BUILDING STONES AND GEOMORPHOLOGY OF WASHINGTON, D.C. THE JIM O'CONNOR MEMORIAL FIELD TRIP

Famous O'Connor Quote: "Stone is rock that you pay money for."

Cohn (1995): "You don't have to scale cliffs or descend into quarries to see the geological forces that shaped the Earth. Just tour the Mall from the Capitol to the Washington Monument and use this page as your guide. The very buildings have stories to tell about boiling magma, ancient seas and the creatures that inhabited the planet millions of years ago. You can look for fossils on a restroom wall, find clues as to how building stone was sliced from ancient seabeds and spot signs of how pollution is weathering stone today. And some stones are so beautiful that they are worth a look for that reason alone... James V. O'Connor, the official city geologist for the District,..."

In order to preserve the personality of James O'Connor, his words have been quoted directly from his notes wherever possible (see especially "Remarks" in "Description of Washington, D.C., Buildings"). To read his biography, go to the end of this document.

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With thanks to:

Ray Rye and Karen Gray (National Museum of Natural History), Jane Huff (Audubon Naturalist Society), D'Vera Cohn (Washington Post), Marie Nofs and Chrissy Welter, (U.S. Geological Survey), Pat McGeehan (National Geographic Society), Jan Delburto (Washington National Cathedral), and Julie Washburn (National Parks and Conservation Association)

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Natural History Museum Project (by J.V. O'Connor, 5/13/98)
How to Use the Great Urban Outcrops: Investigations of Building Stones (by J.V. O'Connor, 1985)
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GEOMORPHOLOGY AND OTHER NOTES FROM J.V. O'CONNOR AND FRIENDS

Geomorphology (from O'Connor, 1986; O'Connor, oral commun., May, 1999): Alluvial deposits and artificial fill: Lowlands along Potomac and Anacostia Rivers <u>25-foot terrace (Talbot):</u> Mall, upper Constitution Ave, lower Pennsylvania Ave. (White House) <u>50-foot terrace (Penholoway):</u> upper Pennsylvania Ave., F and G Streets NW <u>90-foot terrace (Wicomico):</u> Capitol, large part of Washington, including Dupont and Logan Circles (Capitol Hill) <u>200-foot terrace</u>: Mt. Pleasant area, St. Elizabeth's Hospital <u>"Lafayette Plateau" (420-300 ft):</u> Reno Reservoir, Soldiers Home, Good Hope Hill O'Connor (4/29/99 conversation): The subway and I St. are on the 60+ ft terrace. Both the

subway and the White House have their own ground water problems, dealing with the gravels.

Curbstones

Many of the curbstones in DC are made of Chelmsford Granite, MA.

L'Enfant's original plan (O'Connor, 1989):

Build on the high dry ground of the 3 knolls that overlook the Potomac estuary:

1) Jenkin's Hill on the Wicomico Terrace became Capitol Hill.

2) The Burnes Farm knoll of the Talbot terrace became the White House site.

3) Easby's Point, a bedrock ledge to the west was used for defense and site of the old Naval Observatory (21st and C Sts. NW).

Faults (O'Connor, oral commun., May, 1999)

1) At Lafayette Square, in the Metro data core logs. This information is not placed on maps.

2) Another runs under National Geographic.

Floods along the Potomac River (O'Connor, 1989)

1) 1889

2) 1924

3) March 1936 flood is the highest recorded on the river so far.

Fossils (O'Connor, 1995)

How to look and what to look for:

- 1) Are the fossils whole or in pieces? Did the animals die in place or were they transported and dumped?
- 2) Is each building stone graveyard the remains or traces of a creature? What was the environment of deposition represented in the host rock?
- 3) What is the type of fossilization, e.g., how did the fossil get preserved? What is the method of preservation: cast and molds, infillings?
- 4) What are the common fossils and do they have living relatives? Were they pre- or post-rockification (lithification)?
- 5) What are the size and shape of the fossils? How many of each species are in the rock?
- 6) What are pseudo-fossils and why do they fake people out? Can you identify the fossil pieces for classification of life form?
- 7) What evidence will the rock age and rock type yield? Why are some rocks more fossiliferous than others?

- 8) What good are fossils anyway? What is the true meaning of paleontology?
- 9) What was the most fun fossil you observed today? Why?
- 10) Which fossil rock did you like the best? Why?
- 11) Draw the main fossils in each rock. Compare your drawing to the real whole animal/plant.
- 12) Where would you find environments today for tomorrow's fossiliferous rocks?

Lost rivers (O'Connor, 1989)

1) Tiber Creek flowed between the White House and the Capitol, along what became Constitution Ave.; it empties into the Potomac near the lowland that much later became the Washington Monument. The Tiber trunk sewerline, built in the 30's, runs under Constitution Ave. or old B Street. This DC stream flowed from springs at the Soldiers Home and emptied into the Potomac at 17th and Constitution Ave. This stream was transformed into the flush system for the Washington, DC Canal. The extension of the C&O Canal linked the Navy Yard and Anacostia to Georgetown. The canal was then a tidal bypass and allowed marble to be shipped to the base of the Capitol for construction. In the 1960's they cut the pipe and ran the water the other way to RFK stadium and dumped it into the Anacostia.

2) (O'Connor, conversations May-Sept., 1999) The Tiber Creek sewer system was built in the 1930's by the Corps of Engineers to flow into the Potomac; in the 1960's they cut off the sewershed and ran it to RFK stadium and dumped it into the Anacostia River. Tiber Bay, Duck Creek, these are the real lost rivers of the District. The Tiber came out of 17th St. as its headwater with E St. and then ran south on the real old maps. On H St., it's downhill in both directions, so that is the drainage divide. Slash Run is another lost river; it is L St. around Connecticut Ave., there is a nice big valley from Dupont to H St.; today there is a sewer line, but was real river system ("Everything was urbanized out of existence."). Along the shores of Tiber Creek there must have been bogs. McAtee (1904) discovered a bunch of highland terrace swamps there, at the confluence with the terrace plateau. There was an alder swamp on the west side of Capitol, which is the weird wiggle of Tiber Creek. The canal is now the middle of the Mall, but on the old map, the river ran in front of the Capitol, through the Smithsonian.

3) At Natural History, the east wing of the building is sinking and pulling away from the main building because Tiber Creek is still there.

Canals (Karen Gray, written comm., 10/19/00) The Washington City Canal from early maps: 1) 1810-15: This is the construction period of Benjamin Latrobe's canal. The western part ends at the lock just east of 6^{th} St. The depth of the canal throughout its length varies because of tidal fluctuations.

2) By about 1840, the Tiber had been canalized to 15th St. The triangular Tiber mouth basin from $15^{\text{th}}-17^{\text{th}}$ was then created. The river shore curves SE from 17^{th} and the Canal basin (now Constitution). So the Mall does not exist west of 17^{th} .

3) By 1880, all of the Washington extension of the C&O Canal and the Washington City Canal was abandoned, most of it filled in. The James Creek Canal was in use, however. Reclamation of the tidal flats at the west end of the Mall began.

4) By 1900, the west Mall and Hains Point were created, largely by filling in the tidal flats with material dredged from the river and Washington Harbor. Waterways, impoundments and lakes existed but development toward the present appearance went on through the first half of the 20th century with minor changes subsequently.

Springs (Karen Gray, written commun., 10/19/00; G.P. Williams, 1977)

In addition to private springs, there were the public springs:

Blue House spring (on 10th St. between K St. and Massachusetts Ave., NW)

- Brown's spring (just north of Boundary St. (Florida Ave.), between 14th and 15th Sts., NW) Produced a sizable stream which led to Slash Run.
- Capitol Hill spring (foot of Capitol Hill near Pennsylvania Ave., northwest of Capitol). Site marked today by brick grotto.
- Carroll spring (Intersection of New Jersey and Virginia Aves., SE) Actually a group of several springs.
- City Hall spring (Near northwest corner of 5th and D Sts., NW)
- City spring (6th and C Sts., NW)
- Dunlop spring (just east of present U.S. Soldier's Home) Water rights sold by Elizabeth Dunlop to U.S. Government for \$500, probably about 1835.

Easby's Point spring (D and 26th Sts., NW, just east of today's Kennedy Center)

- Franklin square spring (the square is bordered by I, K, 13th, and 14th Streets) This spring was supposedly connected early-on to the White House by a pipeline.
- Gales spring (just northeast of intersection of 1st St., E, and Boundary St. [Florida Ave.]) Gibson spring (15th and E Sts., NE)
- James White spring (near northwest corner of Georgia Ave. [16th St.] and Ingraham St.) Proctor (<u>Evening Star</u>, Dec. 9, 1945, p. C-6) states that this spring, referred to by L'Enfant, existed up to about 1925.
- Leech spring, (on New York Ave. between 5th and 6th Sts., NW). So named because Dr. Devaughn, a noted cupper and leecher, kept leeches there.
- Moore's spring. Vicinity of 11th and Boundary Sts., NW. The origin of one of the branches of Tiber Creek.
- Octagon House spring (northeast corner of 18th St. and New York Ave., NW)
- Pierce Mill spring (in the present Tilden St. a few hundred feet west of Rock Creek.) The spring for the Pierce homestead. The springhouse still exists.
- Post Office spring (northwest corner of 7th and E Sts., NW). Water piped down 7th St. at least to Pennsylvania Ave.
- Quarry Road spring (just east of Rock Creek and opposite the zoo). The only supply of drinking water for the neighborhood's early residents in the late 1880's.
- Reedbirds Hill spring (North Capitol and M Sts.)
- Smith spring (McMillan Reservoir area) Provided water to the Capitol and adjacent parts of Pennsylvania Ave.
- Spring Garden spring (south side of canal just west of 6th St., SW)
- Many small springs along or near right bank of Anacostia River (between about C St. North and C St. South).
- Several springs, Pennsylvania Ave. and 2nd St., SE. Springs gave rise to a little stream which eventually flowed into St. James Creek.
- Willow spring (just north of L St. between 4th and 5th Sts., NW). Gave rise to a prominent stream that flowed through the City and into Tiber Creek.
- Unnamed spring, 13th and K Sts., NW, and vicinity
- Unnamed spring, Intersection of North Carolina Ave., D and 3rd Sts., SE
- Unnamed spring, Just southeast of intersection of 10th and M Sts., NW

