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DEPARTMENT OF NATURAL RESOURCES

MARYLAND GEOLOGICAL SURVEY
Emery T. Cleaves, Director

Educational Series No. 10

A GEOLOGIC WALKING TOUR OF BUILDING STONES OF DOWNTOWN BALTIMORE, MARYLAND

by
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with contributions and photography by the
Environmental Geology and Mineral Resources Program
of the Maryland Geological Survey

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STATE OF MARYLAND

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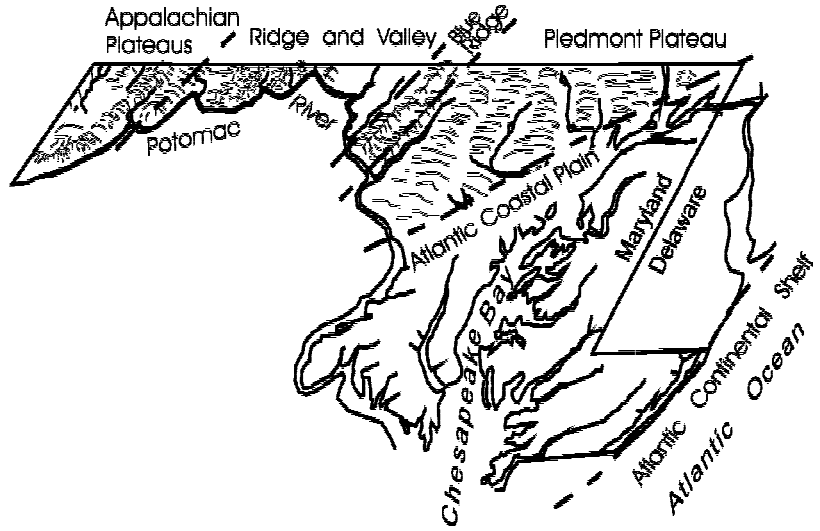
INTRODUCTION

A rock is formed naturally on or inside the earth and is made up of one or more minerals. It is called a building stone once the rock is used in construction. Rocks are divided into three major groups—sedimentary, igneous and metamorphic—on the basis of how the rock formed. Sedimentary rocks are formed from sediments, such as gravel, sand, clay, or organic material, that have become cemented together naturally. Igneous rocks are formed from magma, or molten rock, as it cools and solidifies either deep inside the earth or on the surface when it is extruded as lava from volcanoes. Metamorphic rocks are formed when heat and/or pressure change or rearrange the composition of sedimentary, igneous or other metamorphic rocks. Metamorphic rocks often contain unique metamorphic minerals which help characterize these rocks.

A great variety and quality of native building stones used in Baltimore come from the geologic part of Maryland known as the Piedmont Plateau Province (Map 1). Roughly the western half of the City of Baltimore lies in the Piedmont Plateau Province. Ranging in age from about 200 million to 1.1 billion years old, Piedmont rocks consist of granite, gneiss (pronounced “nice”), slate, marble, quartzite, and other rocks. Most of these rocks are igneous or metamorphic in origin, but a few rocks have a sedimentary source. The majority are hard, durable, attractive, and polish well, making good building stones.

