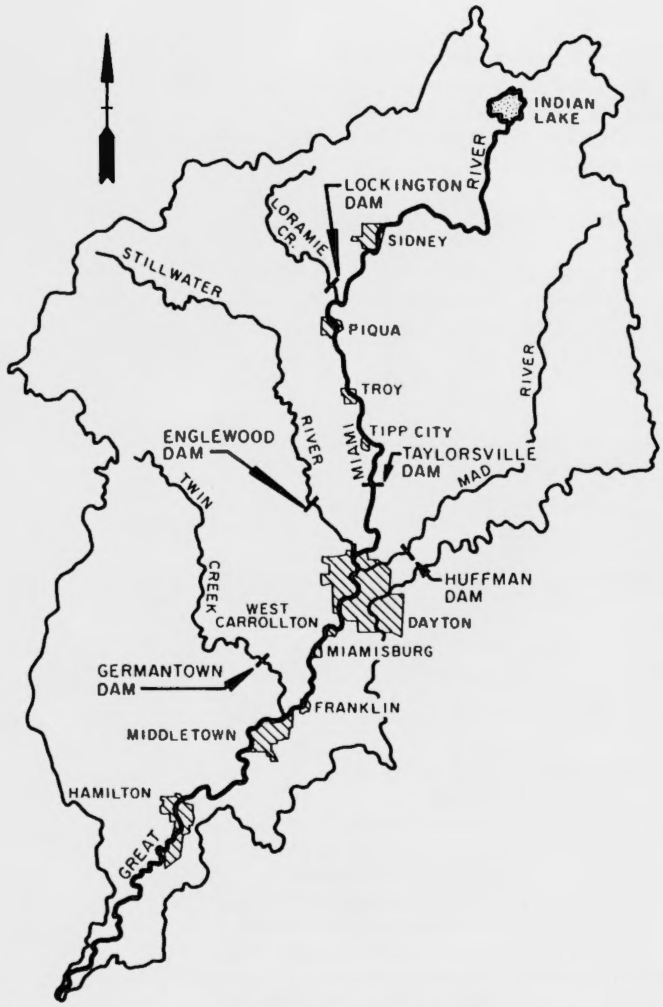


FIGURE 5.—Map of the drainage basin of the Great Miami River and the location of the five dams of the Miami Conservancy District: Englewood, Germantown, Huffman, Lockington, and Taylorsville. (From Becker and Nolan, 1988.)

Locality 5 - Collins Obelisk

The Collins Obelisk (pl. 4.2), at 40 feet (12.2 m), is the tallest obelisk in the cemetery. The base and column are constructed of *Barre granite* (granodiorite). Adjacent is a pink granite memorial for Samuel Showalter. Close by is a marker for A. C. Brown (pl. 4.3). It is a rounded glacial erratic composed of a sedimentary rock, a quartz-pebble conglomerate believed to be a boulder of the Sharon conglomerate, of Pennsylvanian age, that crops out in northeastern Ohio (Hannibal and Feldmann, 1987). The boulder was transported by glacial ice and deposited as the Pleistocene glaciers melted. Only the name A. C. Brown appears on the glacial erratic. The marker is for Anthony C. Brown, born in New Jersey, September 15, 1816, died October 17, 1891; he was a hatter in Dayton (Beers, 1882b). Roadside of this marker is the Mead Obelisk made of distinctive Quincy Granite (pl. 1.9)—*Quincy light* (Chuck Meinerding, personal communication). Continue along the road. On the corner of the section (section 101) is an obelisk for J. Powell crafted from another igneous rock, possibly *Rockville granite* from Minnesota, which is geologically a quartz monzonite. It contains banding and darker inclusions or xenoliths, where pre-existing rock fragments were incorporated into the liquid magma but did not entirely melt.

At the four-way intersection by the Powell Obelisk take the road on the left. On the right is the Edgar-Herrman obelisk of *red granite*, and on the left the Phillips obelisk of *red granite*. A series of obelisks on the right include Shaw of *gray granite*, which is just past the mausoleum for W. S. Hawker on the left, of the same rock. A smaller obelisk of *Georgia marble* for David, Nancy, James, and Sallie Shaw stands by the larger granitic obelisk on the right side of the road. The marker for Jennings, on the right, is of Quincy Granite. At the end of this section is a tall obelisk of *gray granite* (Callahan) on the right. A road joins from the right.

In the next section on the right is the McKee marker, which has a granitic base with a carving on top, probably of *Carrara marble*. Next to this is the obelisk for W. P. Huffman of Quincy Granite, as is that for Dickey. At the end of this section on the right is the Miller marker, of *gray granite*. On the left is the Art Deco tablet of Willoughby, also of *gray granite*. The marker for Kuhns-Mallow is Quincy Granite. The large memorial for Schantz-Kuhns, a sepulchral sarcophagus, is of *Ebony Mist*, a gabbro, as is the smaller tablet of Marvel behind it.

At the intersection, turn left (section 120 on left, section 113 on right). Markers for Lippard-Davidson and Campbell on the left are both *gray granite*. Lippard-Davidson is lighter in color, and Campbell is darker. Both are coarse grained and both may be Vermont *granites*. Close by on the left-hand side of the road is the tablet for Nushaw of granite, with large pink feldspar crystals (phenocrysts). Adjacent to this is the tablet for Protzman-Burnett-Arnold of the migmatite known as *Minnesota Rainbow*.

Follow the road round and take the right-hand fork. A marker for Gibbs of Quincy Granite on the right is below the life-size sculpture (pl. 4.4) of German born Gustav Wiedeke (1849-1910), an impressive monument of *gray granite* built by Henry Wunderlich in Dayton. With his sons, Wiedeke had a tool company that made furnace boilers. Back at the road on the left-hand side is an unnamed mausoleum of a rock resembling *Rockville Pink*. The tablet for James Middleton Cox (1870-1957), former Governor of Ohio and publisher of the Dayton Daily News, is possibly of Woodbury Granite from Vermont. Cox's tablet is in front of the Deeds Mausoleum. The large marker to the right for F. Cappel is of Quincy Granite.

Locality 6 - Deeds Family Mausoleum

The Deeds Mausoleum (pl. 4.5) is constructed of a stone with the trade name of *Tennessee marble*. Geologically it is actually a limestone. Colonel Edward A. Deeds (1874-1960) is interred here. He was an associate of Charles Kettering. Close by the Deeds Mausoleum are a number of tablets that are probably all of *Minnesota Rainbow* (migmatite): Canby, Berry, Fluhart (unpolished), and Crowe (polished). The tablet for Bieser is of a *red granite*. Behind the Bieser tablet, the Cooper tablet is a good example of *Minnesota Rainbow*. The tablet for Heck is of a pale *pink granite*. The monument for Reibold has two square columns with a lintel and an urn and is of *Minnesota Rainbow*. Towards the southwest corner of section 121 are two mausoleums. That for

PLATE 4

4.1. Tablet of Orville Wright (1871-1948), of *Barre granite* (granodiorite), section 101.
4.2. Collins Obelisk, tallest (40ft/12.2m) obelisk in Woodland Cemetery, of *Barre granite*, section 101.
4.3. Marker for A. C. Brown, glacial erratic, probably from Dayton area, of Sharon conglomerate, a quartz-pebble conglomerate that occurs in northeastern Ohio, section 101.
4.4. Wiedeke monument, carved from *gray granite*, section 113.
4.5. Deeds Mausoleum, of *Tennessee marble*, section 121.
4.6. Tablet of paleontologist August F. Foerste (1862-1936), of *Barre granite*, section 126.
4.7. Portrait of August F. Foerste (from Bassler, 1937).
4.8. Tablet of Louisa Foerste, mother of August F. Foerste, of *Georgia marble*. The effects of over 100 years of weathering on the tablet can be seen by the faint inscription, which reads: "Louisa wife of August J. Foerste Died Oct. 24. 1884 aged 56Y. 2M. 16D." Section 126.

Albert H. Scharrer is constructed from a rock that has large feldspar crystals (phenocrysts) and is possibly *Diamond Pearl*, a Precambrian granite from Texas. On the corner of the section is the Hartman Mausoleum of *gray granite* with a dark-green trim around the doors. Behind this vault is the Elliott tablet, of *Minnesota Rainbow*. Thirty yards (27.4 m) south-east of the Deeds Mausoleum is the sphere for Dr. H. W. Dickinson of *gray granite*. The dark tablet for Maréchal is of diabase (George Springer, personal communication).

From the southwest corner of section 121 you may turn left (east) and proceed through the tunnel to Locality 7, the new section ("300 series"), to see a number of tablets from a variety of igneous rocks, or turn right to return to the main entrance of Woodland Cemetery and to Woodland Mausoleum. Some of the tablets in the new section are described below. If you choose to return to the main entrance, skip the next section and turn to "Return to main entrance and Woodland Mausoleum" below.