- Unnamed spring, On Massachusetts Ave. between 15th and 16th Sts., NW. Drained into Slash Run. In 1807 Nicholas King reported to Thomas Jefferson the elevation and distance of this spring relative to the White House, probably in contemplation of using it as a source of water for that building.
- Unnamed spring. South side of Rhode Island Ave., just east of Connecticut Ave., NW
- Unnamed spring. On 18th St. near Boundary St., NW (near Brown's Spring)
- Unnamed spring. On 13th St. Near Boundary St., NW. On Sept. 21, 1872, \$50 was authorized from city funds to enlarge the spring to 4 feet in diameter, to cement the wall, and to install an iron pump.
- Unnamed spring. 11th St. between Florida Ave. and Euclid St., NW. On the grounds of Cardozo High School
 - (formerly Central High School) and the former Garfield Hospital.
- Unnamed spring. Head of Reedy Branch, about 13th and Harvard Sts., NW
- Unnamed spring. On Virginia Ave., between 26th and 27th Sts., NW
- Unnamed spring. East bank of Rock Creek near K St. This spring reportedly provided Georgetown residents with their best drinking water after the construction of the K Street Bridge in 1792. The water was sold around Georgetown for 2 cents a bucket.
- Unnamed spring. P and 22nd Sts., NW (near or on the eastern bank of Rock Creek) Reportedly a favorite spot for courting couples. At least during mid-1880's supplied the Metropolitan car stables in Georgetown by a pipe which went under the P Street Bridge.
- Unnamed spring. Corner of Wisconsin Ave. and Q Sts., NW, in Georgetown. Waters eroded a ravine southward to the Potomac.

Swamps and wetlands of Washington, DC (O'Connor, 1989; oral commun., May, 1999): 1) South and West of Washington Monument is fill material that filled the Potomac and tidal flats in the 1890s reclamation

2) Sangamon age fossils found during building of the Walker-Mayflower Hotel and peat under the new National Geographic Building; this swamp underlies much of area between the original city and Georgetown; Berry from the Smithsonian did the palynology and plant fossils.

3) Lafayette Square peat: Arthur Knox did the palynology, redid the old samples from the 20's, and found a Sangamon age. The Metro contractor lost his shirt by not expecting downdropping and peat swamps between the faults. They couldn't dig, they put their drill holes in the wrong spot, and they lost their shirts. Therefore, at least one contractor appreciates the fact that the geology of Lafayette Square wasn't on any map.

4) Along Florida Ave, along the shores of Tiber Creek, there must have been bogs. These were then turned into little lakes, which were then flooded for agriculture. This data set needs to be put together, a wonderful hydrogeology of lost rivers and their ecology. From 14-17th Sts., from NOAA, all the streams draining down the cliffs, so there were probably wetlands at some of these sites.

5) They filled in 2-3 marshes at the Navy Yard, especially filled in a giant bay—not even a marsh. No rise and fall in sea level here; the average person can't find the maps.

6) The terraces, each one had a swamp system like Huntley Meadows—all through the District the bog and the swamps have a paleo-connection as streams hit the terraces, made a modern pond, and hit the edge of the step and went down the next level; all were wiped out of existence. But if you core you find the peat layers—small and large; the Metro data shows Lafayette Park and Mayflower swamps at different elevations and these still have their impacts; you have the

streams, the modern day 19^{th} century streams went through them, rejuvenated and took a different way; the process from the past; they are remnants, but modern people are affected by them. The ones not at river level are related to whole terrace geology system. Go pull the old maps—and make modern useful maps so in modern management, you can make new realistic maps with geology and urban (features) together, especially around 14^{th} St. (7th to 12th and F to G Streets). A new wetlands map has just been published of the whole city – 52 major wetlands in the city. Will Logan at GWU finished Ft. Lincoln area and Hinkey Run using EPA #306 and #319 money.

7) Hydrologically, two terraces are involved in seeps and former wetlands. How much of the White House is dug up and built underneath, I don't know. Looking to the core of Pennsylvania Ave., E St., Constitution Ave. The new levee system for Constitution Ave. was one objective for changes at the White House; they want stuff underground and to have bigger parties. There are lots of people looking underground, but not at cost and engineering, because geologists haven't been brought into the mixture yet. For example, the underground rivers are major issues. Somewhere on front lawn, the base of the terrace would have a seep.

8) Guy Williams on vanishing springs of Washington and Tiber Creek; he discovered a bunch of highland terrace swamps; the confluence at the terrace plateau; alder swamp W side of Capitol, weird wiggle of Tiber Creek; the canal in middle of Mall. On an old map, it is the river in front of Capitol, through Smithsonian. There are lots of alder swamps in the old literature (McAtee, 1904).

Water table of Washington, DC (O'Connor, 1989):

The subway system, the FBI's Hoover Building, and the Federal Triangle Complex depend on sump pumps to regulate high underground water flow. The older buildings lie on wooden pilings, and water levels must be maintained to prevent rot and building collapse. Marshy ground made it unsafe to build the Monument of L'Enfant's plan, which would have created a right-angle alignment with the Capitol and White House. It had to be offset to the east of the White House.

The story of the levees (O'Connor, oral commun., May, 1999)

1) The levee was built by the COE in the 1950's to protect downtown from the Potomac River floods. They did a great job hiding the hill with trees. It is between the Vietnam Memorial and the Reflecting Pool and separates the Potomac from Pennsylvania Ave. It goes from the Washington Monument to Lincoln Memorial. It is so well camouflaged you have to know what you are looking at to see it. And who goes downtown to look at engineering stuff? It is between the Vietnam Memorial and the Reflecting Pool, between Constitution Ave. and the Pool. On the north side of levee, the Vietnam Memorial. Foundry Park and Constitution Gardens are behind the levee. It is a high level walkway, from 17th to the Memorial with trees planted. They took the levee out of reflecting pool. They did a nice job, actually a great job. Previously, DC Public Works used dump trucks which they deployed on 17th St., ready for the flood; if they needed sandbags, they could put them in. Part of redoing security for the White House, they added flood management plan. Since then, the Potomac has changed a whole lot from 1990's in terms of flood levels. The levee has never been breached yet.

2) The hydrogeology is really neat. No one knows it's there. They spent time and thought it out and did their job. Most people there see it as flat, which it is when you look on a microscale. (Jim often took teachers out to Lincoln Memorial steps; if you lay down on the stairs, you can

look out to see how high the levee is and where the water would come up if we had a big flood. He always asked: why would Lincoln be an island?)

How DC's rivers became sewers (O'Connor, oral commun., May, 1999)

1) There are two issues that control rivers in big cities: public health and development. The COE was in charge of water supply for DC. Colonel Montgomery Miegs (later General) started before the Civil War, and built the water supply from Great Falls to Washington. Our rivers were not initially designed to be sewer sheds; development gave us this in the name of health, and to provide needed land for development. So they filled in the valleys to make land for development. Flat land is more valuable. In many cases, they put in pipes in the time interval between 1890-1910. These pipes have started to fail, to collapse.

2) Today the COE dredges the rivers to control the water. We keep hearing about cleaning the Anacostia, but they will never clean the Anacostia, because the rivers were turned into sewers. There are lots of controls right now for cleaning up the water, the sediment, and the ground water. But when you try to pinpoint the causes, the problem is the extra sewage going into the Potomac. There is not really one person that can be blamed; it happened as a result of politics between the Federal Government and the City. They got money and permission to do it and the question became: how fast can we clean up the Potomac under the Johnson Administration? The quickest way was to run the Tiber Creek pipeline the other way. This is a band aid; rather than solving the problem, they built greater capacity, holding tanks, and they calculated how much is coming in from where. But with time it caught up with them. Their intention wasn't to pollute the Anacostia. And no one complained (as far as Jim was able to trace on paper). The Federal government was giving money to solve a problem; who would be opposed to cleaning? 3) The Navy Yard is the gorilla problem on the Anacostia. The shoreline contains 200 years of industry. You don't see it today, but the Navy Yard made guns. It was a former Pittsburgh (full of steel mill pollution); they used nasty chemicals such as As, Hg, Cu, Zn, Pb. It really is a superfund site—the Navy needs to devote millions a year for an estimated 40 years. And this is just one of a hundred sites along the Anacostia. Right now the USEPA is running the efforts, and the strategy is to pave it over and ignore it all.

4) Where do all the tires come from? The tires stop in low tide. There is a Anacostia Watershed Society that pulls out tires every 3-6 months. What about all the other rivers that are supplying the tires? Everyone goes out to do their little part; every river has some of this: auto parts, shopping carts. In Reston, kids pick up the tires, they are fun to roll down hills, all river valleys are hills. It's like throwing stones. Plus, there are also the nasty people.

5) The creation of Kingman Lake and Kingman Island: They used the original maps for redesigning the Anacostia River and the Army Colonels added their names. Kingman was a Colonel, so there is Kingman Lake. Many of the names in Rock Creek are named for Colonels. Colonel Hains of Hains Point for example. Kingman took over from Hains to finish the dredging. Their drive is this: they are all engineers and they have an average of only three years to be in charge. They are here long enough to do something, to get something named after them.