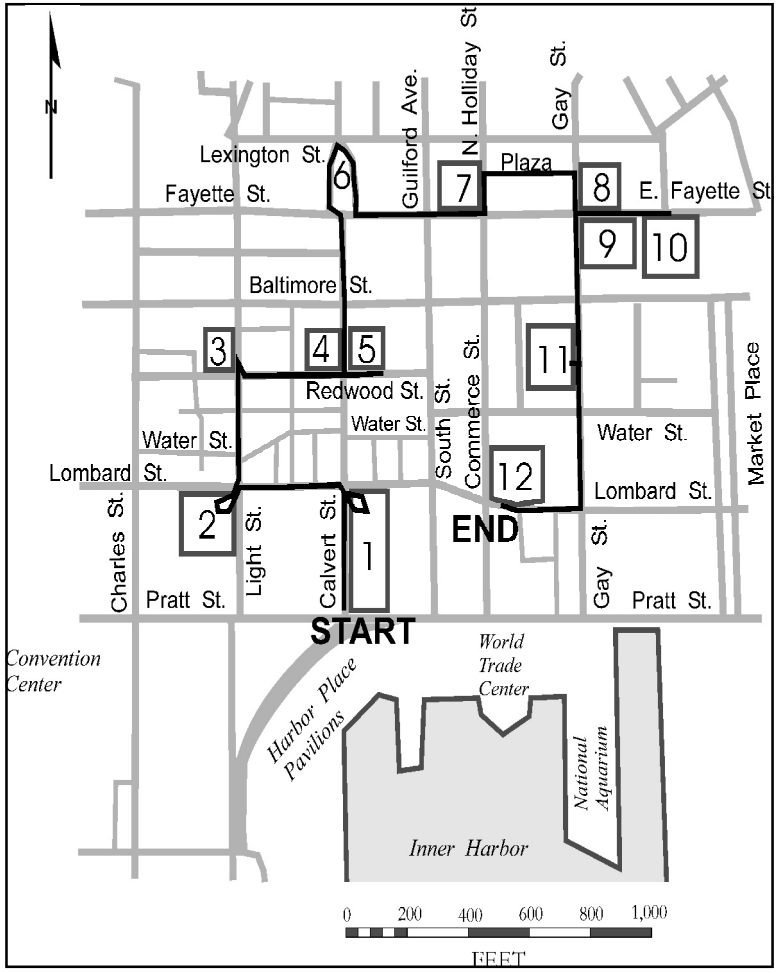


Map 1. Maryland’s physiographic provinces.

Although some of the building stones observed on this tour were extracted from quarries in Maryland, most of the stones are not native to Maryland. An

assortment of rock types was selected for this tour of downtown Baltimore, however, there are many more types of building stones located around the city which can be explored.

Map 2 shows the route of the walking tour. The route was selected to illustrate a variety of building stones in a small geographic area near downtown hotels. Some additional examples of the building stones that are described in this booklet, are present in buildings along the route between Stops, but are not specifically mentioned in the text for sake of brevity. After a while, the observer will be able to recognize some of the more common building stones (e.g., Indiana Limestone). The complete tour should take less than two hours, but you can tailor it to your needs.



Map 2. Route of the walking tour in downtown Baltimore. *(See Stop List on page 1.)*

STOP 1: THE GALLERY
200 East Pratt Street

Figure 1a. The Gallery entrance (Stop 1).

The Gallery (Figure 1a) is a shopping area located across the street from the Inner Harbor. The Gallery shopping area has interior floor tiles made of limestone, a sedimentary rock (Figure 1b).

Figure 1b. Fossiliferous limestone tiles on the lobby floor (Stop 1).

The tan limestone is from central France. The limestone formed from sediments and shells deposited in shallow, clear seawater millions of years ago. As layers of sediment slowly built up over time, the burial pressure and natural chemical cements changed the sediments into solid rock. The marine fossils present and the fine grain size of the material surrounding the fossils reflect the environment of deposition. Not all of these fossils are easily recognized because of the way the stone was cut. Most fossils have been sectioned at various angles between horizontal and vertical. The small, black tiles on the floor (Figure 1b) are also limestone. This limestone came from Spain.

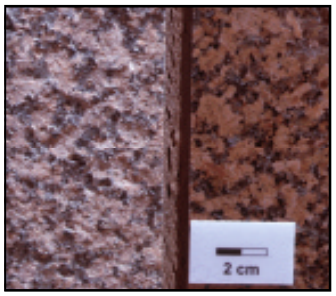


Figure 1c. Granite on the outside wall of The Gallery. Rough "flamed" texture left; polished surface right (Stop 1).

Exit The Gallery, turn right and walk north along Calvert Street, where a polished red granite covers the exterior walls of The Gallery (Figure 1c). This red granite is from Taivassalo, Finland, and is of Precambrian age, more than 544 million years old. Granite is an igneous rock formed by the cooling of molten magma. The slower the magma cools, the larger the crystals, and conversely, the faster it cools, the smaller the crystals. The large crystal size indicates that this granite formed deep inside the earth where cooling took place slowly. The two minerals essential to

any granite are feldspar and quartz, but mica is another mineral often present. The feldspar crystals in this rock are pink to red in color. Feldspar minerals are the most abundant mineral group in the earth's crust. The smoky colored mineral is quartz, the second most common mineral found in rocks. The black mineral is biotite, a type of mica. One distinct property of micas is that they split into fine sheets or layers along cleavage surfaces similar to pages of a book.