Locality 7 - New section

Go through the underpass and take the left-hand road. On the right-hand side of the road is a distinctive black marker (Fortson) with a tree trunk carved on it (pl. 1.14, 1.15). A number of markers close by on the right side of the road are described briefly below. Detail from a number of the igneous rocks represented here are shown on plate 1.

Roadside on right, front row:
Fortson - *Impala Black*, a gabbro from South Africa (pl. 1.14, 1.15).
McGee - Honorable James H. McGee, Mayor of City of Dayton, 1970-1981. Headstone of gabbro, *Ebony Mist* from Virginia (detail shown in pl. 1.11; more general view of rock from Lager tablet shown in pl. 1.12).
Lee - *Barre granite*, a granodiorite (pl. 1.1, 1.3). Compare this tablet to the light-gray granodiorite of D. Davidson in the second row.
Adkins - *India Black* from India, a gabbro (pl. 1.13 shows detail of this rock from the Blackmon tablet).
Hunter - also *Ebony Mist*.

Second row:
W. and F. A. Davidson - *Ebony Mist* (detail from McGee shown in pl. 1.11; general view of rock from Lager tablet shown in pl. 1.12).
D. Davidson - light *Southern Gray granite*, a granodiorite (pl. 1.2, 1.4), possibly from Elberton, Georgia.
Stone - *Wausau Red granite*, a syenite from Wausau, Wisconsin (pl. 1.6 shows an example from a tablet for Wortham in section 307).
K. R. Davidson - *Mount Rushmore Mahogany*, a coarse-grained red granite (pl. 1.7).
D. W. and O. F. Brewer - *Salisbury Pink*, a *red granite*.
W. R. and J. D. Brewer - possibly *Colonial Rose*, a *red granite*.

Walk towards the white-barked birch tree. There is a tablet for:
Fahrenholz - *Mount Rushmore Mahogany*.

Behind the tree are tablets for:
Gaston - *Jet Black*, a gabbro form South Africa.
Lager - *Ebony Mist*, a gabbro (pl. 1.12).
Blackmon - *India Black*, a gabbro (pl. 1.13).

A little to the left (south) is a tablet for:
Vandenbrock - *Blue Pearl granite*, a syenite (larvikite) from Norway (pl. 1.10), on a gabbro base.

Continue towards the Lawn Crypt section and the walled Garden of the Soaring Spirit. The *gray granite* wall is capped by *Diamond Pink* (pl. 1.5). Beneath the central bronze statue two granites are used for facing; one with large feldspar phenocrysts is probably *Rockville White*, the other, *Sierra White*; the path is of white marble. To return to the main entrance and Woodland Mausoleum, return back through the tunnel under Stewart Street and turn left (west).

Return to main entrance and Woodland Mausoleum

Heading back (west) towards the main entrance on the road parallel to Stewart Street, a number of *gray* and *red granites* can be seen, with some *black granites* (gabbros). On the left-hand side of the road near the Greek Altar (which is on the right-hand side, fig. 1, T) is a distinctive black tablet for Elias. It is probably of *India Black* gabbro (example shown in pl. 1.13). The engraved lettering is highlighted by white flashing. Nearby, the marker for Sotiropoulos is also of black gabbro. The Tanksley tablet is of *Mount Rushmore Mahogany* (example shown in pl. 1.7). Adjacent is a tablet for Greene of *Ebony Mist* gabbro (examples shown in pl. 1.11, 1.12).

Across Stewart Street, to the south, buildings of the University of Dayton appear, initially student residences (Marycrest Hall), then two four-story brick build-

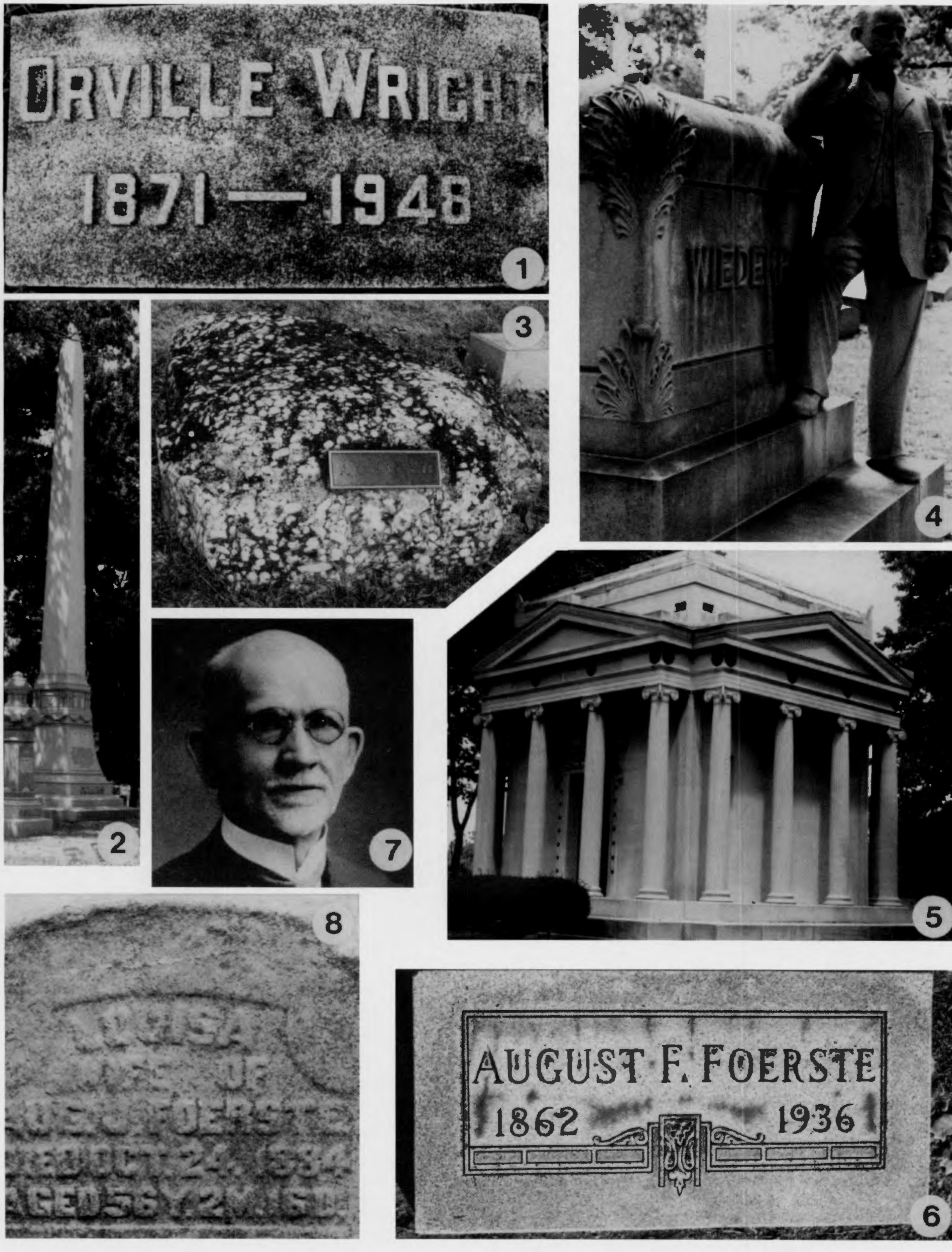

ORVILLE WRIGHT
1871—1948
1
2
3
4
5
6
7
8
AUGUST F. FOERSTE
1862
1936

PLATE 5

5.1. Detail of trace fossil (arrows), possibly *Palaeophycus*, in Dayton limestone (parallel to original bedding). Gagel Mausoleum. Lens cap diameter 5 cm (2 inches).

5.2. Barnett truncated obelisk of fine-grained, tan-colored Buena Vista sandstone, near Veterans' plot, section 61.

5.3. "McMillen Angel," of *Carrara marble*. Steps, tablet, and cross of *gray granite*, section 69.

5.4. Detail of Barnett truncated obelisk (see 5.2). Easterly facing inscription in Buena Vista sandstone reads: "IN memory of JOHN BARNETT, who departed this life July, 16, 1805. Aged 56 years." Note how much sharper this inscription is compared to that in 5.6.

5.5. Towner obelisk, near "McMillen Angel," fine-grained, tan-colored Buena Vista sandstone, section 69.

5.6. Detail of Towner obelisk (see 5.5). Southerly facing inscription in Buena Vista sandstone reads: "CHARLES HENRY, Died Jan. 26, 1838: Aged 4 years and 7 months, ALSO THERON, Died Feb. 9, 1838: Aged 6 years and 10 months. Sons of E. W. & A. P. TOWNER."

ings (Wohlleben and Sherman Halls) and then a taller building, Miriam Hall. On the Stewart Street entrance, Miriam Hall is faced with light-colored *Indiana limestone* (Salem Limestone) and at ground level with dark-green to black slate. A red fire hydrant will come into view at the corner of the campus road entrance to Miriam Hall. When level with this fire hydrant look right (north) from the cemetery road towards section 94. Two conifers visible in front in section 94 should have a more distant tree line up between them. Start walking towards the more distant tree and you will come across the Dornbusch family plot. August F. Foerste is buried here, 14 rows back from the roadside.

