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Ronald N. Young
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October 16, 1995

Ms. Sherry McCann
1324 Hazel Nut Court
Annapolis, MD 21401

Dear Sherry:

Enclosed please find draft #2 of the revised revision to your summary of the past summers work. After your review and that of those named at the bottom of this letter. I plan to go to press with a "preliminary" copy (sans photographs) to be distributed at the NSTA Regional Convention November 15-18. That being the case, I would hope to have your critical review and comments, as well as those by copy of this letter no later than November 1. A telephone call to 554-5525 is sufficient, or FAX at 554-5502.

See you at the convention! A bunch of us will be staffing the Minerals Education Coalition booth, so drop by and say hello.

Yours very truly,

Ken

Kenneth A. Schwarz, Chief
Earth Science Information Center

KAS:dab
Encl.
cc:Tom Doyle
Robert Ridky
Jim Reger
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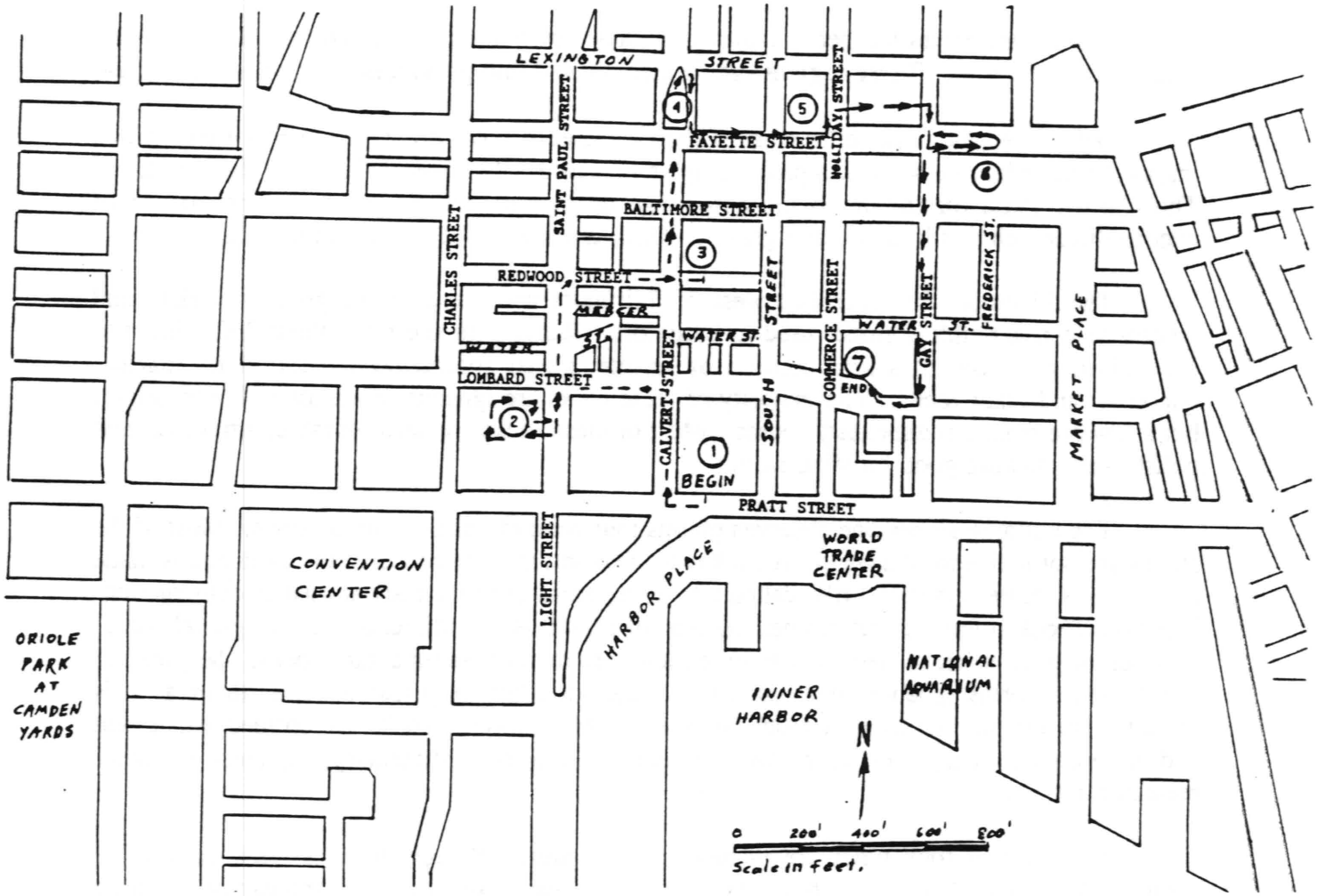
A GEOLOGIC WALKING TOUR OF BUILDING STONES OF DOWNTOWN BALTIMORE