Further along the building wall, about half way along the block, there is a section of the granite which has a smooth, polished finish adjacent to one with a rough texture, or "flamed" finish (Figure 1c). A "flamed" finish is caused by exposing the surface of the rock to the heat of a torch. The differential temperature causes rapid expansion and flaking of surface fragments. Different finishes provide variety in the texture and appearance of the same stone.

Continue walking north along Calvert Street. At the corner of this block, within the same office-shopping complex, look to the right at the interior of 111 South Calvert Street. The same pink to red granite from Finland is used in the lobby floor along with inlaid strips of South Dakota gneiss. The gneiss formed during the same Precambrian Era as the granite. This is a good opportunity to compare the igneous granite with the gneiss, which is a metamorphic rock. The granite has conspicuous crystals of the quartz, feldspar, and mica, scattered throughout. In the gneiss, the same components tend to occur in alternating irregular bands of lighter minerals and darker, generally elongate, minerals that were recrystallized under tremendous pressure (Figure 1d).

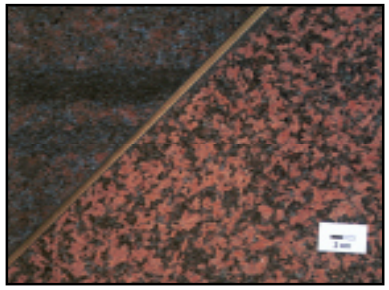


Figure 1d. Pink granite (lower right) and gneiss (upper left) on the lobby floor of 111 South Calvert Street (Stop 1).

STOP 2: LEGG MASON TOWER
100 Light Street

From the corner of Calvert and Lombard Streets, walk west (left) along Lombard Street for one block to Light Street. The Legg Mason Tower is on the west side of Light Street.

Two types of stone are the focus of this stop: granite and travertine. The exterior plaza and the low perimeter railings that surround the plaza are made of pink granite, with a flamed finish. Notice also that the pillars and upper exterior of the building is faced with the same granite (Figure 2a). Observe the color and crystal size of each mineral.

Figure 2a. Precambrian pink granite on the exterior plaza and portions of the Legg Mason Tower (Stop 2).

The granite, quarried in Alicante, Spain, was formed during the Precambrian Era over 544 million years ago. This area of Spain has 20 to 30 quarries and is known for the great variety of pink granites (as well as red and black marbles typically used in building interiors) (source: Hilgartner Natural Stone Company). It is possible for two different-colored granites to come from the same quarry or nearby quarries. The difference in color can be because of changes in the relative amounts of each mineral present in the rock.

The color of a mineral, however, is not always constant. Many minerals, such as quartz and feldspar, vary in color. The different colors can be due to variations in a mineral's chemistry, defects in crystal structure, or the presence of an impurity. For example, iron oxide can be an impurity that gives a reddish color to many minerals including some feldspars and calcite.

Figure 2b. Travertine on the exterior walls (plaza level) of the Legg-Mason Tower (Stop 2).

The two exterior side walls of the building (at plaza level) are faced with the second stone of interest: travertine, a sedimentary rock (Figure 2b). Travertine is a type of freshwater limestone. It is composed of the minerals calcite or aragonite (two forms of calcium carbonate) which formed in warm or hot springs, rivers, lakes or caves, by the precipitation of these dissolved minerals out of solution. This means that the stone is made of minerals that were deposited (crystallized) when the characteristics of the water changed, often because of evaporation or agitation of the water and often in combination with organic growth (commonly algae or bacteria). Stalactites and stalagmites are types of travertine formed in caves.

Italy is a well-known source of travertine. Travertine near Tivoli, Italy, (slightly east of Rome) formed in ponds and lakes associated with warm springs. These deposits of travertine are extensive and have been quarried since Roman times for use as building and ornamental stone in many structures, including parts of the Roman Colosseum (Folk, and others, 1985). Some warm springs are active in the same region today, and travertine is still being deposited.

The travertine at the Legg Mason Tower originated in the Middle East (source: Hilgartner Natural Stone Company). As each layer of calcium carbonate covers the previous layer, the rock may take on a banded or layered appearance. Layers may be thin and flat or rounded. Travertine is typically white, tan and/or cream in color. The reddish brown color of the travertine at the Legg Mason Tower is likely to be due to the presence of some iron oxide in the limestone. Some of the darker bands and irregular voids appear to be related to plant-influenced precipitation, perhaps once incrusting algal or bacterial colonies. White rectangular fragments appear to be deposits that were broken and moved before the sediments were completely hardened into rock.