Locality 8 - August F. Foerste's grave

August Frederick Foerste (tablet, pl. 4.6; portrait, pl. 4.7) has a simple marker of pale-gray *Barre granite* (granodiorite). Foerste was born in Dayton on May 7, 1862, and died at his home in Dayton on April 23, 1936. A memorial of August Foerste was written by Bassler (1937). The following is based on Horvath and Sparling (1967).

Foerste acquired an interest in geology during his youth while roaming the swamp and woodland of Oakwood and the area south of Dayton. In 1887, 10 years after completing his elementary education in Dayton, he graduated from Denison University at Granville with a bachelor of arts degree and in 1890 was awarded a Ph.D. from Harvard. From 1890 to 1892 he studied at Heidelberg, Germany, and Paris, France. Foerste was an assistant in the U.S. Geological Survey as early as 1887, and later was associated with the geological surveys of Ohio, Indiana, and Kentucky. In 1911 and 1912 he was with the Geological Survey of Canada. He taught physics at Steele High School in Dayton, where he worked for 38 years. It was mostly during the summer vacations from his teaching duties that Foerste studied the Silurian strata of southern Ohio and neighboring states. During his last year (1931-32) at Steele, he was offered the Chair of Paleontology at the University of Chicago but declined because it would interrupt his research and because such a position would be temporary due to his advanced age. Foerste was President of the Ohio Academy of Science in 1931. After retiring from teaching in 1932 he spent time preparing a monograph on fossil cephalopods in cooperation with E. O. Ulrich of the National Museum in Washington, D.C. He was renowned as a teacher and scientist. He earned the reputation in Europe and America as one of the leading paleontologists and geologists of his time.

Steele High School (now demolished), where Foerste taught, was located at the intersection of Monument Avenue and Main Street. This location is by the Great Miami River that flows through Dayton. Foerste kept his paleontological collection, as well as manuscripts and field notes, in his school laboratory (Bassler, 1937). At the time of the Dayton Flood in March 1913, the flood waters swept through the school building, carrying away manuscripts and much of his collection. One of the school's towers was demolished during the flood (Becker and Nolan, 1988, p. 72). Most of Foerste's collection was packed in wooden boxes, which were washed downstream and subsequently stranded as the flood waters receded. These boxes were retrieved from along the Miami Valley by Dr. Foerste's many friends (Bassler, 1937). Foerste did take advantage of one geological opportunity the Dayton Flood provided—he sampled the sediment deposited in his house (Dunbar and Rodgers, 1957, fig. 17)! In 1915 Foerste had a book on the geology of Dayton published. Colonel Deeds paid for the printing of the book.

Dr. Curt Teichert, University of Rochester, met Foerste during a year at the U.S. National Museum in 1930. Teichert notes (1976, p. 10) "Foerste was a most generous man, both intellectually and monetarily." Foerste's sister, Martha, married a man named Dornbusch, and this accounts for his burial in the Dornbusch plot. Close by are the tablets for his mother, Louisa Foerste (pl. 4.8), and his father, August J. Foerste. The tablet for Louisa Foerste is probably *Georgia marble*. Solution of the calcite in the marble over the past century is evident from the low relief of some of the inscription on her tablet (pl. 4.8).

The Dayton Society of Natural History makes an award to a college apprentice or junior staff member at the Dayton Museum of Natural History, generally on an annual basis. The recipient is known as an August F. Foerste Associate. The award was established in 1960 by Louise M. Dornbusch, Foerste's niece.

Close by the Dornbusch plot is a tablet (Buhl, pl. 1.8) of *Minnesota Rainbow* (migmatite). Return to the road by Stewart Street and follow it around to Woodland Mausoleum, or walk to the road that passes "Dog and the Boy" (fig. 1, R). This is a well-known marker in the cemetery, for Johnny Morehouse. It is probably made of *Carrara marble*, and is set on a base of Dayton limestone. Continue towards the cemetery entrance and the Woodland Mausoleum.

Locality 9 - Woodland Mausoleum

The Woodland Mausoleum was constructed in 1969; a more recent extension has been added on the east side. The facing of the upper part of the front of the mausoleum is of Salem Limestone (*Indiana limestone*), of Mississippian age. This stone continues to be used extensively throughout the United States and beyond as a dimension stone (*i.e.*, cut to specific dimensions). Salem Limestone was used to face the Empire State Building in New York City. Patton and Carr (1982) have given a most useful summary of the Salem Limestone from Indiana. Granite has also been used for the exterior of the mausoleum.

Inside the mausoleum, extensive use has been made of polished metamorphic marble and serpentinite and sedimentary limestone (pl. 2; fig. 6). Many marbles and limestones used in the mausoleum have come from Europe, and many are Mesozoic in age (fig. 3; table 1). They formed in or along the margins of the Tethys, an ocean that closed during the Miocene Epoch (a division of the Tertiary), when much Alpine mountain building occurred in Europe. The Tethys was in the approximate position of the present Mediterranean Sea. Like the Mediterranean of today, the Tethys was at low latitudes, and its waters were warm. In such a setting, limestones formed in abundance. Subsequent movements of the Earth's crustal plates resulted in the formation of the Alps, the Caucasus, and the Himalayan Mountains farther east. Such earth movements uplifted these marine limestones to expose them on land. During these movements some limestones were metamorphosed into marble. As a consequence of these geological events, southern Europe has been a classic area for the quarrying of limestone and marble.

The following descriptions outline some of the features of the rocks used in the mausoleum (refer to fig. 6 for location of the rock types). The order of information, where known, is given thus: trade name for the rock (although there may be other trade names for the same rock), place of origin, geologic age, geologic rock type (rock group). The trade names were supplied by James LaVoy of Woodland Mausoleum; geological information has been obtained from Hund (1990), Broadhurst and Selden (1989) and guidebooks describing the geology of building stones in a number of cities (listed in Acknowledgments). In addition to the geological features described here, there are a number of stained-glass windows and a mosaic to be seen in Woodland Mausoleum (fig. 6).

Roman travertine, Italy, Quaternary, limestone (sedimentary). In the entrance to the mausoleum is an example of this limestone. It shows the layering that characterizes many sedimentary rocks. Originally the layering, or bedding, was horizontal. You can see that the limestone is now mounted with the bedding vertical, running from the ceiling to the floor. Extensive travertine deposits near Tivoli, about 18 miles (30 km) east of Rome, Italy, are the source of much travertine from Italy. Some quarries have been active for over 2,000 years. Travertine forms when ground water (springs) rich in elements in solution deposits calcium carbonate. A familiar example of this phenomenon in the United States is Mammoth Springs in Yellowstone National Park, Wyoming. A local example of a travertine deposit is that of the Yellow Spring, Glen Helen, Yellow Springs, Greene County; others are also present in Glen Helen and nearby John Bryan State Park (fig. 7). A detailed account of travertines was given by Chafetz and Folk (1984).

Fior di Pesco Carnico (pl. 2.1), Carnia, Dolomite Mountains (part of the Alps), northeast Italy, Devonian, brecciated limestone (sedimentary). A gray limestone with rose-colored patches. Calcite veins fill fractures in the limestone. Also present are stylolites—irregular, commonly undulating lines formed by solution of the rock and the concentration of impurities (see Pl. 6.8). The fracturing indicates tectonic deformation.

Italian Cremo (pl. 2.2), Carrara, Italy, Triassic, brecciated marble (metamorphic). Broken blocks of white marble (brecciated) in a pale-tan matrix. Stylolites are poorly developed. The brecciation suggests tectonic deformation. The marble is from the Apennines.

St. Florient Rose (pls. 2.3, 6.2-6.4), Pero Pinheiro, Portugal, probably Cretaceous, limestone (sedimentary). Pink to cream-colored limestone. Numerous large rudist bivalve fossils. The rudists (shown in a variety of sections in pl. 6.2-6.4) are an extinct group of bivalves that lived in the Tethys. They were abundant during the Cretaceous Period.

Andejura (pl. 2.4), Spain, ?Cenozoic, travertine, limestone (sedimentary). A pale-cream limestone. The layered, laminar structure of the travertine is well displayed. Lamination is fine-scale layering. Layering is a characteristic of sedimentary rocks, although some show it better than others. Some thin red laminations occur. Gastropods (snails) have been fossilized in the limestone. Some travertines are quite porous but this travertine has a solid texture. Coarse calcite has infilled some pores or vugs.

French Escalope (pls. 2.5, 6.5, 6.6), France, probably Mesozoic, limestone (sedimentary). A pale-pink to rose-colored limestone. Fossils of ribbed rhynchonellid brachiopods (pl. 6.5, 6.6) that indicate ancient marine conditions are present, some showing geopetal infillings (sediment lined the bottom of the valves and calcite crystals formed in the cavity above). Bivalves (clams) and stromatoporoids (layered calcareous mounds with affinities to sponges, pl. 6.5) may also be present. Stromatoporoids are preserved as large, layered, white calcite structures, which may be over 12 inches (30 cm) across.