DESCRIPTION OF WASHINGTON, DC, BUILDINGS

BUILDING CONTENTS

African Art Museum (see National Museum of African Art) Air and Space Museum (see National Air and Space Museum) Albert Einstein Memorial (see Einstein Memorial) American Art Museum (see National Museum of American Art) American Institute of Pharmacy American History Museum (see National Museum of American History) Anacostia Museum and Center for African American History and Culture Andrew W. Mellon Memorial Apex Building/Federal Trade Commission/Sears House Archives Metro Station Ariel Rios Federal Building (formerly Post Office Department) Arlington Memorial Bridge Arthur M. Sackler Gallery Arts and Industries Building Benjamin Franklin Statue **Botanic Gardens** Bulfinch Gatehouses (see Capitol Gatehouses) Bureau of Indian Affairs Building [see (Department of) Interior South Building] Butt-Millet Fountain (also see Zero Milestone) Canadian Embassv (US) Capitol Capitol Gatehouses ("The Bulfinch Gatehouses") Posts (The Capitol Gate Four Piers of the Bulfinch Gatehouses) **Capitol Reflecting Pool** Castle (Smithsonian Institution (Main) Building) Chesapeake and Ohio Canal **Civil Service Commission Building** Commerce Department Building (Federal Triangle Buildings) Constitution Hall (of the DAR) "Daughters of the American Revolution Building" (see also Memorial Continental Hall) Corcoran Gallery of Art Daughters of the American Revolution Building (see Constitution Hall) Department of ... (see Agriculture, Commerce, Interior, etc.) **District Building** District of Columbia Employment Services Building District of Columbia World War Memorial Einstein Memorial Embassy of ... (see country name, e.g. Canadian Embassy) Enid Haupt Garden Evening Star Building Executive Office Building (Old State-War-Navy Building) FBI Building (see J. Edgar Hoover FBI Building)

Federal Reserve Building Federal Trade Commission (see Apex Building) Federal Triangle Buildings (see Commerce Department Building) First Division Memorial Ford's Theatre Fort Washington Franklin Delano Roosevelt Memorial Franklin Statue (see Benjamin Franklin Statue) Freedom Plaza Freer Gallery of Art Gatehouses (see Capitol Gatehouses) General George Gordon Meade Plaza General Services Administration Building General William Tecumseh Sherman Memorial German-American Friends Fountains (Ulysses S.) Grant Memorial Hancock Statue (see Major General Winfield Scott Hancock Statue) Haupt Fountains ("Two Fountains") Haupt Garden (see Enid Haupt Garden) Henry Statue (see Joseph Henry Statue) Herbert Clark Hoover Building (see Hoover Building) Hirshhorn Museum and Sculpture Garden (U.S.) Holocaust Memorial Museum Hoover Building (Herbert Clark Hoover Building) Hoover FBI Building (see J. Edgar Hoover FBI Building) Hotel Washington Indiana Plaza Interior Department Building Internal Revenue Service Building International Cultural and Trade Center J. Edgar Hoover FBI Building Jefferson Memorial John F. Kennedy Center for the Performing Arts John J. Pershing Park John Marshall Park John Paul Jones Memorial Jones Memorial (see John Paul Jones Memorial) Joseph Henry Statue Justice Department Building J.W. Marriott Hotel Kennedy Center (see John F. Kennedy Center) Korean War Veterans Memorial Library of Congress Lincoln Memorial Lock House

Major General Winfield Scott Hancock Statue Market Square Marriott Hotel (see J.W. Marriott Hotel) Marshall Park (see John Marshall Park) Meade Plaza (see General George G. Meade Plaza) Mellon Memorial Memorial Bridge (see Arlington Memorial Bridge) Memorial Continental Hall (original DAR building) Metro (see individual stations) National Academy of Science (see also Einstein Memorial) National Air and Space Museum National Archives Building National Bank of Washington National Building Museum National Cathedral (see Washington National Cathedral) National Gallery of Art East Building National Gallery of Art West Building National Geographic Society National Museum of African Art National Museum of American Art (in old Patent Office Building) National Museum of American History (Museum of History and Technology) National Museum of American Indian National Museum of Natural History ("Smithsonian") National Place and the Shops National Portrait Gallery National Postal Museum National Theater National Zoological Park Natural History Museum (see National Museum of Natural History) Organization of American States (see Pan Am Union Bldg.) Old Executive Office Building Pan American Union Building (Organization of American States) Patowmack Canal Peace Monument 601 Pennsylvania Ave. 1001 Pennsylvania Ave. 1201 Pennsylvania Ave. 1301 Pennsylvania Ave. Pennsylvania Building Pentagon Pershing Park (see John J. Pershing Park) Plaza One (office complex for Warner Theater) Postal Museum (see National Postal Museum) Post Office Department (see Ariel Rios Federal Building) Post Office Pavilion and Nancy Hanks Center Tower Posts (see Capitol Gate Posts)

Presidential Building Rayburn Building Red Cross Buildings Reagan Building (see Ronald Reagan Building and International Trade Center) Reflecting Pool (see Capitol Reflecting Pool) Renwick Gallery of the National Museum of American Art (formerly U.S. Court of Claims and Old Corcoran Gallery) **Riggs National Bank Building** Rios Federal Building (see Ariel Rios Federal Building) Ronald Reagan Building and International Trade Center Roosevelt Memorial (see FDR Memorial) Sackler Gallery (see Arthur M. Sackler Gallery) Sears House (see Apex Building) Second Division Memorial Sherman Memorial (see General W.T. Sherman Memorial) **Smithsonian Institution** (see individual museums, e.g., National Museum of Natural History, Castle, National Air and Space Museum, etc.) Supreme Court Building State Department Building **Treasury Department Building** Two Fountains (see Haupt Fountains) Ulysses S. Grant Memorial (see Grant Memorial) Union Station U.S. Botanic Gardens (see Botanic Gardens) U.S. Capitol and related structures (see Capitol, Capitol Reflecting Pool, etc.) U.S. Department of ... (see individual Department, e.g. Commerce, State, etc.) U.S. Holocaust Memorial Museum (see Holocaust Memorial Museum) U.S. Navy Memorial Vietnam Veterans Memorial Warner Theater (see Plaza One) Washington Monument Washington National Cathedral White House Willard Hotel Zero Milestone Zoo (see National Zoological Park)

Agriculture, North Building

References: No. 26 USGS (1998), No. 24 USGS (1975)

Location: 12th St. and Independence Ave., SW

Construction history: The main administration building between the east and west wings was designed by Rankin and Kellogg of Philadelphia. The entire building has a floor space of 300,000 square feet.

Building stones: Central part, Georgia White Cherokee marble; wings, Vermont marble; foundation, Massachusetts granite; interior, Tennessee marble

American Institute of Pharmacy

Location: 2215 Constitution Ave., NW

Construction history: Designed by John Russell Pope and dedicated May 8, 1934, the building is notable for the 1,100-pound bronze entrance doors and for the nearby urns, each carved from a solid block of marble from the Green Mountains. **Building stone:** Vermont marble

Anacostia Museum and Center for African American History and Culture

Location: 1901 Fort Place, SE References: O'Connor (1995) Construction history: Part of Smithsonian Institution Building stones: Texas sunset red granite

Andrew W. Mellon Memorial

Location: Across from National Gallery at 6th St. junction with Pennsylvania and Constitution Aves., NW **References:** No. 36 O'Connor (1989)

Apex Building/Federal Trade Commission/Sears House

Location: 633 Pennsylvania Ave., NW
References: No. 15 USGS (1998), No. 16 USGS (1975), O'Connor (1989)
Construction history: This building, designed by Bennett, Parsons, and Frost, was completed in 1937 and serves as the apex of the Federal Triangle.
Building stones: Exterior base, Milford, MA, granite; exterior, Indiana limestone; interior, marble from Harrisonburg, VA
Remarks: O'Connor (1989): Indiana Limestone (Mississippian) has numerous crinoids and bryozoans as fossil deltaic hash.

Archives Metro Station

Location: NW corner of 7th St. and Pennsylvania Ave., NW **References:** No. 24 O'Connor (1989)

Ariel Rios Federal Building (formerly Post Office Department)

Location: 12th St. and Pennsylvania Ave., NW **References:** No. 1 O'Connor (1989)

Arlington Memorial Bridge

Location: Crosses the Potomac River at the Lincoln Memorial **References:** No. 33 USGS (1998), No. 30 USGS (1975), Moore and Jackson (1989, p. 104) **Construction history:** A bridge was proposed at this point as early as 1851. The present bridge, completed after 6 years' work, begun in 1932 and now one of Washington's major traffic routes, closely resembles one suggested by the earlier commission in 1901. **Building stones:** Piers, GA, granite; facing of spans, granite from GA, VT, NC, NH, and ME.

Arthur M. Sackler Gallery

Location: 1050 Independence Ave., SW References: O'Connor (1995) Construction history: Part of Smithsonian Institution Building stones: Minnesota granite

Arts and Industries Building

Location: 900 Jefferson Dr., SW

References: (Ray Rye, written commun., 10/19/00; Bleiberg [1995])

Construction history: Part of Smithsonian Institution; built in 1881 as the second building. Undersecretary Baird was in charge of all government exhibits for the 1875 Centennial Exhibition in Philadelphia. He got a clause in the authorization from Congress that if the government pavilion made money, the Smithsonian would get a new building. The pavilion was successful and A&I was built; it holds the distinction of being constructed at the lowest cost per square foot of any Federal building in DC. Garfield had his inaugural ball there, and some call it "Baird's Castle," with affection, not derision. For a long time it housed the materials donated to the Smithsonian after the 1875 Exhibition was dismantled. It also housed the space rockets before Air and Space was built.

Building stones: New York marble and brick; limestone from Isle de Motte, VT, Ordovician Age. Note the outlines of shells on the marble floor: *Maclurites* = gastropod (snails) and *Orthoceras* = cephalopod (squids) in "Radio Black or Champlain Black marble."

Benjamin Franklin Statue

Location: 12th St. and Pennsylvania Ave., NW References: No. 42 O'Connor (1989)

Botanic Gardens

Location: 1st St. and Maryland Ave., SW **References:** No. 23 USGS (1998), No. 4 USGS (1999), No. 21 USGS (1975) **Construction history:** The present conservatory was built when the Botanic Garden was relocated on the Mall. **Building stones:** Indiana limestone; patio, Pennsylvania sandstone

Remarks: Built near the site of the Baltimore and Ohio Railroad Station where President Garfield was shot. There are trace fossils in the bioclastic sediments.

Butt-Millet Fountain (also see Zero Milestone)

Location: Ellipse, NW edge

References: No. 2 USGS (1975)

Building stones: Tennessee marble

Remarks: Designed by Daniel Chester French and Thomas Hastings. The small pink fountain, with a bas-relief symbolizing Art and Chivalry, memorializes Major Archibald W. Butt, military aide to Presidents Roosevelt and Taft, and Francis D. Millet, painter, at the time a member of the National Commission of Fine Arts, who lost their lives on the Titanic, April 15, 1912. O'Connor (1998): The stone is a variation of Tennessee marble. Are the fossils popping out?