Limestones can be vulnerable to weathering particularly from acids in rain and the air which over time can gradually dissolve, discolor or disintegrate the stone. The travertine at the Legg Mason Tower has a protective coating to help protect the finish from such weathering (source: Hilgartner Natural Stone Company).

STOP 3: BANK OF AMERICA BUILDING
10 Light Street

Walk north on the west (left) side of Light Street and continue across Redwood Street. The Bank of America Building, on the northwest corner of Light and Redwood Streets, shows an outstanding example of Indiana Limestone. This stone, which is quarried in central Indiana, is called Indiana Limestone in the quarrying and building trade, but is known as Salem Limestone by geologists. Indiana Limestone formed over 300 million years ago during the Mississippian geological time period.

Figure 3. Indiana Limestone (also known as Salem Limestone) on the exterior of the Bank of America building.

Indiana Limestone is a sedimentary rock formed by the cementation of broken shells and hard skeletal fragments of ancient marine organisms (Figure 3). Notice that some of the smaller fragments appear to have "weathered" away leaving behind the larger fossils. The cementing material also appears to have weathered faster, owing to its lesser durability.

This limestone is a popular building stone with high durability and ease of cutting and etching. Indiana Limestone was used in the National Cathedral and the U.S. Holocaust Memorial Museum in Washington D.C. More examples of Indiana Limestone can be seen in this walking tour at Stops 7 and 8.

STOP 4: 120 EAST REDWOOD STREET BUILDING

From the corner of Light and Redwood Streets walk east to the building at 120 East Redwood Street, Stop 4 (currently the location of Metropolitan Health and Fitness). The stone on the exterior of the building is a fine-grained granite. The smaller crystals indicate a faster cooling rate than in the other granites observed previously. This granite has two contrasting finishes: a smoother finish from a multiple point chisel and a rougher finish from a single point chisel (these finishes are referred to in the building-stone trade as a "flat 6 or 8 cut bush hammered finish" and a "rough point finish with a margin draft," respectively) (Figure 4a).

Figure 4. Fine-grained granite showing two contrasting finishes: a smoother "bush hammered finish" (left) and a "rough point finish" (right); weathering of granite also shown at the corner of the smoother block (Stop 4).

Notice that along the base of the vertical rock panels below the window sills, the stone is spalling, or peeling away (see also Figure 4a). This may be due to physical disintegration by frost action, in which water in fractures in the rock freezes, expands, and wedges the rock apart, or to chemical decomposition in which the minerals in the rock react with atmospheric oxygen and moisture to alter the composition of the rock. Both of these processes may actually be taking place simultaneously; collectively they are termed "weathering."

STOP 5: MERCANTILE TRUST & DEPOSIT COMPANY BUILDING
222 Redwood Street

Continue walking east along Redwood Street, crossing Calvert Street, to Stop 5. This dark red brick building, located at the northeast corner of Calvert and Redwood Streets, was constructed in 1885-1886 (Figure 5a).

Figure 5a. Front of the Mercantile Trust & Deposit Company building (Stop 5).

The building has extensive trim made of "Seneca Red" sandstone. The sandstone is of Late Triassic age, about 210 to 230 million years old, and was quarried in either Montgomery or Frederick County, Maryland. This is the first sandstone encountered on the tour (Figure 5b). It is a sedimentary rock formed by the cementation of sand-sized grains of quartz (silica). Sandstones can usually be recognized by their "sandpaper feel." The chief minerals in this rock are quartz, feldspar (microcline and plagioclase), and white mica (muscovite). The red color is largely due to iron oxide in the rock, mainly in the cementing material.

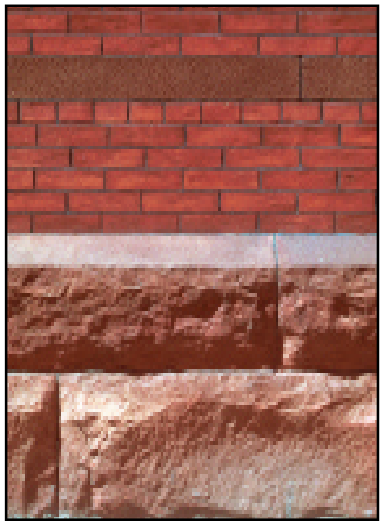


Figure 5b. "Seneca Red" sandstone in a textured layer between red bricks and as basal blocks of the Mercantile Trust & Deposit Company building (Stop 5).