Verde Antique or *Vermont Green*, Rochester, Vermont, Ordovician, serpentinite (metamorphic). This rock is used for the windowsill and shows its characteristic dark-green color with white veins. Serpentinite can form from the metamorphism of basaltic oceanic crust rocks. This rock formed during the Taconic Orogeny on the eastern margin of North America. At that time a chain of volcanic islands (an island arc) collided with the eastern margin of the continent to form a mountain belt, the Taconic Mountains. During the deformation, slices of ocean-crust material were metamorphosed to serpentinite. Serpentinite is quarried today at Rochester Quarry, Rochester, Vermont.

Pavonazzo White (pls. 2.6, 6.7), Danby, Vermont, Ordovician, marble (metamorphic). Metamorphosed white limestone. Green streaks containing the clay mineral chlorite are present. These clay seams may be stylolitic in places. This rock is being quarried today at Imperial Quarry, Danby, Vermont.

Brecha Lioz (pl. 2.7), Olhao, Province of Faro, Portugal, Jurassic, limestone (sedimentary). Pale-pink to cream limestone with inconspicuous fossils, including colonial corals, preserved in white calcite. The features that this rock exhibits suggest that it represents part of a fossil coral reef. Some of the corals are phaceloid (fingerlike) scleractinian corals. Scleractinian corals are "modern" corals (Mesozoic to Recent), and their presence suggests the rock is probably Mesozoic. Rhynchonellid brachiopods are also present. Stylolites are developed. Holes or vugs are filled with calcite forming stromatactis-like structures (flattened structures, probably originating as cavity infillings, or by recrystallization, Tucker and Wright, 1990). Some masses of cloudywhite calcite are present. Weak lamination visible in some of these masses suggests they are stromatolites (layered structures built by blue-green algae) or stromatoporoids.

Botticino (pls. 2.8, 6.8), Lombardy, Italy, Lower Jurassic (Lias), limestone (sedimentary). Cream colored micritic limestone characterized by pale cream blebs and stylolites. The blebs which are commonly rounded, may be up to 1.4 inches (3.5 cm) in diameter. They may be micritized oncolites (oncolites—rounded algal structures; micritization results from boring by microorganisms and associated recrystallization, generating micrite, fine-grained calcium carbonate.) The name *Botticino* is also used for limestones quarried in Sicily and Puerto Rico.

Dolcetto Perlato (also known as *Perlato Sicilia marble* or *Creme Perle marble*), (pls. 2.9, 6.9, 6.10), Mount Erice, Sicily, Italy, Cretaceous, limestone (sedimentary). Fossiliferous pale-cream limestone with poorly developed pink stylolites. Fossils include corals (pl. 6.9), sponges (pl. 6.10), and brachiopods with geopetal infillings. Massive white laminar calcite may represent stromatolites. Lamination is cut (truncated) in places by stylolites.

Casino Rose (pl. 2.10), Vicenza, Italy, ?Mesozoic, limestone (sedimentary). Pale-cream to pink brecciated micritic limestone. Blocks contain pale-cream to pink-stained balls approximately 1/25 inch (1 mm) in diameter. If such grains contain no internal concentric structure they are termed peloids (which commonly

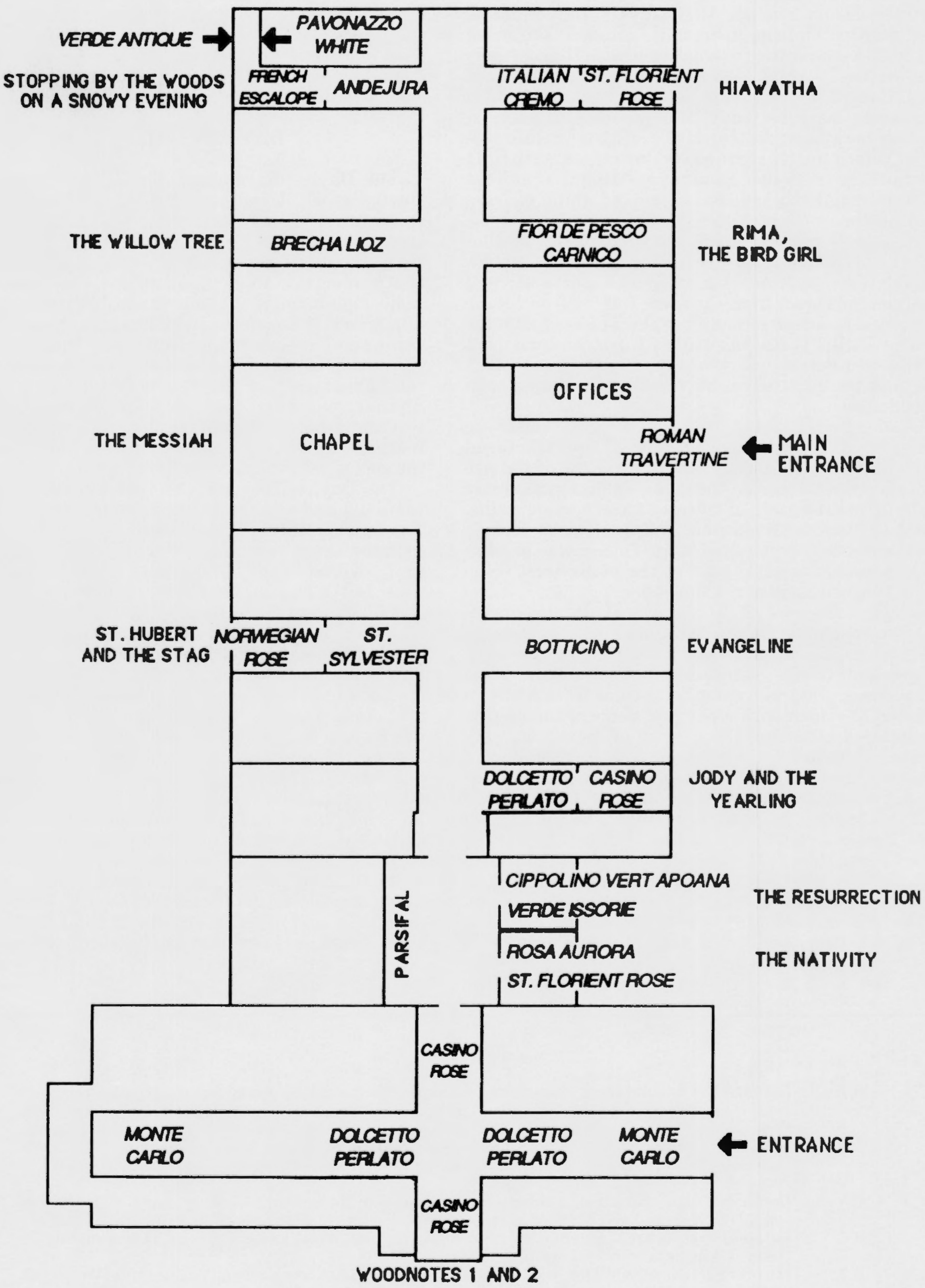


FIGURE 6.—Map of the interior of Woodland Mausoleum showing, in italics, the location of stones discussed in the text. Titles of stained-glass windows and mosaic also are given. Based on information from James LaVoy and "Visitor's guide to the original stained glass and marble in the Woodland Mausoleum" (Woodland Mausoleum, undated). Long axis of building runs approximately west-east.

originate as fecal pellets from invertebrates), which is what these grains may be. Alternatively, they could be altered ooliths. Ooliths are small, rounded sediment grains with a concentric internal structure that form by a combination of algal activity and agitation by wave activity. Ooliths are known to be forming along parts of the Bahamas coastline today. It is possible that recrystallization may have destroyed the original oolitic textures in this limestone. However, in places a distinct center can be seen to the grains, suggesting that at least some were originally ooliths. Some red veins of iron-stained calcite are present.

A number of types of stone are used in the smaller chambers or columbaria of the mausoleum (fig. 6). *Cippolino Vert Apoana* is a gray and white striped gneiss (metamorphic) from Carrara, Italy. *Verde Issorie* is a green serpentinite (metamorphic) of Jurassic age from the Valle D'Aosta, Italy. *Rosa Aurora* is a Cambrian-age Portuguese white marble (metamorphic). It has pink to red streaks. *St. Florient Rose* has been described above.

St. Sylvester (pl. 2.11), Italy, ?Mesozoic, limestone (sedimentary). Light-brown brecciated and fractured micritic limestone. More than one phase of calcite cementation can be seen in the veins. In many cases it is possible to see red-stained calcite at the edge of veins, adjacent to blocks of limestone. This red calcite formed before the coarsely crystalline white calcite was precipitated to form the central part of the vein. Such veins postdate the formation of the limestone.