Canadian Embassy

Location: 501 Pennsylvania Ave., NW References: No. 31 O'Connor (1989) Building stones: Adair marbles, dolostone reef stone, Silurian Age

Capitol, U.S.

Location: Capitol Hill, between Constitution Ave. and Independence Ave. **References:** No. 19 USGS (1998), No. 1 USGS (1999), No. 19 USGS (1975), Moore and Jackson (1989) (p. 23); O'Connor undated ms

Construction history: On the site chosen by L'Enfant, President Washington laid the southeast cornerstone of the main building September 18, 1793. Dr. William Thornton drew the original design, and Stephen H. Hallet, James Hoban, George Hadfield and Benjamin Latrobe each had subsequent turns at directing the work. The north wing was completed in 1800; the south wing in 1807. Both were burned by the British seven years later in 1814.

Building stones: North and south wings, marble; center building, painted Aquia Creek sandstone, VA; Senate and House wings, Lee, MA, marble (dolomitic); rotunda floor, Seneca, MD, sandstone; columns of wings, Cockeysville, MD, white marble; center steps, Renville, MN, granite; steps, west elevation, Mt. Airy, NC, granite; balustrade west elevation, Vermont marble; interior balustrades and columns of stairs leading to House and Senate galleries and wall of Marble Room, Tennesee marble; east front exterior, Georgia White Cherokee marble (covering original Aquia Creek sandstone, VA); columns (24) exterior, Georgia marble; interior columns, Statuary Hail, Old Senate Chamber and foyer, Potomac marble or Calico Rock from near Point of Rocks, MD; columns in Crypt and those with corn and tobacco leaves, Aquia Creek sandstone, VA; columns, east front addition, Colorado brecciated marble.

Degradation: SE corner blackened alteration in the Corinthian column capitals black crust is gypsum plus dirt that accumulated in sheltered areas; where no crust present along cracks, rain water probably flows and dissolves the gypsum; some blackened areas are a greenish black moss; on balustrade, deterioration in exposed areas; top surfaces are coarse and rough (dissolution between grains); pockmark effect on square bases of columns; non-calcite inclusion loosened by dissolution of surrounding calcite, cause inclusions to pop out; good example in 4th column west from SE corner; under rail in places blackened crust has spalled off, exposing fresh surfaces; carvings on balustrade corners, some worm possible due to local effects of wind and rain; along steps leading to terrace on west side, gypsum has accumulated on large areas of wall surface; along W side, walls are painted; accentuated lines from bedding and pock marks can be seen under the paint; at NW corner, preferential dissolution where calcite dissolved away; some of the black may be an alga or a fungus. The granite stairs show the wear and tear of shoe abrasion. The stairs of the NW side still have their quarry wire marks while the center stairs do not. Observe the terrace system. East Capital St. was on the flat terrace where the city was to develop along toward today's RFK Stadium. The development, however, went the other way toward the city of Georgetown.

Repairs: Major cleaning, replacement, and repair begun in late 1980s; some parts of balustrade replaced.

Inside: The statues are important not only for our history but the solid material that each famous American is sculptured from. Each state is allowed two citizens from their realm to grace the interior. Follow the spiral staircase down to the Rotuda museum. Study the Aquia columns. Observe the photos that document the building of the Capitol and changes to neighborhood.

Carefully study the marble of the Suffragette statue. Bullet holes in the Aquia from the British attack on the Capitol in August of 1814 are now covered at the east entranceway.

Cohn (1995): "The most popular building stone in Washington from 1790 to 1840 was Aquia Creek sandstone, used for the central section of the Capitol and the White House. One advantage was that it could be quarried in nearby Stafford County, Va. Most stone that occurs naturally in the District is a loose jumble unsuitable for construction because the city sits on land formed as gravel, sand, silt and clay washed down from mountains to the north and west. So builders turned to Aquia Creek sandstone, made of similar material but cemented into solid rock by silica. The problem was that this "Virginia freestone" -- so called because it's easy to cut -- deteriorates quickly when exposed to the elements. One solution is to paint it, as was done at the White House. Another is to cover it with marble, as happened at the Capitol's East Front. On the West Front, however, you still can see the sandstone. Climb to the second floor Rotunda, and you can see what the stone looked like when the Capitol was built. Walk close to the blocks. If the grain is coarse, the rock was formed during a period of rushing water that allowed only larger particles to settle to the bottom, eventually to harden into rock. A finer grain means that it was created in a gentler flow. All of this occurred about 100 million years ago. Next door, in the Hall of Statuary, check out the Corinthian columns of so-called calico marble, sometimes called puddingstone, "whose only big claim to fame was this room," O'Connor says. The reason is that, although this is a beautiful stone, quarried in Leesburg and Frederick, working with it is nearly impossible. The pebbles in it are of various hardnesses, so some fall out or fall apart when the material is cut and polished. The columns have waxy plugs to fill the holes. Calico marble is not a true marble but a sedimentary rock formed when limestone, quartz and other pebbles roll off a mountain and aggregate at its base. This happened 180 million years ago during the Jurassic period, when dinosaurs roamed the region."

Capitol Gatehouses ("The Bulfinch Gatehouses")

Location: Was at W entrance of Capitol on 1st St. from 1828 until 1874; moved in 1880. The house went to 17th St. and Constitution Ave., NW, northeast corner.

References: No. 7 USGS (1999); O'Connor (1998 and undated notes); Goode (1974) **Construction history:** Designed by Charles Bulfinch in 1828.

Building stones: Same sandstone used in central part of Capitol and White House, Aquia Creek sandstone, VA

Degradation: Three types, spalling, pockmarks, and preferential weathering of layers in the stone; the degree of deterioration greater than other buildings that are maintained **Repairs:** Restored by National Park Service in 1938-1939.

O'Conner (1989): The Capitol Gate House was a guard's station for entrance to the capitol, and are now used as tool sheds. The other house sits opposite at the NW corner of 17th and Constitution. The columns and blocks of the Virginia Freestone highlight the changes in this delta deposit. Look for the crossbeds and energy changes in the sedimentary layers between high energy (large/coarse grains) and low energy (strata of small grains.) These structures were ousted from the Capital grounds by landscaper Frederick Law Olmsted. What is his claim to fame? Which of his masterpieces have you ever been in? The southeast corner of the building had four major floodlines etched into the stone. Can you still read any of the dates from the last century floods? How far would any of these flood levels go as you look north (up) 15th St. NW? Do you know the significance or name of June 1, 1889 catastrophic flood event recorded here?

Goode (1974): Finely carved neoclassical friezes with central panels of ornate foliage. Both the two gatehouses and the four piers were saved and reconstructed on their present sites in 1880.

Capitol Gate Posts (The Four Piers of the Bulfinch Gatehouses) ("Sidewalk Secrets at 15th Street and Constitution")

Location: On the opposite of Constitution from the Gatehouses; SW and NW corners of 15th St. and Constitution Ave., NW, and SW corner of 14th St. and Constitution Ave. The posts went to 15th St. and Constitution Ave., NW, northwest corner, and one at 7th St. and Constitution Ave. **References:** Goode (1974); O'Connor (undated notes)

Construction history: These posts, originally at the Capitol, were constructed in 1828 after a design by Charles Bulfinch.

Building stones: Virginia freestone or Aquia Creek sandstone, VA

Remarks: Gate Posts stand at three corners of 15th Street and Constitution Avenue. Originally, they stood around the Capitol connecting a wrought iron fence. These Gate Posts were constructed in about 1829 of Aquia Creek sandstone, which was quarried at Government Island in the creek just north of Stafford, VA. The age of the rock is Cretaceous and part of the Potomac Group. It is an iron-rich cross-bedded deltaic deposit of an ancestral Potomac River. This stone is listed as a poorly sorted, coarse- to fine-grained sandstone. It has local weak spots due to clay pellets (up to1 mm diameter) scattered throughout. The stone was popular from about 1790 to 1840 and was used for older parts of the White House, Capitol, Treasury Building, and National Portrait Gallery. It was popular because it was the first local freestone close to Washington (about 46 miles away in Stafford, VA) and it could be loaded directly onto boats and transported upriver to the District. Unfortunately, much of the Aquia Creek sandstone building rock has weak cement holding it together. Outside it begins to disintegrate shortly after being laid, but the block sizes can compensate for that. Examine the Gate Post and see what has been done to preserve it. This structure was made of "poor quality" Aquia Creek sandstone. On the post on the northwest corner of 15th Street and Constitution Avenue are two lines chiseled into the stone about 3 feet from the bottom which indicate the heights of flooding in the 1930's and 1940's. The gateposts have suffered from air pollution and elements.

Capitol Reflecting Pool

Location: W side of Capitol

Cohn (1995): "The pool and steps around it are formed of beige-yellow Indiana limestone, the most common building stone in Washington because it resists erosion and is easy to work with. All buildings erected on Pennsylvania Avenue in recent decades are of this stone, to assure continuity of appearance. This sedimentary rock was formed 300 million years ago when animal skeletons -- shells and corals -- piled up. By looking closely, you can see remains of some creatures of the time. The fossils formed when the animals made trails through the rock or when they died there and their hard parts were chemically preserved. Limestone erodes more quickly than the fossils in it, so some of the fossils almost jump out at you. Wormy trails snake across the steps, signs of shrimplike crustaceans that burrowed through piles of shells millions of years ago. The steps also have fossil remains of bryozoans, invertebrates whose descendants live today in the Chesapeake Bay, and of crinoids, which are sometimes called "sea lilies" and are extinct relatives of starfish. Similar fossils can be found on many other limestone buildings."