Since construction of the Mercantile Trust & Deposit Company building, however, weathering has had an effect on the building stone. Weathering is obvious on the stairs where spalling (flaking) is occurring.

An interesting architectural design for the time was the placement of "spy steps" (Dorsey and Dilts, 1981) in the front of the building. This would allow police officers to step up and peer into the bank while on patrol (Figure 5c). A brass ring at shoulder level was used to balance them on the step.

Figure 5c. A "Spy Step" (Stop 5).

Seneca sandstone was a popular building stone in Baltimore and Washington, D.C. due to its accessibility and ease of transport. The sandstone was also popular because it is easy to cut and carve for decorative stone when first quarried, but then hardens over time. Seneca Red sandstone was used in the building of the original Smithsonian Institution ("castle") building in Washington D.C. (constructed between 1848 and 1859) (Merrill and Matthews, 1989).

STOP 6: CALVERT STREET MONUMENTS
Battle of North Point Monument and Monument to Negro Heros of the United States
Calvert and Fayette Streets

Figure 6a. Battle of North Point Monument in Calvert Street (Stop 6).

From the corner of Redwood and Calvert Streets, walk north on Calvert Street for two blocks to Fayette Street. Calvert Street is divided here and Stop 6 is on the "island" in mid-street (Figure 6a).

The stone wall (Figure 6b) around the Battle of North Point Monument is Cockeysville Marble, a building stone quarried in Baltimore County, Maryland. The Cockeysville Marble is a metamorphic rock of Precambrian age, about 600 million years old. Originally a limestone, it was transformed by heat and pressure into marble. The term meta-limestone also describes this marble, meaning that it was a limestone changed by metamorphism. The main minerals in marble are calcite ($CaCO_3$) (just as in limestone) and dolomite [$CaMg(CO_3)_2$]. Fossils have not been found in this marble, however, if there had been any fossils in the original limestone, it is likely that metamorphism would have destroyed them. Crystal size ranges from fine grained to coarse and sugary.

Figure 6b. Close-up of Cockeysville Marble used in the low stone wall surrounding the Battle of North Point Monument (Stop 6).

Cockeysville marble is mainly white although some layers can be gray or pink. Where the building stone surfaces are kept cleaned and polished the marble generally remains white; where dust accumulates or impurities in the stone weather, the marble may become a dove-colored gray. Like limestones, however, marbles can occur in a wide array of colors.

Cockeysville Marble was used in building the United States Capitol, the majority of the Washington Monument in Washington, D.C., and the Washington Monument in Baltimore, located a few blocks north of the Inner Harbor area. Cockeysville Marble has also been used to form door steps and sills in residential Baltimore.

Walk around to the north side of the monument and into the small park. The benches and walls in this area are made up of a Georgia gneiss (building stone trade name "Tidal Gray Granite") which was quarried near Elberton, Georgia (source: Maryland Stone Service) (Figure 6c). This is a metamorphic rock with obvious foliation, which is a banding or layering of minerals. The dark minerals in this gneiss are biotite mica and hornblende; the light minerals are feldspar and quartz. The parent or original rock was probably an igneous rock, such as a granite. The original rock was metamorphosed (changed) during an orogeny (mountain-building event) when the resulting heat and pressure caused partial melting and segregation of the minerals. The banded appearance developed when minerals grouped on the basis of different densities.

Figure 6c. Wall of Georgia gneiss in small park north of the Battle of North Point Monument (Stop 6).

Figure 6d. Monument to Negro Heroes of the United States (Stop 6).

Notice the bench on the east side that has been repaired with a granite slab. This provides an excellent comparison of the two classes of rock: igneous (the granite) and metamorphic (the gneiss).

Another type of stone seen at the north end of the park forms the base of the Monument to Negro Heroes of the United States (Figure 6d). This is a dark gray, fine-grained granite (Figure 6e) from Canada.

Figure 6e. Dark gray granite on the pedestal of the monument (Stop 6).

The color is due to the glassy, gray grains of quartz mixed with the white feldspar and a scattering of very small crystals of black biotite mica.

Figure 7. City Hall, faced with Cockeysville Marble (Stop 7).

STOP 7: CITY HALL AND VICINITY
100 North Holliday Street

Return to Fayette Street, turn left and head east. After crossing Guilford Avenue on the approach to City Hall, notice that the sidewalk contains slabs of a dark sandstone, probably the Catskill Sandstone from the Susquehanna River Valley of Pennsylvania or New York. This rock can easily be mistaken for slate because of its characteristic breaking along flat parallel surfaces.