Norwegian Rose (pl. 2.12), Norway, Paleozoic, metamorphosed conglomerate. Rock initially looks brecciated but is probably a metamorphosed conglomerate with rock fragments (clasts) within a carbonate matrix. Some of the clasts are marble, ranging in color from white to pink to red to golden with a red rim. Some of the marble is micaceous, indicating the growth of mica from clay minerals in the original limestone. The deformation of the clasts in the rock suggests that it has been metamorphosed twice. The rock is from the Caledonide Mountains, which formed in northern Europe as an ancient Paleozoic precursor of the Atlantic Ocean, the Iapetus Ocean, closed. The continental areas of northern North America and northwestern Europe collided and formed the mountain belt.

In the new extension to the mausoleum, use has been made of *Casino Rose* (pl. 2.10), *Monte Carlo*, and *Dolcetto Perlato* (pl. 2.9). *Casino Rose* is used in the linking corridor and end walls, *Dolcetto Perlato* for most of the interior of the new extension, and *Monte Carlo* for tiled edging at ground level. *Monte Carlo* is a pale to dark-brown mottled and fractured limestone with white calcite veins.

DAYTON LIMESTONE

The Dayton Formation (fig. 7), also referred to as Dayton stone, Dayton marble, and Dayton limestone, was quarried extensively for building stone in the Dayton area (figs. 8-10), especially during the nineteenth century. Stout (1941) and Horvath (1967) used the name Dayton Formation for the name Dayton Limestone because the unit is not just pure limestone—in places it is dolomitic, in others it is shaly. Subsurface geological information indicates that the Dayton Formation is mainly composed of the mineral dolomite, rather than calcite, which is necessary for a limestone. Similar reasoning was given for the use of the name Brassfield Formation rather than Brassfield Limestone. Incidentally, Foerste introduced the name Brassfield to the geological literature in 1906.

The Dayton Formation is approximately 430 million years old and was deposited during the Silurian Period. The fossils recovered from the rock indicate that it accumulated at the bottom of a relatively shallow marine sea that covered much of Ohio and adjacent states at the time. In the Dayton area the Dayton Formation generally ranges between 4 and 5 feet thick (1.2 and 1.5 m) (Horvath and Sparling, 1967). It seems appropriate to give a brief account of Dayton's building stone, as none has been given since Bownocker (1915) and Foerste (1915). I have not been able to ascertain the exact dates of opening and abandonment for many of the quarries in the Dayton limestone. Locating former quarry sites can also be problematic. As the Dayton limestone is only a few feet thick, if the overburden is thin, former quarry sites might leave only a shallow depression on the surface; infilling of quarries may subsequently obliterate this more obvious evidence. Additional archival research may help to resolve some questions.

The tan to white Dayton limestone was commonly used for the construction of walls, basements of dwellings, and other structures in the Dayton area. Its widespread use is evident from the examination of nine-

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PLATE 6

6.1. Detail of the colonial coral *Favosites* from the Dayton limestone. Arrow points to a small individual corallite of the colony. The whole coral colony (corallum) is composed of many corallites. Specimen visible in steps of the Waldo Street gatehouse. Lens cap in lower right for scale.

6.2-6.4. Detail of *St. Florient Rose*, a Portuguese limestone in Woodland Mausoleum, showing various sections through rudist bivalves (arrows); 6.2-6.3, height of letters 48 mm (1.9 inches); 6.4, height of numbers 25 mm (1 inch).

6.5. Detail of *French Escalope*, a limestone in Woodland Mausoleum, showing possible stromatoporoid (solid arrow) and brachiopod (open arrow). Width of view approximately 30 cm (1.2 inches).

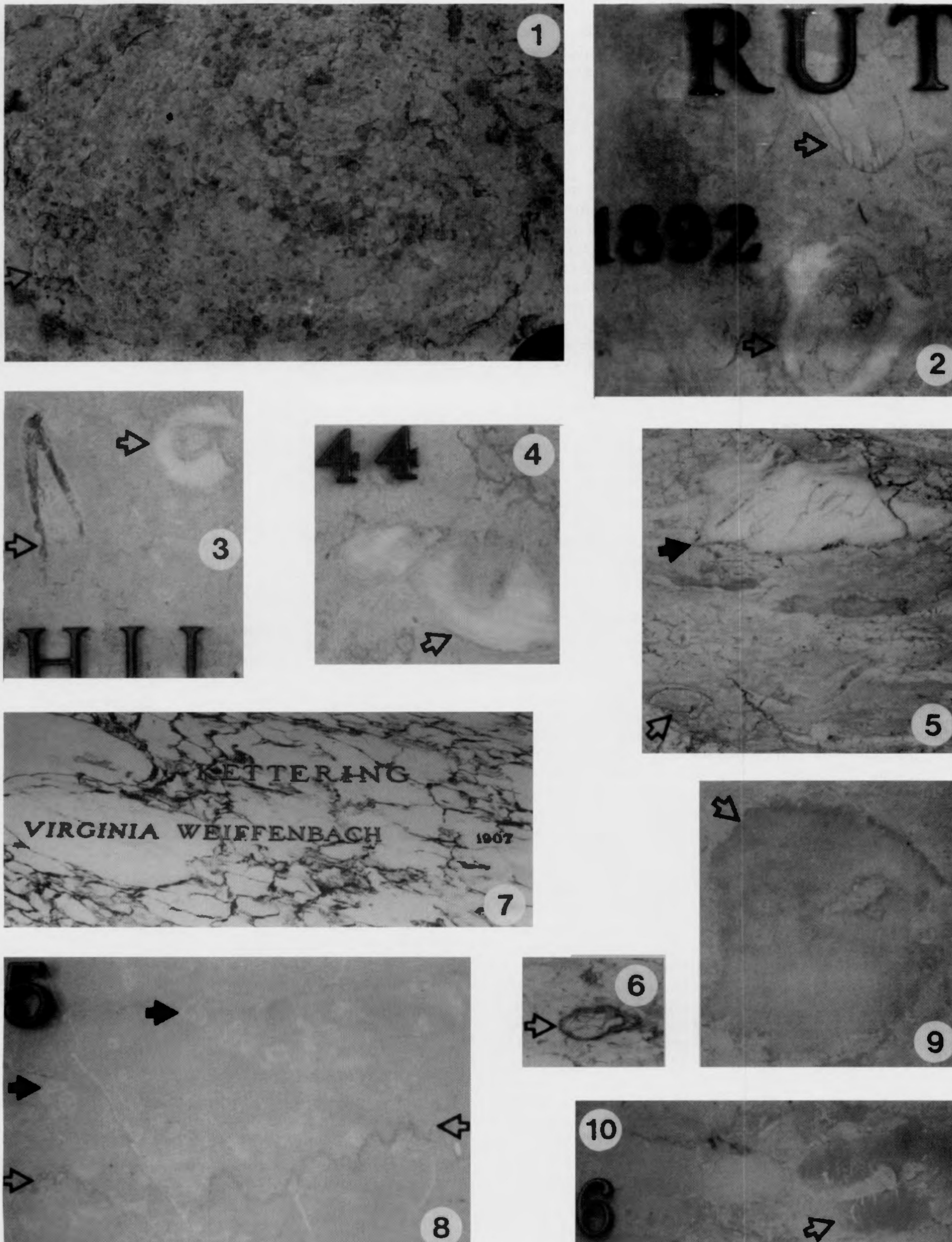
6.6. Detail of *French Escalope* showing brachiopod (arrow). Width of field of view approximately 35 mm (1.4 inches).

6.7. Detail of *Pavonazzo White*, a white marble with green streaks from Vermont, in Woodland Mausoleum. Stylolitic in places. Height of tallest letters 48 mm (1.9 inches).

6.8. Detail of *Botticino*, an Italian limestone, in Woodland Mausoleum, showing characteristic blebs (solid arrows) and a stylolite (open arrows). Height of number 25 mm (1 inch).

6.9. Detail of *Dolcetto Perlato*, a Sicilian limestone, in Woodland Mausoleum, showing coral colony (arrow). Height of field of view approximately 14 cm (5.6 inches).

6.10. Detail of *Dolcetto Perlato* showing sponge (arrow). Height of number 25 mm (1 inch).


1
RUT
1892
2
44
4
3
HIL
5
KETTERING
VIRGINIA WEIFFENBACH
1907
7
6
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8
10
6

teenth- and early twentieth-century structures. A good example of the use of Dayton limestone for walls is seen along Main Street in Dayton by the County Fairgrounds and Miami Valley Hospital. The Dayton limestone can be seen in the chapel (pl. 3.1-3.3), office, main entrance wall (fig. 1, 1; pl. 3.2), Waldo Street gatehouse (pl. 6.1), and old pump house (fig. 1, E) of Woodland Cemetery. It has also been used for bases for some of the older tablets in the cemetery.