FINAL DRAFT

by

Sherry McCann



It was a great experience working on this summer 1995 project, and with the wonderful people involved. I gratefully acknowledge the geologists with the Maryland Geological Survey: Mr. Kenneth Schwarz, Dr. James Reger, Dr. John Edwards, Dr. David Brezinski, and Dr. John Glaser. Thank you, Ms. Claire Richardson, for your many hours of conversation and guidance. Thanks, Dale Shelton and Dean Freeman for the many rides downtown; it would have been a long walk without you! Peggy McCabe, thank you for all the moral support. I owe a special thank you to Mr. Thomas Doyle, president of Hilgartner Natural Stone Company in Baltimore, for your many hours spent with me looking through books and walking downtown. Also, thank you Dr. Robert Ridky of the University of Maryland for your inspiration and sharing your knowledge of the downtown area.

To dad, thanks.

A GEOLOGIC WALKING TOUR OF BUILDING STONES OF DOWNTOWN BALTIMORE

by Sherry McCann

The United States has been divided into physiographic regions based on the geology and landforms in the area. These regions are further divided into provinces specific for each area.

Baltimore, about 12 miles west of the Chesapeake Bay, straddles the Fall Line, which marks the boundary between two physiographic provinces, the Coastal Plain and the Piedmont. The Coastal Plain formations to the east range up to 140 million years old and consist of unconsolidated clay, silt, sand, and gravel. These are unsuitable for use as building stones.

The Piedmont Province lies west of Baltimore and contains the greatest variety and quality of native building stones used in Baltimore. Ranging in age from about 200 million to 1.1 billion years old, this area consists of granite, gneiss (pronounced nice), slate, marble, quartzite, and other rocks. The majority of these rocks are igneous or metamorphic in origin, but a few are from a sedimentary source. Most of these rocks are hard, durable, attractive, and polish well, making good building stones.

The building stones one observes on this tour were extracted from quarries. Most of the stones are not native to Maryland. A rock is formed naturally on or inside the earth and is made up of one or more minerals. It's called a building stone once the rock is used in construction. The way a rock originates determines the type of rock it is . Sediments, such as gravel, sand, clay, or organic material become cemented together to form sedimentary rocks. Magma, or molten rock, forms igneous rocks as it cools and solidifies deep inside the earth or as it is extruded on the surface 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.

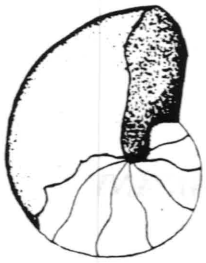
A variety of rock types are included in this tour, although the tour does not offer a complete selection. Many more building stones are located around the city and can be explored in addition to these few tour sites in downtown Baltimore.

STOP 1: THE GALLERY

200 East Pratt Street

The tour begins with a sedimentary rock. The Gallery, across the street from the Inner Harbor, is a shopping area with floors made of limestone. This limestone formed in shallow, clear water about 200 million years ago in central France. As layers of sediment slowly built

up over time, the pressure of deep burial and chemical cements transformed the sediments into solid rock. The marine fossils present and the fine grain of the material surrounding the fossils indicate the environment of deposition at that time. Not all of these fossils are easily recognized because of the way the stone was cut. Some fossils have been sectioned at various angles between horizontal and vertical. A few commonly seen fossils are illustrated below.



cephalopod

gastropod

coral

clam

The black squares on the floor are also limestone and came from Spain. This stone is Carboniferous in age, or about 200-345 million years old.

As one leaves the Gallery and walks north along Calvert Street, one will see a polished red granite covering the exterior walls. This red granite is from Taivassalo, Finland and is Precambrian in age, over 544 million years old. Granite is an igneous rock formed by the cooling of 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 inside the earth where cooling was slow. The two minerals essential to any granite are feldspar and quartz. Mica is another mineral often present. These feldspar crystals are pink to red in color. The mineral feldspar makes up about 60% of the earth's crust and is therefore the most common mineral found in rocks. The smokey 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 mica is that it splits into fine sheets or layers along cleavage surfaces similar to pages of a book.

Further along the building wall one sees a section of the granite with a smooth, polished finish adjacent to a rough texture or flamed finish. A "flamed" finish is caused by exposing the surface to a torch. The differential temperature causes rapid expansion and flaking off of surface fragments. These different finishes allow greater variety in texture and appearance using the same stone.