Castle (Smithsonian Institution (Main) Building)

Location: 1000 Jefferson Dr., SW

References: No. 25 USGS (1998), No. 22 USGS (1975); Ray Rye (written commun., 10/00) **Construction history:** Founded in 1829, the Smithsonian Institution was a bequest of James Smithson. Designed by James Renwick in the Gothic Revival or Romantic style; completed in 1855. The Smithsonian was established by an Organic Act on August 10, 1846. 1829 is the year Smithson died, but the original bequest was to his nephew, Henry James Hungerford, who was 23 at the time. Should said nephew die without issue, THEN the United States was next in line of succession. Henry died at age 29, in 1835. That started the ball rolling, but Congress, being the world's greatest deliberative body, lived up to it's reputation and wrangled for 11 years before it agreed on how to spend Smithson's bequest. The bill was passed by Congress and signed by President Polk on the same day.

Building stones: Seneca, MD, sandstone

Cohn (1995): "After giving up on freestone (see "The Capitol"), builders turned to red Seneca sandstone, another sedimentary rock, popular during the "brownstone era" of 1840 to 1880. The stone was formed in the Triassic, about 200 million years ago, and it crops out along the Potomac River from Seneca to just east of Point of Rocks, Md. The Castle, designed by James Renwick, was built of stone quarried along the Potomac just north of Washington. When the building was completed in 1855, the stone was described as lilac gray. The sandstone darkens upon exposure to air, and the building has become a dark red."

Chesapeake and Ohio Canal

Location: 180 miles along Maryland side of the Potomac River between Washington, DC, and Cumberland, MD. (Park Headquarters is in Sharpsburg, MD) **References:** Moore and Jackson (1989) (p. 95)

Civil Service Commission Building

Location: 1900 E St., NW
References: No. 34 USGS (1975)
Construction history: Built by John McShain, Inc., the structure was begun in 1960 and completed in 1963.
Building stones: Base and first floor, Cold Spring, MN, granite, flame finished; upper exterior, Indiana limestone.

Commerce (Department of) Building (Federal Triangle Buildings)

Location: 14th between E St. and Constitution Ave., NW

Reference: No. 6 USGS (1998), No. 13 USGS (1999), No. 12 USGS (1975)

Construction history: Submitting their preliminary plans March 5, 1928, the architects, York and Sawyer of NY, designed the building with a net floor area of 1,092,800 square feet and 5 miles of corridors.

Building stones: Exterior, first and second floors, Stoney Creek granite, CT; interior, Georgia and Missouri marbles. Plaster for walls from gypsum deposits near Medicine Lodge, KN.

Constitution Hall (of the DAR) "Daughters of the American Revolution Building" Location: 1776 D St., NW

References: No. 6 USGS (1975), No. 9 USGS (1999); Fig. 2 in Doe (1989)

Construction history: Completed in 1929 when Continental Hall condemned.

Building stones: Vermont marble and Alabama limestone

Degradation: Minor overhangs protect stone; columns along 18th St. show precipitation direction from south; smoother, but polluted surfaces on the north

Repairs: Restoration in 1985 to correct damage possibly related to salting of steps and landing; some limestone replaced in 18th St. steps;

Remarks: Along with the Administration Building, two other buildings are part of this complex, the Memorial Continental Hall, situated on the west side of 17th Street, and Constitution Hall, in the northwest corner of the square. The building was designed by Edward Pearce Casey.

Corcoran Gallery of Art

Location: 17t^h St. and New York Ave., NW References: No. 4 USGS (1975), No. 11 USGS (1999) Construction history: Designed by Ernest Flagg, was completed in 1879 and enlarged according to Charles A. Platt's design in 1927. Building stones: Exterior, coarse-grained Cambrian Murphy Marble Formation (=Cherokee marble from near Tate, GA); foundation of Milford, MA, pink granite Degradation: Ornamentation deeply degraded; but also flat, vertical areas smooth, perhaps

Degradation: Ornamentation deeply degraded; but also flat, vertical areas smooth, perhaps because of overhang protection; old stone rails deeply degraded, but granular feel; some mineral in positive relief, (magnesian calcite? dolomite?); stone in railing replaced; runoff from bronze lions causes stains on coarse-grained marble, but does not crack or sugar the rock **Remarks:** The present Corcoran Gallery outgrew its first building, which served first as the U. S. Court of Claims and is now the Renwick Gallery.

District Building

Location: 1350 Pennsylvania Ave., NW References: No. 3 O'Connor (1989)

District of Columbia Employment Services Building

Location: 6th St. and Pennsylvania Ave., NW **References:** No. 30 O'Connor (1989)

District of Columbia World War Memorial

Location: On the Mall south of 19th St., NW, West Potomac Park References: No. 30 USGS (1998), No. 28 USGS (1975) Construction history: Designed by Fred Brocke, Nathan Wyeth and Horace Peaslee, the Memorial was a gift of the citizens of Washington to honor the District's war dead. Building stones: Vermont marble

Einstein Memorial

Location: 2101 Constitution Ave., NW
Reference: O'Connor (undated notes)
Building stones: Emerald pearl larvikite from Norway; Mt. Airy granite, NC
Remarks: Investigate the 28 ft diameter map of the universe on noon, April 22, 1979. How does the energy of the universe relate to the three equations in his notebook (photoelectric

effect—"quanta," theory of general relativity—"E=mc2," and equivalence of energy and matter)? Do you believe in the Big Bang Theory? Discover the energy secrets of magma for both the larvikite (emerald pearl granite from Larvik, Norway) and the base white granite (Mt. Airy, NC). What is the process for making bronze? Is alchemy still alive and well? Check out the three Einstein quotes behind the memorial: what do they tell you about the man? The dark blue igneous rock is polished to highlight the blue feldspar: what color does it shimmer to in the sunlight? For the granite base, what are the three colors and the minerals they represent? What are the three equations that are in Einstein's notebook? Why has the statue not changed color by weathering? What do the nails represent in the universe?

Enid Haupt Garden

Location: Near National Museum of African Art **References:** O'Connor (1995), Cohn (1995)

Cohn (1995): "The garden arches are a granite called Texas sunset, a colorful blend of pink feldspar, black mica and gray quartz. This granite is a plutonic igneous rock, meaning it's coarsegrained and found in large underground intrusions. Other types of igneous rock are volcanic, also called extrusive, and hypabyssal. Both are found in smaller intrusions. The granite is formed from cooling magma, or molten lava. Look for the scalloped edges of the arches, the drill marks from where it was cut. Compare the material of the arches to the stone used in the garden pool. It's the same stone, cut and polished differently."

Building stones: Oriental pools, five finishes, granite from TX

Evening Star Building

Location: 1101 Pennsylvania Ave., NW References: No. 19 O'Connor (1989)

Executive Office Building (Old State-War-Navy Building)

Location: 17th St. and Pennsylvania Ave., NW
References: No. 40 USGS (1998), No. 37 USGS (1975)
Construction history: At the time of its completion in 1888, this structure was the largest office building in the world. Its architect, A. B. Mullett, used 900 Doric columns in the building.
Building stones: Exterior, granite from Richmond, VA, ME, and MA; sub-basement, Maryland sandstone

Federal Reserve Building

Location: Constitution Ave., between 20th and 21st Sts., NW

References: No. 36 USGS (1998), No. 31 USGS (1975)

Construction history: Designed by Paul P. Cret and begun in 1936, the building features an impressive staircase.

Building stones: Exterior, Georgia marble; foundation, Massachusetts granite; fountains, Pennsylvania black diabase "granite"; interior, marbles from GA, MD, MO, NY, TN, VT, Belgium, France, Sweden; and limestone from KN

First Division Memorial Location: 17th St. and E St., NW **References:** No. 3 USGS (1975)

Building stones: Milford, MA, pink granite

Remarks: Reaching a height of 60 ft, including a 35-ft monolithic shaft weighing 56 tons and a 15-ft statue of Victory, the Memorial stands in dedication to the men of the First Division. Designed by Cass Gilbert and executed by Daniel Chester French, the Memorial was dedicated October 4, 1924.

Ford's Theatre Location: 511 10th St., NW Building stones: Brick

Fort Washington

Location: 13551 Fort Washington Road, Fort Washington, MD **References:** Moore and Jackson (1989) (p. 106)

Franklin Delano Roosevelt Memorial

Location: On the Tidal Basin, West Potomac Park **References:** No. 29 USGS (1998) and Michael Zisk, Museum Architect, U. S. Holocaust Memorial Museum (written commun., 2000)

Building stones: Carnelian granite, quarried in SD, with a small amount of "Academy Black" granite, quarried in CA and fabricated in Cold Spring, MN.

Remarks: Designer Lawrence Halprin started work on the project in 1974, but construction did not begin until October 1994. More than 6,000 tons of granite, enough to erect an 80-story building, was used in the construction of the FDR Memorial. That includes 75,000 square feet of granite pavers and 31,000 pieces of stone. The FDR Memorial is also the first presidential memorial to honor a First Lady. The Memorial was dedicated in May 1997.

Freedom Plaza

Location: on Pennsylvania Ave., between 13th and 14th Sts., NW

References: No. 8 USGS (1998), No. 10 O'Connor (1989)

Building stones: Border, red-pink granite from Llano, TX; interior, L'Enfant's original plan for Washington portrayed with streets of Georgia marble, waterways of New York sandstone, and city blocks of California granite.

Remarks: The Park was dedicated in 1980; its southwest end contains a time capsule honoring Dr. Martin Luther King, Jr. The western end has a small pool.

Freer Gallery of Art

Location: 12th St. and Jefferson Dr., SW References: No. 23 USGS (1975) Building stones: Exterior, Stoney Creek, CT, granite; interior, Tennessee white marble Construction history: Part of Smithsonian Institution.

General George Gordon Meade Plaza

Location: Constitution and Pennsylvania Aves., NW References: No. 33 O'Connor

General Services Administration Building

Location: F St. between 18th St. and 19th St., NW
References: No. 38 USGS (1998), No. 35 USGS (1975)
Construction history: Completed in 1917, the structure originally served as the U. S. Interior Department's headquarters building, now serves as headquarters of the General Services Administration.
Building stones: Exterior, Indiana limestone; interior, Maryland marble

General William Tecumseh Sherman Memorial

Location: E St and East Executive Ave. and 15th St., NW **References:** No. 5 O'Connor (1989)

German-American Friends Fountains

Location: 16th St. and Constitution Ave., NW, south side References: O'Connor (1995), O'Connor (undated notes) Building stones: Granite, gray; gabbro, unpolished/polished Remarks: On the south side of Constitution Ave. are the newer matching German-American Friends Fountains made from Jurassic Age Virginia diabase. This rock represents the magma from our local rift system and is associated with "the dinosaur lake deposit" red beds from which the Smithsonian Castle is made.