Bownocker (1915, p. 26) commented that newly quarried Dayton stone is light gray with just a trace of blue which disappears on weathering. In buildings it is commonly light gray, with a characteristic mottled appearance due to the presence of trace fossils. Creatures burrowing through the once-unconsolidated sediment appear to have differentially affected the porosity of the sediment, resulting in preferential dolomitization along the burrow pathways (pl. 5.1). Fossil remains of brachiopods, corals (pl. 6.1), cephalopods, bryozoans, and crinoids have also been recorded (Foerste, 1935; Ausich, 1987).

John Locke (*in* Mather, 1838) recorded a section from a quarry 3 miles southeast of Dayton belonging to Colonel Partridge. This section may be from the disused quarry (now a lake) along Wilmington Pike, by Lakeview Apartments, which is approximately 3 miles southeast of downtown Dayton (fig. 8, locality 3). This disused quarry is probably the site of the Bosler/Harshman quarries of F. E. Weakley and others (*in* Beers, 1882b). It is interesting that Locke noted (*in* Mather, 1838, p. 227) he was accompanied on one visit to this quarry by "Mr. Vancleve." This person may have been the founder of Woodland Cemetery, John Whitten Van Cleve. Cranes with blocks, pulleys, and cables drawn by ox teams were used to extract the stone (Locke *in* Mather, 1838, p. 229). The quarried stone was transported to Dayton and then shipped on the canal. In 1838 the Miami Canal between Dayton and Cincinnati was operating; the northward route to Toledo and Lake Erie was not completed until 1845 (Carillon Park, undated). The Dayton limestone splits readily along bedding planes into thin, workable layers. Locke (*in* Mather, 1838) recorded the use of wedges to split the layers. Peppel (*in* Orton and Peppel, 1906, p. 213) commented that hand drills and wedges are the mainstay of the Ohio building-stone quarryman. The quarryman's drill consisted of a light steel bar approximately 6 feet (2 m) long sharpened at one end. The drill was raised vertically and then dropped. By turning the drill part of a revolution on the down stroke a hole was drilled. Typically a series of vertical holes perhaps 5 to 6 inches (15 cm) deep, spaced a few inches apart, were created. Wedges were driven in along bedding planes to split the upper slab of rock along the drilled holes. Evidence for the use of such drills can sometimes be seen in blocks of Dayton limestone. Such drill holes can be seen in blocks of Brassfield limestone used in the National Asylum Church at the Veterans' Administration, Dayton. Locke observed (*in* Mather, 1838, p. 228-229) large annular or hemispherical rings up to 9 inches (22.5 cm) in diameter, with a relief of 1 inch (2.5 cm), in the Dayton limestone; these rings were likely stromatoporoids (layered calcareous mounds with affinities to sponges). Locke (*in* Mather, 1838, p. 229) noted the presence of the Brassfield Formation below the Dayton: "Underneath the quarry is a softer, coarsely crystalline limestone, of a reddish drab color, sometimes variegated with blue." Foerste (1935) named a clay-rich sediment resting on top of the Brassfield in the Dayton area the Beavertown marl.

Three stone quarries were active in the City of Dayton in 1841 (R. C. Brown *in* Beers, 1882a, p. 594). In 1870, five firms were quarrying the Dayton limestone in the area (Bownocker, 1915, p. 28). According to Bownocker (1915, p. 29) the largest quarries were near the village of Beavertown (fig. 9, localities 4, 5, 6), in Van Buren Township. The following section was given of the Dayton Formation at Beavertown (Bownocker, 1915, p. 29):

Yellow stone of poor quality.	
Used for walls and foundations.	
Splits into 3 or 4 layers	1'-1' 4"
"Yellowback" course	9"- 13"
Six-inch course	6"
Twenty-inch course.	
Could usually be split into two layers	1' 8"
Four-inch course	4"
Twelve-inch course	1'
Clay, unmeasured	

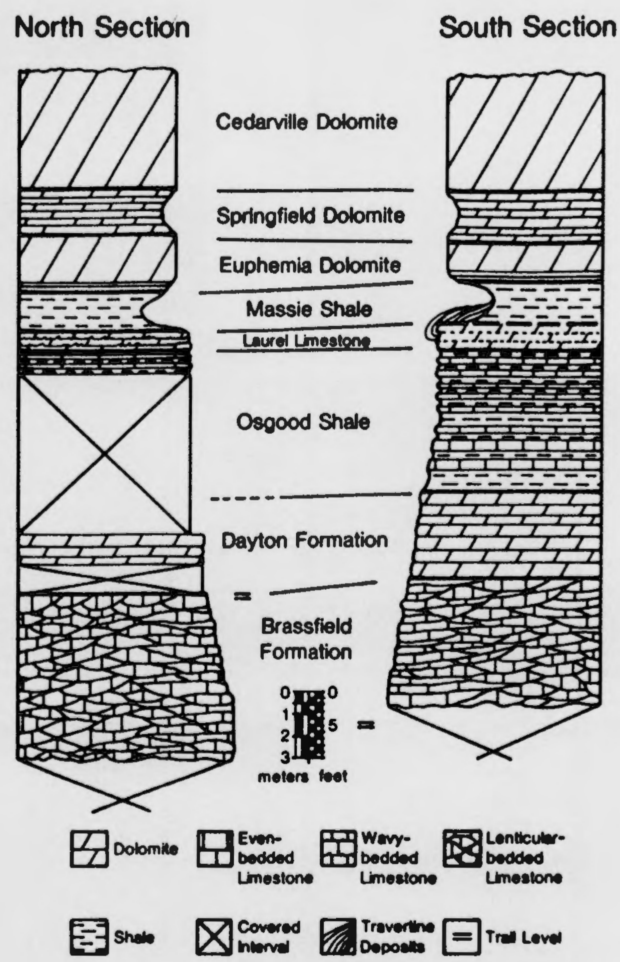

FIGURE 7.— Stratigraphic sections from the north and south sides of the Little Miami River at John Bryan State Park, Greene County, showing the relationships of the Lower Silurian rocks. (Modified from Kleffner and Ausich, 1988.)

The quarries in this area were abandoned by about 1903 (Bownocker, 1915); evidence for abandonment comes from a sketch map of Beavertown in the early 1900's (Benedict, 1976). The Beavertown quarries were located off present-day Wilmington Pike. Three quarries appear to have been in operation close to the intersection of Wilmington Pike and Dorothy Lane (Jane Bolka, Dayton Power and Light Company, personal communication; Benedict, 1976), northeast, northwest, and southwest of this intersection (fig. 9, localities, 4, 5, 6). Older residents in Beavertown remember the one to the northeast as a gravel pit (fig. 9, locality 5; Benedict, 1976)—possibly the Wead quarry (Weakley and others *in* Beers, 1882b)—and when disused, the one to the northwest was a pond (fig. 9, locality 4). The quarry to the southwest is turfed over and used as a training ground for police dogs on the west side of Rushland Drive (fig. 9, locality 6).

In the nineteenth century, Van Buren Township was more extensive than today. Most of the major Dayton limestone quarries of Montgomery County were located within the township. From an account of the stone quarries in Van Buren Township (Weakley and others *in* Beers, 1882b) there appear to have been a number of operations extracting the Dayton limestone: Dickey, Frybarger, Fauver, Wead, Bosler, Harshman (continued as Bosler), Huffman, and Jones quarries. Other stone quarries to the north, in Randolph and Wayne Townships, yielded building stone (E. Warner *in* Beers, 1882b; Henry Cuppy *in* Beers, 1882b).