At the corner of this block, within the same complex, look at the interior of the Legg Mason Building. The same pink granite from Finland covers the floor with inlaid strips of South Dakota 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 minerals mentioned above whereas the gneiss has bands of the same minerals which were melted and recrystallized.

Notice the planters near the window. This combination of small pebbles cemented together is an artificial (man-made) product, and not a natural building stone.

Turn west now along Lombard Street and walk one block to Light Street.

STOP 2: UNITED STATES FIDELITY AND GUARANTY COMPANY

100 Light Street

Two types of stone are the focus of this stop. As one faces the front entrance one sees pink granite with a flamed finish, covering the entire walkway and surrounding the building as three-foot high walls. Notice also that the entire building is faced with the same granite. Observe the color and crystal size of each mineral.

The granite, quarried in Spain, was formed during the Precambrian Era over 544 million years ago. This area in Spain has 20-30 quarries and the greatest variety of granite color ranging from light pink to dark pink. It is possible for two different-colored granites to come from the same quarry or from one close by. The difference in color is determined by the relative amounts of each mineral present.

The two exterior side walls of the building are faced with the second stone of interest, travertine. Although most travertine is quarried in Italy, this stone originated in the Iran-Iraq area. Travertine is a sedimentary rock composed of the minerals calcite or aragonite (calcium carbonate) formed around hot springs or in caves, both by precipitation of these dissolved minerals from solution. This means that the stone is formed of minerals left behind when the liquid evaporates. Stalactites and stalagmites are types of travertine formed in caves.

The travertine at this site was precipitated near hot springs. As each layer covers the previous layer with varying amounts of calcite, the rock takes on a layered appearance. The white rectangular fragments are deposits that have been broken and moved by the pressure from other sediments. The yellow and brown coloring are due to iron oxide and the dark bands are organic material, probably encrusting algal colonies.

Look into the lobby and focus on the light gray granite planters. The finish is flamed rather than polished. The lighter-colored granite is caused by white feldspar in contrast to the pink feldspar in the exterior granite. The smoky-colored quartz and biotite mica are still present. This granite is from the same quarry in Spain as the pink granite and shows a range in color.

Walk north on Light Street and cross Redwood Street. Here at the Nations Bank on the corner of Light and Redwood is an outstanding example of Salem Limestone. Quarried in central Indiana, Salem (Bedford) Limestone is Mississippian in age, about 340 million years old.

Salem Limestone is a sedimentary rock formed by the cementation of broken shells of marine fossils. Notice that the smaller fragments appear to have "weathered" away leaving behind the larger fossils. The cementing material also appears to have weathered faster due to lesser durability. Salem Limestone is a popular building stone with high durability and ease of cutting and etching. More examples of Salem Limestone can be seen between stops 5 and 6.

As one walks east toward the next stop along the north side of Redwood Street, the stone seen on the exterior of the building between Grant and Calvert Streets is a fine-grained granite. The smaller crystals indicate a faster cooling rate than in the other granites we have observed previously. This stone has two contrasting finishes: a rough, flamed finish and a flat, honed finish. Notice that along the bottom of the windows the stone is spalling or peeling away. 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 phenomena may actually take place simultaneously; collectively they are termed "weathering."

STOP 3: MERCANTILE - SAFE DEPOSIT AND TRUST COMPANY

222 Redwood Street

This building was constructed in 1886 of "Seneca Red" sandstone. The sandstone is of Triassic age, about 210 million years old, and was quarried in Montgomery and Frederick Counties, Maryland. This is the first sandstone encountered on the tour. 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 due mainly to iron oxide in the rock and in the cementing material. It was a popular building stone in Baltimore and Washington, D.C. due to its accessibility and ease of transport. Seneca sandstone was also popular because it is easy to cut and carve when first quarried, but then hardens over time.

The original stones were possibly textured similar to the trim set about 6 feet high horizontally along the building. Weathering is obvious on the stairs where spalling (flaking) is occurring.

An interesting 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.

Backtrack to Calvert Street and walk north two blocks to Fayette Street.

STOP 4: BATTLE OF NORTH POINT MONUMENT

Calvert and Fayette Streets

The stone wall around the monument is Cockeysville Marble, a building stone quarried in Baltimore County, Maryland. 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 metalimestone also describes this marble, meaning that it is a limestone changed by metamorphism. The main minerals in marble are calcite ($CaCO_3$) and dolomite [$(CaMg)(CO_3)_2$], just as in limestone. If there were any fossils in the limestone, metamorphism has destroyed them. Earlier in the tour, limestone with fossils was observed at The Gallery (Stop 1). These two stones were not quarried from the same area but a comparison can be made between the fine-grained limestone with fossils and the coarser-grained marble. Both have the same chemical composition but have a different history of formation. Cockeysville Marble was used in building the United States Capital and the Washington Monument in Washington and also the Washington Monument in Baltimore, a few blocks north of the Inner Harbor area.