(Ulysses S.) Grant Memorial

Location: Grant Circle, at Union Square, on the east end of the Mall **References:** No. 3 USGS (1999)

Degradation: Like the Red Cross building with bronze statues sitting on top of marble bases, runoff from the bronze is staining the marble bluish green and there are also patches of dark purple; cracking of the marble appears to be related to the mineral stains; cracking is more severe in dark purple areas (Bruce Doe, USGS, oral commun., Oct. 2000)

Haupt Fountains ("Two Fountains")

Location: The Ellipse at Constitution Ave. References: No. 4 USGS (1998), No. 10 USGS (1975), O'Connor (undated notes)

Construction history: Built in 1967.

Building stones: Granite-gneiss, MN

Remarks: The Haupt Fountains are each built from a single huge rock, which was smoothdressed and polished on top, but left rough-faced on the edges. In the pegmatic veins, you will notice large crystals of light-colored minerals. These are primarily pink-white orthoclase feldspar. The black bands are once again biotite. This rock comes from a formation in Minnesota called the Montevideo Gneiss.

Hirshhorn Museum and Sculpture Garden

Location: 8th St. and Independence Ave., SW Construction history: Part of Smithsonian Institution

(U.S.) Holocaust Memorial Museum

Location: 2000 L Street, NW

References: Michael Zisk, Museum Architect (written commun., 2000) **Construction history:** The U. S. Holocaust Memorial Museum was designed by James Ingo Freed of Pei, Cobb, Freed and Partners, of New York, NY. Construction started in July, 1989, and the Museum opened to the public in April, 1993. The General Contractor for the project was the Blake Construction Company, of Washington, DC. The stone setting subcontractor was Roubin and Janiero, Inc., of Fairfax, Virginia.

Building stones: Primary exterior stone: Indiana limestone, quarried in Bedford, Indiana. Exterior landscape stone: Cedar Rose granite, supplied by the North Carolina Granite Corporation; also used as base on building and for retaining walls, landscape features, steps, bollards, paving border blocks, and street curbs. Primary interior stone: Cedar Rose granite; also used for flooring, stairs, walls and counters. West wall of the Hall of Witness: Premium Plus black granite, from the BG Hyderabad quarry, India. East wall of Hall of Witness: Rosa Aurora marble, Portugal. Hall of Remembrance paving: Prato Fiorito granite. Hall of Remembrance paving and steps, and ambulatory accent stone: Chassagne beige marble, Chassagne, France. Hall of Remembrance walls: Indiana limestone, quarried in Bedford, IN. **Remarks:** The building, being relatively young, has not suffered stone degradation. Museum is in the process of developing an appropriate cleaning method for the exterior limestone, which has exhibited a biological growth in limited areas. In an effort to preserve the finish of the stone, investigating a number of methods for removing this in a non-aggressive manner. These tests began in Spring 2000.

Hoover Building (Herbert Clark Hoover Building)

Location: 14th St. and Pennsylvania Ave., NW References: No. 4 O'Connor (1989)

Hotel Washington

Location: 15th St. and Pennsylvania Ave., NW References: No. 7 O'Connor (1989)

Indiana Plaza

Location: Junction of Indiana Ave., 7th St., and Pennsylvania Ave., NW **References:** No. 26 O'Connor (1989)

Interior Department Building

Location: C St. between 18th St. and 19th St., NW References: No. 37 USGS (1998)

Construction history: First occupied in 1937 after a years' construction, this 5-1/2 acre, 1,178,769 square-ft structure was designed by Waddy Wood in accordance with specifications of then Secretary of Interior, Harold Ickes. It was built at the cost of \$3 million. The mechanical equipment, including four escalators, automatic air conditioning and heating, and an elaborate telephone system, represented the most modern improvements of the time.

Building stones: Foundation and steps, Milford, MA, granite; exterior, Indiana limestone; interior, Tennessee marble

Interior Department (South) Building (formerly Bureau of Indian Affairs Building) Location: 1951 Constitution Ave., NW References: No. 37 USGS (1998), No. 33 USGS (1975)

Construction history: Built in 1933 and originally occupied by the Public Health Service, this 245-room office building was designed by J. H. de Sibour. The building is of neoclassical design.

Building stones: Exterior, Georgia White and Tennessee marbles; North Carolina granite; Indiana limestone

Degradation: Salem limestone has coarse pore size and is resistant to degradation

Internal Revenue Service Building

Location: 10th St. and Pennsylvania Ave., NW References: No. 40 O'Connor (1989)

International Cultural and Trade Center

Location: 13th St. and Pennsylvania Ave., NW **References:** No. 2 O'Connor (1989)

J. Edgar Hoover FBI Building

Location: 900 Pennsylvania Ave., NW References: No. 21 O'Connor (1989)

Jefferson Memorial

Location: Tidal Basin, East Potomac Park

References: No. 28 USGS (1998), No. 5 USGS (1999), No. 26 USGS (1975)

Construction history: Designed by John Russell Pope, the Memorial cost \$3 million and was dedicated April 13, 1943, on the 200th anniversary of Jefferson's birthday. The memorial forms the south part of the cross with the Capitol, the Lincoln Memorial, and the White House. **Building stones:** Exterior columns and walls, Vermont white marble; foundation, Georgia granite; circular terraces, Georgia granite; floors, Tennessee pink and gray marble; interior dome, Indiana limestone.

Degradation: Much damage, polish gone from exterior vertical surfaces; grooving as much as 6 mm deep where silicate-rich swirls in the Shelburne marble are eroding preferentially, even on column interiors; silicate minerals such as chlorite fall out as the carbonate matrix dissolves, and this provides a greater rate of erosion in the swirl areas; can see mica and pyrite in grooves; pyrite normally looks fresh so alteration rinds must be continuously removed; once grooving begins, freeze-thaw action creates spalling; its location near the bottom of "foggy bottom," brackish water nearby, and a coal-fired power plant nearby, its location in flight path of National Airport probably all contribute. Grooving is seen high up near the tops of the columns; the sloping surface of the roof of the portico has mineral accumulation in positive relief, probably magnesium calcite or dolomite; rate of erosion is mm/10 years. Stalactites and stalagmites are growing in the basement along cracks in the concrete floor; the bronze letter in the interior are staining the marble, but with no other discernible effects; unusual locations of damage probably are result of aerodynamics of the building where rains swirl through the structure and acid fog has free access; structural damage is noted in cracks through the interior blocks of marble, especially at the NW corner that was built on fill; subsidence may be the cause; some marble has been; the effect of tourists seems to be to polish the surfaces; the steps look good, so perhaps continuous polishing seals pores.

Repairs: some marble has been replaced such as at the base of columns at the foot of the memorial and at the entrance to the restrooms on the ground level **Cleaning methods:** hydraulic cleaning regularly by NPS

John F. Kennedy Center for the Performing Arts

Location: New Hampshire Ave. at Rock Creek Pkwy., NW References: No. 34 USGS (1998) Building stones: Carrara marble from Italy Remarks: Built on bedrock of Piedmont

John J. Pershing Park

Location: on Pennsylvania Ave. between 14th and 15th Sts., NW References: No. 9 O'Connor (1989), O'Connor (1995) Building stones: Dakota mahogany granite, SD; entrance, Stoney Creek granite, CT

John Marshall Park

Location: 4th St. extended from Pennsylvania Ave., NW References: No. 32 O'Connor (1989)

John Paul Jones Memorial
Location: 17th St. and Independence Ave., SW
References: No. 27 USGS (1975)
Construction history: The work of sculptor Charles Henry Nichaus, the 10-foot statue was unveiled April 17, 1912.
Building stones: Vermont marble

Joseph Henry Statue

Location: In front of Smithsonian Institution Main Building (Castle), 1000 Jefferson Dr., SWReferences: O'Connor (1995)Building stones: Pink granite, gray granite; sidewalk, red granite

Justice Building

Location: 9th St. and Pennsylvania Ave., NW **References:** No. 39 O'Connor (1989)

J.W. Marriott Hotel

Location: 14th St. and Pennsylvania Ave., NW References: No. 11 O'Connor (1989)

Korean War Veterans Memorial

Location: The National Mall between Independence Ave. and the Reflecting Pool **References:** No. 31 USGS (1998) **Building stones:** Wall was made of "Academy Black" granite from CA, sand blasted in Cold Spring, MN, with more than 2,500 photographic, archival images from the war; on the base of the pool, highly reflective black granite from Canada.

Remarks: A design was created by a team from State College, PA, and later revised by Cooper-Lecky Architects. The memorial was dedicated on July 27, 1995, the 42nd anniversary of the armistice that ended the Korean War.

Library of Congress

Location: 10 1st St., SE References: No. 21 USGS (1998) Building stones: Concord, NH, granite

Remarks: The main building, named in honor of Thomas Jefferson, is of Italian Renaissance design and was completed in 1897. The library has more than 86 million items in its collections, including one of the three existing copies of the Gutenberg Bible (the first book printed with movable type) and a large collection of books printed before 1501; numerous Civil War photography; recordings of American folk music; and letters, papers, and drafts from many Presidents.