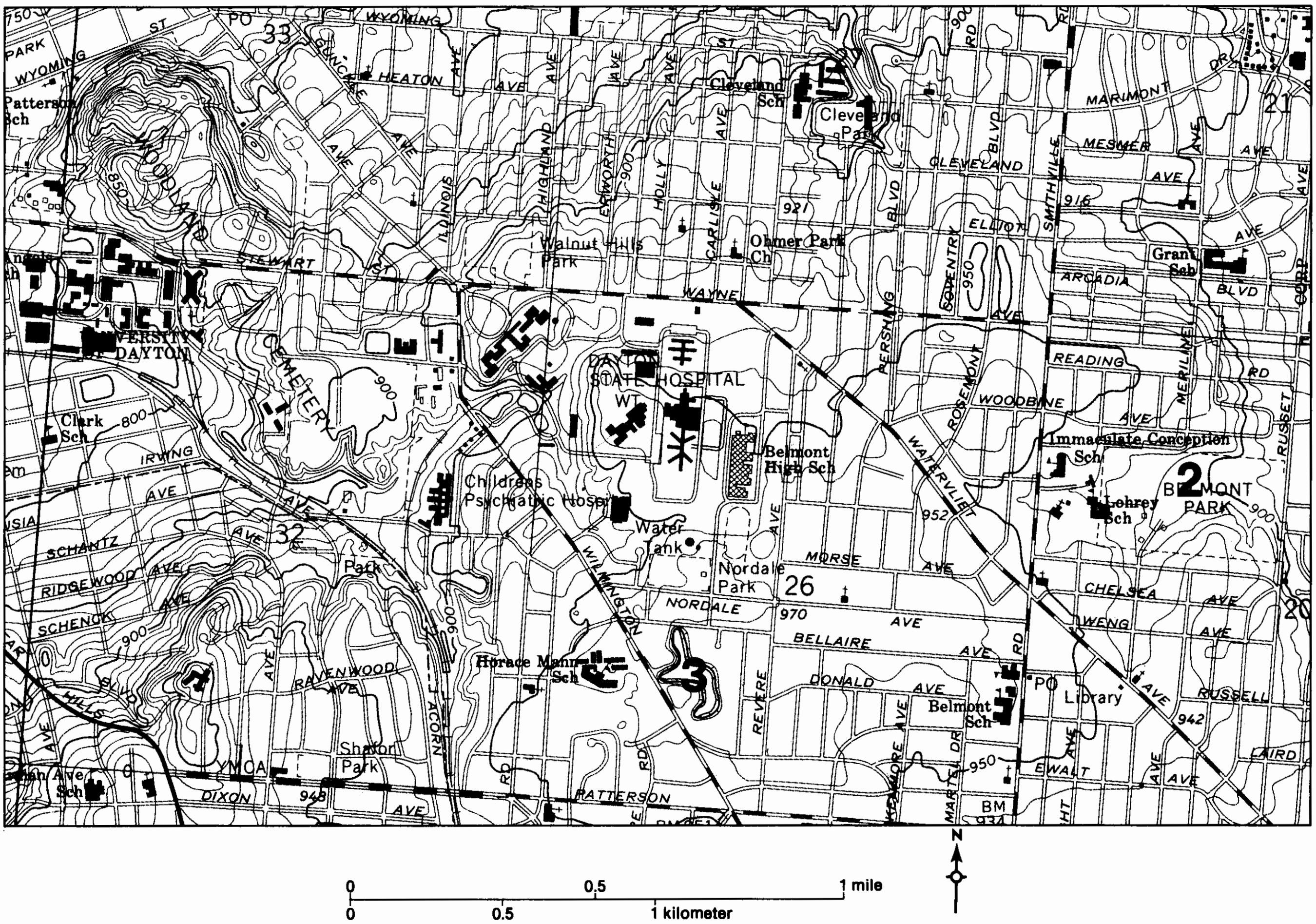

FIGURE 8.— Portion of the U.S. Geological Survey Dayton South 7.5-minute quadrangle map showing the location of former quarries in the Dayton Formation in the Dayton area. **1**, Cleveland Park, believed to be the site of at least one quarry (including possibly the Dickey quarry) referred to by Foerste (1915) as located along Smithville Road, northeast of the Ohmer Park Plat, Dayton. By 1915 both the railroad and the quarries were abandoned (Foerste, 1915). **2**, Belmont Park, may be the site of at least one quarry site, and is probably the site of the Jones (or Summit Spring) quarry. **3**, Flooded old quarry by Lakeview Apartments on Wilmington Pike. This may well be the quarry that Locke (*in* Mather, 1838) records 3 miles southeast of Dayton belonging to Colonel J. Partridge. Contour interval is 10 feet (3.5 m).

The Booher quarry in Wayne Township provided Dayton limestone for the Cathedral of St. Peter in Chains, Cincinnati (Cuppy *in* Beers, 1882b). Enlargement of the Cathedral in the 1950's resulted in the reopening of the Centerville quarry, in Washington Township (see below) to obtain new supplies of Dayton limestone (see Hannibal and Davis, 1992 for further information). The quarries of Wayne Township also produced lime (Cuppy *in* Beers, 1882b).

A railroad served quarries in the Dayton limestone along Smithville Road northeast of the Ohmer Park Plat (Foerste, 1915). By 1915 both the railroad and the quarries were abandoned. The site of at least one of these quarries is thought to be the area now known as Cleveland Park (fig. 8, locality 1). Cleveland Park may well be the site of the Dickey quarry, the first quarry to open in Van Buren Township (Weakley and others *in* Beers, 1882b). The Dickey quarry had an area of about 20 acres (Weakley and others *in* Beers, 1882b). Belmont Park (fig. 8, locality 2) may be the site of at least one quarry along Smithville Road that Foerste recorded. This park is probably the site of the Jones (or Summit Spring) quarry, "lying on the dividing ridge between the two Miamis," (Weakley and others *in* Beers, 1882b). At one time it had a working face of 1,500 feet (460 m) (Weakley and others *in* Beers, 1882b). Both Cleveland and Belmont Parks have steep grassy banks and flat bottoms, suggestive of former quarry sites. Belmont Park is known to be the site of a landfill (Peggy Burris, Superintendent of Recreation and Parks, City of Dayton, personal

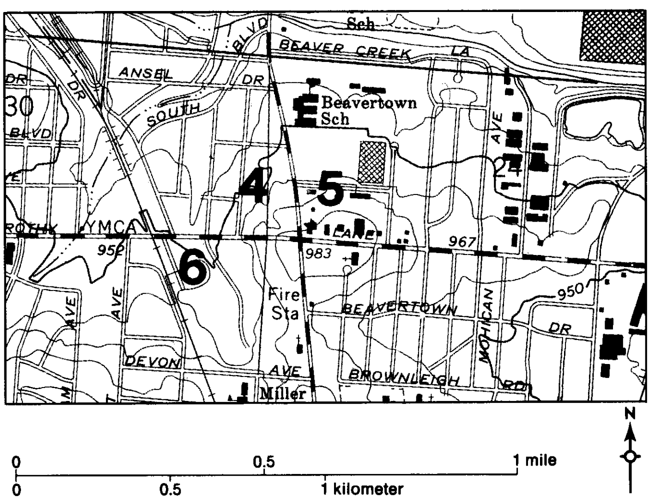

FIGURE 9.— Portion of the U.S. Geological Survey Dayton South 7.5-minute quadrangle map showing the location of the former Beavertown quarries (4, 5, 6) in the Dayton Formation. No. 5 is the probable site of the Wead quarry of Weakley and others (*in* Beers, 1882b). No. 6 on Rushland Drive is now the site of a police dog training area and is the most readily identifiable of the Beavertown quarries as a former quarry. Contour interval is 10 feet (3.5 m).

communication), a classic "use" for a disused quarry. Other quarries have extracted the Dayton limestone to the east of Dayton, in Greene County (Bownocker, 1915).

Another quarry was located to the south in Centerville, Washington Township (Bownocker, 1915, p. 27) (fig. 10, locality 7). From this quarry Dayton and Brassfield Formation limestones were extracted. The quarry opened in the early days of the county (Montgomery County was founded in 1803), but was not worked regularly until about 1860 and was abandoned soon after until around 1880. In the early 1880's the quarry was owned by John E. Allen (Joseph Nutt *in* Beers, 1882b) and was still active around 1915 (Bownocker 1915, p. 28). The now disused quarry is filled with water and used by a fishing club. It is in this quarry that Foerste (1935) named the Centerville Formation at the base of the local Silurian section, beneath the Brassfield Formation. In addition, Bownocker (1915, p. 28) recorded two other abandoned Dayton limestone quarries at Centerville, one abandoned around the beginning of the Civil War, the other apparently opened in 1870, closing in 1907.

Foerste (1915, p. 55) referred to an abandoned quarry at the Soldiers' Home (now the Veterans' Administration) on the west side of Dayton. The Brassfield Formation was formerly quarried here. Gobrecht (1875, p. 94) recorded a stone quarry "Containing an almost inexhaustible supply of stone, which has been used and is still largely used in the construction-work of the Home." It was from this quarry that Foerste, still in high school, collected fossils in his youth (Bassler, 1937). Bownocker (1915, p. 25) recorded two quarries on the grounds of the Soldiers' Home, one near the grotto, the other in the deer park, commenting that they appear to have been the largest quarries in the Clinton limestone (now correctly referred to as the Brassfield Formation). Brassfield limestone can generally be distinguished from Dayton limestone by its coarse crystalline texture of white calcite (2-5 mm across) and tan-yellow dolomite (1 mm across). Fossils such as crinoid ossicles, horn corals, colonial corals, stromatoporoids, and trilobites are common in the Brassfield. In the Dayton area the Brassfield Formation is a dolomitic limestone. To the south, the dolomite content of the Brassfield increases towards east-central Kentucky (Gordon and Ettensohn, 1984). The Brassfield limestone does not appear to have been very suitable as a building stone, as it weathers to a gray color and "the general effect is not very attractive," according to Bownocker (1915, p. 25). Consequently, the Brassfield has been little used and is not very common as a building stone in Dayton. However, Brassfield limestone can be seen in the walls of the National Asylum Church, built in 1868; the buttresses and windowsills are of Dayton limestone. Brassfield (as well as Dayton) limestone has been used in Beavertown Cemetery, presumably because of the proximity of a source of this stone (the Beavertown quarries). Foerste (1915) noted that the Brassfield limestone was still being used in 1915 for pike construction in Montgomery and adjacent counties. However, the lower part of the Brassfield, low in dolomite (and thus magnesium content) and suitable for cement manufacture, is quarried today in the large Southwestern Portland Cement Co. quarries at Fairborn, east of Dayton. This operation represents the largest complex of workings in the Brassfield in the Dayton area.