In walking north around the monument, one can see signs of weathering. The caramel-colored impurity in calcite is a brown mica called phlogopite, which stands out and hasn't weathered to the same degree as the rest of the stone.

Walk around to the north of the monument into the small park. The benches and walls in this area are Virginia gneiss. This is a metamorphic rock with obvious foliation, bands or layers of minerals. The black minerals in this gneiss are biotite mica and hornblende whereas the white minerals are feldspar and quartz. The parent or original rock was probably an igneous rock, such as a granite. This granite was metamorphosed (changed), causing partial melting and segregation of the minerals. The bands occur as minerals grouped together due to different density. The heat was caused by an orogeny (mountain building activity).

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 and metamorphic.

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. This is a dark gray, fine-grained granite from Canada. The color is due to the glassy, gray grains of quartz mixed with the white feldspar, with a scattering of very small crystals of black biotite mica.

STOP 5: CITY HALL
100 North Holliday Street

Walk east along Fayette Street. As one approaches City Hall, notice that the concrete sidewalk is adjacent to a sidewalk made up of slabs of slate. Slate is a metamorphic rock formed from the sedimentary rock, shale. Slate is a distinct rock because it has cleavage, a characteristic of breaking along flat parallel surfaces. This slate, called Buckingham Slate, was quarried in central Virginia.

City Hall is faced with Cockeysville Marble quarried at Beaver Dam in Baltimore County. The facing covers brick walls that are 5 ½ feet thick. This is the same type of stone we saw at the Battle Monument (Stop 4).

Walk east towards the park. As you walk down the steps, it's worth stopping at the large stone to observe the Salem Limestone. This is the same stone seen at the Nations Bank building.

Across from the eastern end of the park is a large Greek statue. The base of this statue contains fossils not usually visible in other construction using Salem Limestone. The longer wormy-looking fossils are not the worms themselves but evidence that they passed through the rock when it was soft sediment. These marine worms ingested sediment through their digestive system. As the worm burrowed, it 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 are commonly called worm burrows.

Cross Fayette Street and walk east along Fayette. On the right, observe the black stone at the base of the building. It was quarried in Canada and is Precambrian in age. Notice the different shapes and sizes of the minerals compared to other rocks seen previously. This is an anorthosite, sometimes called black granite commercially (though it is not actually a granite), composed mostly of long, lath-shaped crystals of dark greenish-gray to nearly black feldspar and some black biotite mica. The rock contains no quartz.

STOP 6: CITY OF BALTIMORE POLICE HEADQUARTERS

601 East Fayette Street

This building is faced with Rainbow Gneiss from Morton, Minnesota. This gneiss is over one billion years old and one of the oldest rocks in North America. The name is well suited for the 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.

Backtrack west on Fayette Street to Gay Street and turn left (south). Approaching the last stop, notice the parking garage on the west side of Gay Street. Can you guess the type of stone? A close examination will show that it is an artificial aggregate. An aggregate is a collection of stones, mixed with cement to form a solid. This is a man-made "rock", purposely designed in color to resemble granite from a distance.

STOP 7: SCULPTURES

Lombard Street

This last stop is on Lombard Street at two stone sculptures. The first is a gray and black limestone. The gray is calcite and the dark color is dolomite. As with most limestones, this rock was formed in shallow, quiet water and contains fossils. The stone is Cambrian in age (about 550 million years old) and was quarried in Tennessee.

The other stone is a light gray and pink limestone, also from Tennessee, and Ordovician in age (about 470 million years old). This stone has irregular contacts called "stylolites" that probably formed by differential solution when the sediments were still relatively soft.

We hope you have enjoyed this tour and learned to recognize some of the more common building stones in downtown Baltimore. One may recognize these same building stones in many other parts of the city.

NOTE: THIS DRAFT MANUSCRIPT IS PROVIDED FOR THE NSTA REGIONAL CONVENTION NOV. 15 TO 18, 1995. IF YOU DETECT ANY ERRORS, PLEASE NOTIFY KEN SCHWARZ OF THE MARYLAND GEOLOGICAL SURVEY, 2300 ST. PAUL ST., BALTIMORE, MD 21218 (410) 554-5525. IT IS THE INTENT OF THE SURVEY TO PUBLISH AN EDUCATIONAL SERIES BOOKLET, COMPLETE WITH PHOTOGRAPHS OF THESE STOPS AS THE BUDGET PERMITS.

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