Lincoln Memorial

Location: West side of the Mall; West Potomac Park at 23rd St., NW

References: No. 32 USGS (1998), No. 6 USGS (1999), No. 29 USGS (1975), O'Connor (1995) **Construction history:** The structure was designed by Henry Bacon, and the statue of Lincoln was by Daniel Chester French, both of which were completed in 1922. The memorial terminates on the main axis of the Mall and counterbalances the Capitol about the Washington Monument. **Building stones:** Reflecting Pool, North Carolina granite; foundation steps, Massachusetts granite; Memorial building, very fine-grained Mississippian Leadville Formation or Yule marble from near Marble, Gunnison County, CO; Interior statue of Lincoln is Georgia Cherokee marble; base of statue and interior floors, Tennessee pink marble; columns and lintles, Indiana limestone; lower stairs, Massachusetts granite

Degradation: unusual amount of pollution damage in the Yule marble, probably related to location at "foggy bottom;" also an inherent vice, locked in stresses are spontaneously resulting in cracking, spalling, and chipping; fossil cracks filled with calcite show where cracking started while the rock was in the ground; modern cracking is horizontal with subordinate cracks at about 45 degrees; stalactites and stalagmites in the basement form along cracks under the front steps; seen under both marble and granite parts of steps; carbonate is likely dissolved mainly from concrete; damage to the granite is unusual—lower levels next to the walkway are spalled; the top of spall zone is linear, so snow and snow removal may be the culprit; on the roof, positive relief seen in mineral grains of mangesian calcite or dolomite; so weathering rate is 1 mm/60 years. **Remarks:** This memorial was completed in 1922 after the dredge and fill operation on the Potomac River was finished and settled. Col. Peter Hains (Hains Point) was in charge of the land fill operation. The reflecting pool is a substantial part of the overall effect and is done completely in North Carolina Mt. Airy granite of Pre-Cambrian or Cambrian Age. You should see this rock in many places around the DC area as it is quarried rather cheaply and weathers very slowly (e.g., all metro stations except one). The excavated material from the pool was used to construct the Potomac levee. Note the mound between the Vietnam Memorial and the pool. This is a US Army levee to protect downtown Washington, DC (see reference to floods at Capitol Gate Posts entry). A portion of the decoration in the walkway up to the Lincoln Memorial is a quartz cobblestone set off by unpolished blocks of Massachusetts granite. Recent renovations by the National Park Service removed the local fossiliferous Potomac cobblestones

and replaced them with exotic stones. The foundation steps of the memorial consist of Pre-Cambrian Age granite from Milford, Massachusetts. The color is slightly pinkish due to the presence of large crystals of orthoclase feldspar. Flecks of dark biotite are also visible. With the right orientation, the biotite is in layers. The building itself is made of marble and limestone. The white marble on the outside is from Yule Colorado. Note the ruts or pots in the marble stairs (physical weathering). Feel your way-360 degrees-around any of the outside columns. What do you discover? The inside columns, walls and lintels are Mississippian Age limestones from Indiana. Indiana limestone is the most common building stone in DC as well as on the GW campus. It is 100 percent fossils (fossil hash) or biorock and is a great example of a coquina. The base of the statue and the floors are made of Ordovician Age marble from southeastern Tennessee. This is really another limestone—look for the white blotches and get close to observe that they are fossils. The Lincoln statue was made from Pre-Cambrian Age Cherokee white marble from Georgia. All soft rock that takes a polish is called marble in Economic Geology that is why most stone is marble but rockwise it's limestone. Remember that limestones are composed primarily of the mineral calcite, and that if limestone is metamorphosed it becomes marble. Thus, most of the memorial is built of rocks that are composed of the carbonate mineral, calcite. One of the ways to identify the presence of calcite or other carbonate minerals is that they will fizz if acid is dropped upon them. So, carbonate rocks gradually disintegrate in the presence of slightly acid rains. Look carefully for evidence of this corrosive weathering. You will see many efforts to "patch" the memorial with concrete. **Repairs:** cracks filled with cement patches

Lock House

Location: 17th St. and Constitution Ave., NW

References: O'Connor (undated notes); No. 3 USGS (1998), No. 8 USGS (1975); **Construction history:** The structure was built in 1833 when the extension of the C&O Canal was completed, joining the two canals.

Building stones: Crystalline metamorphic rocks, Piedmont of MD

Remarks: The Lock House is on what was the western end of the Washington City Canal, where Tiber Creek emptied into the Potomac River. Both were estuaries and smelly at low tide. In the early 1800s this creek became an important commercial route for heavy goods and was converted to the C & O Canal East or the Washington City Canal. The eastern terminus was the Washington Navy Yard on the Anacostia. The western end of that canal entered Tiber Creek at the point of this house. This was the abode of the canal lock keeper. The stone for this house is called the Potomac Bluestone from the metamorphic schist and gneiss associated with Wissahickon Formation, which you can find exposed on the George Washington Parkway just across the Potomac. It is a highly metamorphosed quartz-rich rock that is still quarried just northwest of the city outside the beltway. This rock represents the muds and sands of the pre-Atlantic Ocean called Iapetus. The dark flecks are small crystals of the mineral biotite. The gold flecks are pyrite. The maroon or rusty dots are the January gemstone—garnet (almandine). Very good examples of the "blue" color can be seen on the west wall.

Major General Winfield Scott Hancock Statue

Location: NW corner of 7th St. and Pennsylvania Ave., NW **References:** No. 25 O'Connor (1989)

Market Square

Location: 800 block of Pennsylvania Ave., NW References: No. 22 O'Connor (1989)

Memorial Continental Hall (original DAR building)

Location: 1776 D St., NW

References: No. 10 USGS (1999)

Construction history: started 1904; completed 1909

Building stones: Shelburne marble; Cherokee marble; monolith fluted columns unusual in DC area; unfluted columns may be Alabama limestone

Degradation: balustrades on N and S sides deteriorated so badly that it was replaced;

roughening of tops and bottoms of new stones on railings (which means there has been pollution following the Clean Air Act); hail might be a factor; columns under the portico are smoother and better preserved bases; silicate swirls have begun to weather out of vertical walls; cracked blocks **Repairs:** Stone replaced by Cherokee Marble

Cleaning methods: sandblasted in 1959; hydraulically cleaned in 1982

National Academy of Science (see also Einstein Memorial)

Location: 2101 Constitution Ave., NW

References: O'Connor (1995), O'Connor (undated notes)

Construction history: Architect, Bertram Grosvenor Goodhue; sculptor, Lee Lawrie; decorator, Hildredth Miere; and muralist, Albert Herter combined their talents in this Alexandrian designed building noted for its symbolic statuary, bas-reliefs, and murals depicting the history of science. **Building stones:** New York marble, serpentinite; Einstein Memorial, emerald pearl larvikite, Norway; Mt. Airy granite

Remarks: The National Academy of Science (NAS) building has wonderful, decayed Baltimore marble (yellow colored like human teeth) and the addition is the Cherokee white marble from Georgia—where is the addition? The green is serpentinite from serpentine—how well does a hydrothermal rock hold up to the DC weather? The building of the NAS is also a masterpiece. The bronze reliefs depict the Fathers of Science. Can you find the gurus of energy—like Ben Franklin, James Watt, N. Copernicus, F. Newton, K. Gauss, J. P. Joule, J. C. Maxwell? The owl and lynx on the roof edge are for wisdom and observation. The green rock—serpentine—is a special hydrothermal rock more commonly related to vegetation barrens than energy. The discolored marbles are local Baltimore stone but the copper in the bronze has leached to create stains with new copper carbonate minerals.

National Air and Space Museum

Location: 6th and Independence Ave., SW

References: No. 24 USGS (1998)

Construction history: Part of Smithsonian Institution. Opened in 1976. The interior is designed to resemble an airplane hangar, with huge open spaces and high ceilings to display aircraft. **Building stones:** Tennessee pink marble (a limestone) **Remarks:** Note the baked and pseudofossils (crowsfeet)

National Archives Building

Location: 8th St. and Constitution Ave., NW

References: No. 13 USGS (1998), No. 15 USGS (1975), No. 38 O'Connor (1989) **Construction history:** Part of the Federal Triangle, this building was designed by J.R. Pope and completed in 1938.

Building stones: Exterior, Milford, MA, granite, and Indiana limestone; interior, Missouri golden vein marble; foyer, Tennessee marble

National Bank of Washington Location: 301 7th St., NW

References: No. 27 O'Connor (1989)

National Building Museum

Location: Judiciary Square, F and G Sts., between 4th and 5th Sts., NW **Building stones:** Brick

National Gallery of Art East Building

Location: 4th St. and Constitution Ave., NW **References:** No. 17 USGS (1998), No. 34 O'Connor (1989) **Building stones:** Tennessee light-pink marble; street, driveway, and border of several granites **Remarks:** This building, designed by I.M. Pei, opened in 1978 to house changing exhibits and the museum's collection of 20th century art. The main part of the building is an isosceles triangle, containing two sides of equal length.

National Gallery of Art West Building

Location: 6th St. and Constitution Ave., NW

References: No. 16 USGS (1998), No. 17 USGS (1975), O'Connor (1989), Bleiberg (1995) **Construction history:** Completed in 1941, the gallery was designed by J. R. Pope. **Building stones:** Exterior, Tennessee light-pink marble; floors, Vermont verde antique marble; columns in Rotunda, Carrara, Italy, brecciated marble; restrooms, Missouri marble; fountains at each end, Jasper County, MO, Ozark travertine marble; walls of galleries, Alabama limestone. Note the outlines of chambered nautiluses in the marble walls of the men's bathroom, as well as fossils in the ladies' room. There is a 6-inch, cigar-shaped fossil of a squid in the marble floor in the front of the elevators.

Remarks: The exterior was designed with pink marble at the base becoming lighter pink toward the dome, which is nearly white. Structure is seen to best advantage during a light rain which wets the marble and brings out the color.

Cohn (1995): "O'Connor says that, if he had to pick one place that's "fossil heaven," it would be the west building of the National Gallery of Art. Go in the door on the Mall side and head back toward Constitution Avenue, where the restrooms are. Inside both men's and women's rooms are walls of "radio black" marble from Lake Champlain in New York State, crowded with snail-like gastropods, wormy relatives of the squid called cephalopods and others. On the marble floor next to the elevators outside the men's room is a fossil of an ancient clam, sliced by the stonecutters into a heart-shaped cross section. And in the golden-veined marble of the balustrade between the restrooms, those white blotches are fossils, too. As you leave through the Mall-side door, enjoy the Italian black marble columns and the green floor of serpentinite. The serpentinite, from VT but like stone still mined in Rockville, is the rock that gave the city its name, O'Connor says. The white veins are places where the marble cracked and calcium filled the gap. Serpentinite is

the easiest rock to reproduce in plastic or paint, so "it's the rock that everyone fakes," O'Connor says. Outside, look at the crow's feet and stretch marks in the Tennessee light pink marble. Tennessee pink is known for its "stylolites," or crow's feet, squiggly dark lines that actually are veins of rock, probably volcanic ash. The stretch marks are expansion cracks in the rock. Those other white blotches are fossils. In the commercial world, it is known as Tennessee marble, but to geologists it's really a limestone, formed by accumulation of sea debris. With true marble, you can't see fossils, O'Connor says. If you look at the columns outside the gallery, you can see patterns where waves went through."