Although the Dayton Formation is no longer quarried in Dayton or vicinity as a building stone, many examples of its use can be seen here, especially in the foundations of older buildings. The Old Courthouse (completed in 1850) in Courthouse Square, Dayton, is acknowledged as one of the finest examples of Greek Revival architecture in the United States. Its exterior is constructed of Dayton Formation limestone (not granite as stated by Frame, 1977), quarried from the Dickey and Frybarger quarries in northern Van Buren Township (Weakley and others *in* Beers, 1882b). The Old Courthouse is home of the Montgomery County Historical Society. The Cathedral of St. Peter in Chains, Cincinnati, is another impressive structure built mainly from Dayton limestone.

Because of the plunge to the north of the broad fold in the bedrock known as the Cincinnati Arch the Paleozoic bedrock is younger to the north, west, and east of Dayton. Quarries in the younger Silurian Springfield Dolomite and Cedarville Dolomite (fig. 7) were located a few miles from Dayton (Bownocker, 1915; Foerste, 1915). There are still a few active quarries in these formations (Weisgarber, 1991).

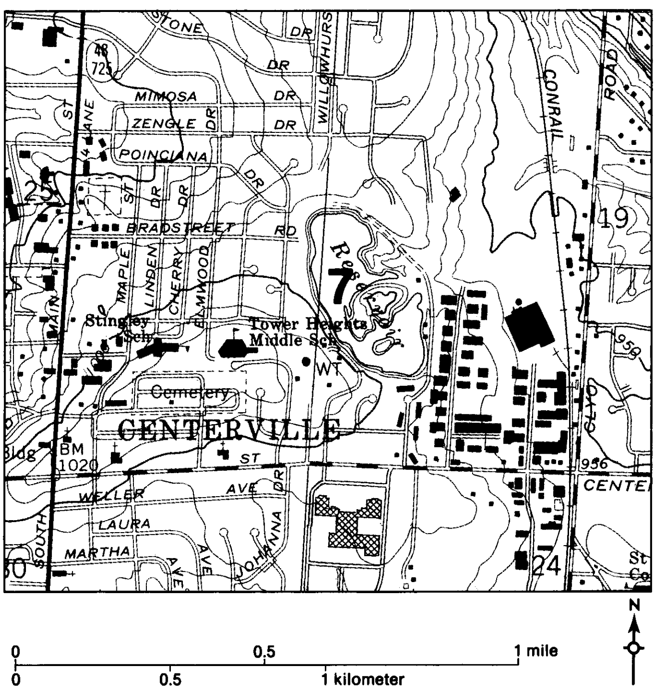

FIGURE 10.— Portion of the U.S. Geological Survey Dayton South 7.5-minute quadrangle map showing the location of former quarry (now flooded) in the Dayton Formation in Centerville. From this quarry Dayton and Brassfield Formation limestones were extracted (Bownocker, 1915, p. 27). It is the type locality of the Centerville Formation named by Foerste (1935). Contour interval is 10 feet (3.5 m).

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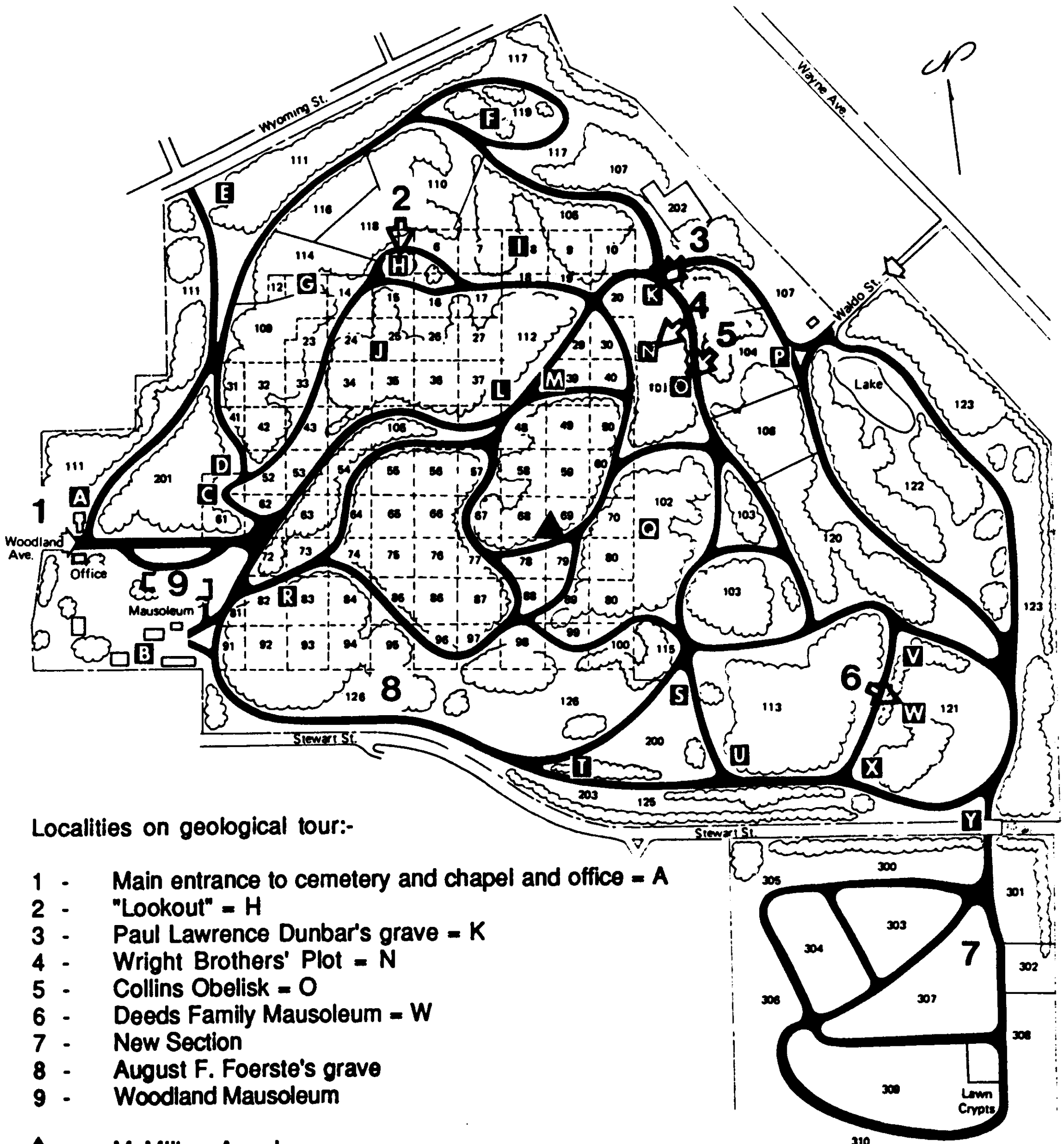

Localities on geological tour:-

1 - Main entrance to cemetery and chapel and office = A
2 - "Lookout" = H
3 - Paul Lawrence Dunbar's grave = K
4 - Wright Brothers' Plot = N
5 - Collins Obelisk = O
6 - Deeds Family Mausoleum = W
7 - New Section
8 - August F. Foerste's grave
9 - Woodland Mausoleum

▲ - McMillen Angel

LANDMARKS AND POINTS OF INTEREST

- A OLD CHAPEL
- B SERVICE BUILDINGS
- C HUFFMAN FAMILY VAULT
- D VETERANS' PLOT
- E OLD PUMP HOUSE
- F STODDARD FAMILY PLOT
- G PATTERSON "KNOLL"
- H "LOOKOUT"
- I VAN CLEVE FAMILY PLOT
- J VALLANDIGHAM PLOT
- K PAUL LAURENCE DUNBAR
- L COTTERILL FAMILY MAUSOLEUM
- M LOWES FAMILY MAUSOLEUM
- N WRIGHT BROTHERS PLOT
- O COLLINS OBELISK
- P DRINKING FOUNTAIN
- Q STANLEY FAMILY PLOT
- R "DOG AND THE BOY"
- S McMILLAN FAMILY MAUSOLEUM
- T GREEK ALTAR
- U PRICE FAMILY MAUSOLEUM
- V DYE FAMILY MAUSOLEUM
- W DEEDS FAMILY MAUSOLEUM
- X HARTMAN FAMILY MAUSOLEUM
- Y UNDERPASS

MAP OF WOODLAND CEMETERY AND ARBORETUM IN DAYTON, OHIO, SHOWING LOCALITY NUMBERS 1-9 FOR GEOLOGICAL TOUR AND LOCATION OF McMILLAN ANGEL. OTHER LANDMARKS AND POINTS OF INTEREST ARE SHOWN AS LETTERS A-Y. SMALL NUMBERS ARE SECTION NUMBERS OF THE CEMETERY. MAP COURTESY OF WOODLAND CEMETERY ASSOCIATION.