City Hall (Figure 7) is faced with Cockeysville Marble from the Beaver Dam Quarry in Baltimore County. The facing covers brick walls that are 5½ feet thick. This is the same type of building stone seen at the Battle Monument (Stop 6).

Walk east towards the tree-lined War Memorial Plaza. As you walk down the steps, it's worth stopping at the large stone to observe the Indiana Limestone. This is the same stone that was seen at the Bank of America building (Stop 3).

Figure 8a. One of two horse statues made of Indiana Limestone (Stop 8).

STOP 8: WAR MEMORIAL BUILDING SCULPTURES
101 North Gay Street

Walk east through the War Memorial Plaza and cross Gay Street. At the north and south corners the War Memorial Building there are two large horse statues (Figure 8a).

The base of the statue at the corner of Gay and Fayette Streets contains fossils not often visible in other construction using limestone. The longer wormy-looking fossils are not the fossilized worms themselves, but trace fossils which are evidence of an organism (in this case a worm) that once passed through the rock when it was soft sediment. These marine worms

Figure 8b. A typical worm burrow in the Indiana Limestone (Stop 8).

Figure 8c. A burrow resembling one produced by modern "Callianasa," a burrowing shrimp, in the Indiana Limestone (Stop 8); (Fayette Street side of the base of the south statue at the War Memorial Building).

ingested sediment through their digestive system. As the worms burrowed, they removed whatever nutrition was in the material and excreted the rest. The excreted material changed the chemical composition of the soft limey muds such that the path was fossilized, and is commonly called a worm burrow (Figures 8b).

Many other creatures, including molluscs and shrimp, burrow into the sediment for food or shelter. Later when a burrow is filled in with a sediment of contrasting texture, the burrow may be preserved as a trace fossil (Figure 8c).

STOP 9: DISTRICT COURT BUILDING
501 East Fayette Street

Cross Fayette Street, turn left and walk east along Fayette to the District Court Building. Observe the nearly black stone at the base of the District Court Building. It was quarried in Minnesota and is Precambrian in age (Figure 9). Its commercial trade name is "Veined Ebony Black Granite." This is not a true granite, but rather an anorthosite, composed mostly of long, lath-shaped crystals of dark feldspar and some black biotite mica. The rock contains almost no quartz (a significant component of granite). Anorthosites range in color from light gray to black. Often anorthosite is largely composed of a particular feldspar mineral called labradorite, which is commonly dark blue, green,

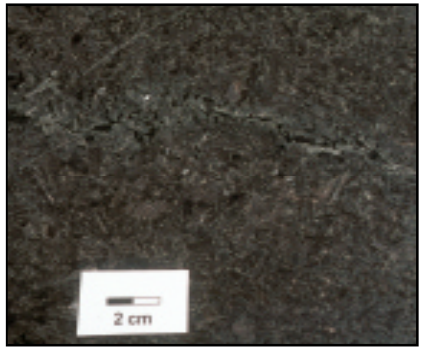


Figure 9. Anorthosite, a Precambrian-aged building stone from Minnesota, along the base of the District Court Building (Stop 9).

gray or brown, with an iridescence (frequently vivid blues or greens). At the District Court Building the feldspar crystals are mainly dark greenish-gray, dark blueish-gray and nearly black. Notice the different shapes and sizes of the minerals compared to other rocks seen previously. The large crystal size indicates that this anorthosite, like granites seen earlier in this tour, formed deep inside the earth where cooling took place slowly.

The rounded columns at the entry to 501 Fayette Street are also anorthosite. There is a red granite trim around the metal doors.

Figure 10a. Polished "Rainbow Gneiss" on the west wall of the City of Baltimore Police Headquarters (Stop 10); photo width corresponds to a distance of about 12 feet.

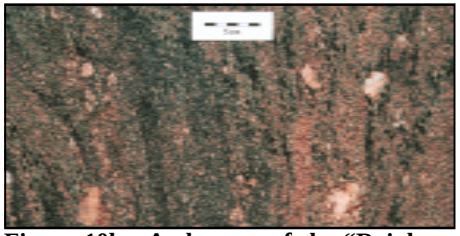


Figure 10b. A close-up of the "Rainbow Gneiss" showing the banding and color contrast of the metamorphic rock (Stop 10).

STOP 10: CITY OF BALTIMORE POLICE HEADQUARTERS
601 East Fayette Street

Continue walking east along Fayette Street to the Police Headquarters. This building and the pedestals for the flag poles are faced with "Rainbow Gneiss" (also known as Morton Gneiss) from Morton, Minnesota (Figures 10a and 10b).

This gneiss is about 3.6 billion years old, one of the oldest rocks in North America. The name is well suited for the contorted bands of black biotite mica, pink feldspar, and gray quartz. The polished finish highlights the grain and texture of this ancient and attractive Precambrian building stone.

STOP 11: PARKING GARAGE
Gay Street

Backtrack west on Fayette Street to Gay Street and turn south (left). Walk south on Gay Street continuing ½ -block past Baltimore Street. Notice the parking

garage on the west side of Gay Street. Can you guess the type of stone seen in this tan surface with the red base? This is a man-made "rock."

A close examination will show that it is an artificial rock called an aggregate. An aggregate is a collection of pebbles, mixed with cement to form a solid man-made rock (Figure 11).

Figure 11. Man-made aggregate at the parking garage on Gay Street (Stop 11).

STOP 12: LOMBARD STREET SCULPTURES
Lombard Street

Continue south on Gay Street past Water Street. Turn west (right) on East Lombard Street and walk about one block This last stop is at two stone sculptures on East Lombard Street just short of Commerce Street.

Figure 12a. Stone sculpture composed of light and dark gray Cambrian limestone from Tennessee (Stop 12).

The first stone sculpture (Figure 12a) is a light and dark gray limestone. The light gray portion is calcite and the dark material is dolomite (Figure 12b). As with many limestones, this rock was formed in shallow, quiet seawater and contains evidence of fossils, perhaps algal mats. The stone is Cambrian in age (about 550 million years old) and was quarried in Tennessee.

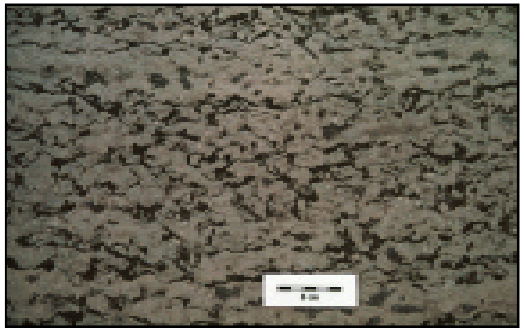


Figure 12b. Close-up of limestone sculpture in 12a, showing light gray calcite alternating with dark gray dolomite (Stop 12).

The other stone sculpture (Figures 12c and 12d) is a light gray and pink limestone also from Tennessee, but is Ordovician in age (about 470 million years old). This limestone contains irregular contacts called stylolites that

Figure 12c. Stone sculpture composed of gray and pink Ordovician limestone from Tennessee (Stop 12).

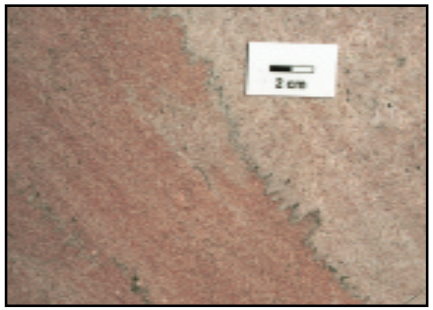


Figure 12d. Close-up of limestone in Figure 12c showing irregular contacts called stylolites (Stop 12).

probably formed by differential solution and compaction or "settling" when the sediments were still relatively soft. Stylolites resemble the pen markings on a seismograph or an EKG (electrocardiogram).

To return to Stop 1 from the corner of Lombard and Commerce Streets, turn south (left) onto Commerce Street and walk one block to Pratt Street. (The harbor is on the opposite side of Pratt Street.) Stop 1, The Gallery, is two blocks to the west (right) at the corner of Pratt and Calvert Streets.

We hope you have enjoyed this tour and learned to recognize some of the more common building stones in downtown Baltimore. You may recognize these same building stones in many other parts of the city. For additional information on the geology of Maryland, you are invited to contact the Earth Science Information Center of the Maryland Geological Survey at (410) 554-5500 or visit the Survey between 8:30 a.m. and 4:30 p.m., Monday through Friday at 2300 Saint Paul Street, about two miles north of downtown Baltimore.

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