National Geographic Society

Location: 17th and M Sts., NW

References: National Geographic Society (Fact Sheet); National Geographic Society (undated) **Building stones:** "868 pieces Swedish black granite in spandrels; main entrance steps and flagpole bases, Vermont White Bethel granite; 2,244 pieces Vermont Imperial Danby marble in vertical fins, sand finish; interior elevator lobbies and Explorers Hall columns, Vermont Imperial Danby marble, highly polished, 19,600 square feet."

Remarks: (National Geographic Society, undated) "The building sits atop the prehistoric remains of a dank Ice Age swamp. Excavators uncovered stumps of giant bald cypresses at least 100,000 years old; an underground creek still runs through the area."

National Museum of African Art

Location: 950 Independence Ave., SWReferences: Bleiberg (1995)Construction history: Part of Smithsonian InstitutionBuilding stones: Sunset red granite with zoned plagioclase from Texas. Note the wormholes carved by shrimp in the limestone wall.

National Museum of American History (Museum of History and Technology)

Location: Constitution Ave. between 12th St. and 14th St., NW

References: No. 11 USGS (1998), No. 12 USGS (1975), Bleiberg (1995), O'Connor (1995) **Construction history:** Dedicated January 22, 1964, and built at a construction cost of \$35,414,052, this 7-acre structure contains 50 exhibition halls.

Building stones: Exterior, TN Marble, mainly light pink; curbs and fountain steps, Pearl Pink Granite, MN. Note the large light-red irregularly shaped feldspar crystals, as well as black layers in the pink marble which are ash left by an ancient volcano.

Remarks: In the Constitution Avenue lobby, look for fossils on the floor, as well as marine fossils in the walls.

National Museum of the American Indian

Location: 470 L'Enfant Plaza, SW **Construction history:** Part of Smithsonian Institution

National Museum of Natural History ("Smithsonian")

Location: 10th St. and Constitution Ave., NW References: No. 12 USGS (1998), No. 14 USGS (1975), O'Connor (1995) **Construction history:** Construction of the building was completed in 1911 as the 3rd building of the Smithsonian Institution. Designed by Hornblower and Marshall, the building is four stories high and originally had 4 acres of space. Wings were added in 1963 and 1965. Built on a natural slope ~11 feet above river level, hit clay so had to dig deeper for a strong foundation. **Building stones:** Exterior, ground floor, pink granite, MA; two main floors and columns, white granite, VT; attic floor, white granite, (Mr. Airy) NC; subtle green and pink of unakite on Mall-side terrace.

Cohn (1995): "On your way to the excellent fossil exhibits inside, look at the petrified wood display outside the Mall-side entrance. About 200 million years ago, dead tree trunks were infiltrated by mineral-rich water, which solidified, turning wood to stone. The petrified wood is from the desert state of Arizona, but O'Connor notes that when it was alive, it probably resembled the three bald cypress trees across Madison Drive on the Mall, also swamp-loving trees. The main part of the building is pink Massachusetts granite. The vertical lines are marks of the wire saw that cut the rock. On the terrace out front is unakite, one of O'Connor's favorite stones and as lightly metamorphosed granite interspersed with a green mineral called epidote. Unakite comes from a belt that runs up the Blue Ridge from Tennessee through Virginia, and a quarry still mines it near I-66 in Virginia. It's prized by mineral collectors and sometimes made into brooches or other jewelry. Pour a little water on the terrace, and you can make it shine like a precious stone."

Remarks: Note the orientation of the fossils in the Invertebrate Hall display (some are coiled left and others right, some whole, and guess their ecology). Also observe the trunk on the Mall side of the building where the wood is petrified. What chemistry caused the change?

National Place and the Shops

Location: 1331 Pennsylvania Ave., NW, N side References: No. 12 O'Connor (1989)

National Portrait Gallery

Location: between 7th and 9th Sts. and F and G Sts. **Construction history:** Part of Smithsonian Institution

National Postal Museum

Location: 2 Massachusetts Ave., NE **Construction history:** Part of Smithsonian Institution

National Theater

Location: 1321 Pennsylvania Ave., NW References: No. 9 USGS (1998), No. 13 O'Connor (1989) Building stones: Exterior, Indiana limestone; interior, fossil-bearing Indiana limestone Remarks: This building was completed in 1923; four other theaters have occupied this site since 1835, making it the oldest continually operating theater in the United States.

National Zoological Park Location: 3001 Connecticut Ave., NW Construction history: Part of Smithsonian Institution

Old Executive Office Building

Location: 17th St. and Pennsylvania Ave., NW Construction history: completed 1888 Building stones: Gray granite

Pan American Union Building (Organization of American States)

Location: 17th St. and Constitution Ave., NW

References: No. 2 USGS (1998), No. 8 USGS (1999), No. 7 USGS (1975); Fig. 3 Doe (1989) **Construction history:** The design of the building by Albert Kelsey and Paul Cret blends architectural styles of North and South America. The building was begun May 11, 1908, and dedicated April 26, 1910.

Building stones: Exterior, Georgia Cherokee marble; steps and fountain, Tennessee marble (two types); steps at rear of patio, green Italian marble; balustrades in Aztec Garden, Georgia marble; foundation of two kinds of Tennessee marble

Degradation: two sculptures in front show alteration crusts in sheltered areas and dissolution in exposed areas; balustrades decaying in back; black coatings from gypsum alteration; blackened crusts have blistered or spalled; patio sides of balusters in better condition than sides that face the garden perhaps because washing of patio has slowed accumulation of gypsum crusts; balusters bordering west patio have granular exposures where coating has exfoliated; staining and cracking of fine-grained marble area beneath browse lamps; removal of gypsum opens pores so get water saturated during storms; sandblasting may produce microcracks; cracking of some rails although; rails have mineral accumulations (magnesian calcite? dolomite? in relief; accumulations of white material under rails gypsum; may get organic acids from trees; 5 balusters missing in front of building facing 17th St; front steps have unusual amount of cracking compared to marble steps elsewhere)

Repairs: vines removed in 1985 **Cleaning methods:** sandblasting probably several times

Patowmack Canal

Location: 9200 Old Dominion Drive, McLean, VA **References:** Moore and Jackson (1989) (p. 98)

Peace Monument

Location: Pennsylvania Ave. at the west front of the Capitol **References:** No. 18 USGS (1975), No. 2 USGS (1999)

Construction history: Designed by Admiral David Porter, executed by Franklin Simmons and Edward Clark, and brought to America and dedicated in 1877, the monument stands 44 feet high **Building stones:** Carrara, Italy, marble

Degradation: alteration crusts in protected places and graininess and roughness where exposed to rain

Remarks: In memory of members of the Navy who died in the line of duty from 1861 and 1865. The figures at the top of the monument represent America weeping upon the shoulder of History. Facing the Capitol is a figure representing Victory with Mars and Neptune at her feet.

601 Pennsylvania Ave.

Location: 601 Pennsylvania Ave., NW

References: No. 29 O'Connor (1989)

1001 Pennsylvania Ave. Location: 1001 Pennsylvania Ave., NW References: No. 20 O'Connor (1989)

1201 Pennsylvania Ave.Location: 1201 Pennsylvania Ave., NWReferences: No. 17 O'Connor (1989), O'Connor (1995)Building stones: Porrino pink granite, Spain

1301 Pennsylvania Ave.

Location: 1301 Pennsylvania Ave., NW References: No. 14 O'Connor (1989)

Pennsylvania Building

Location: 1275 Pennsylvania Ave., NW References: No. 16 O'Connor (1989)

Pentagon

Location: Arlington, VA. This building is in the part of Virginia that was originally given to Washington, DC.References: Moore and Jackson (1989) (p. 109)Remarks: They had to sink pilings through sand, clay, and gravel that was 100 ft thick to reach Piedmont bedrock to support the building.

Plaza One (office complex for Warner Theater)

Location: 501 13th St., at NW corner of E St., NW References: No. 15 O'Connor (1989)

Post Office Pavilion and Nancy Hanks Center Tower

Location: 12th St. and Pennsylvania Ave., NW References: No. 10 USGS (1998), No. 41 O'Connor (1989), O'Connor (1995) Building stones: Exterior, Maine granites; interior mezzanine floor, white and orange marble with green serpentine

Presidential Building

Location: 1151 Pennsylvania Ave., NW at NE corner of 12th St. **References:** No. 18 O'Connor (1989)

Rayburn Building

Location: Independence and New Jersey Aves., SE References: No. 22 USGS (1998), No. 20 USGS (1975)

Construction history: Working 10 years on the project, William H. Livingston designed the structure and furniture of the building which contains 169 suites for Congressmen. The nine-story building was completed in April 1965.

Building stones: Exterior walls, Georgia White Cherokee marble and Vermont marble; interior walls and trim, Vermont marble; perimeter base, New Hampshire pink granite; east and west courts and paving borders, pink granite, TX (note large regularly shaped pink feldspar crystals); inner court, base of Salisbury, NC, pink granite with Indiana limestone above

Red Cross Buildings

New building location: E Street

Old building location: 17th and E St., NW

References: No. 5 USGS (1975)

Construction history of new building: started 1928; completed 1931

Construction history of old building: started 1915, completed 1917

Building stones: fine-grained Shelburne marble, Ordovician age near Danby, VT; the base of balustrade is granite (MO?)

Degradation: rougher feel of columns directly exposed; portico, outward flute faces abrasive, inward facing flutes are smooth; cracking and staining of fine-grained marble from drainage off bronze lamps; green and purple staining on marble removing carbonate matrix (sugaring); cracking on north check wall of steps; beginning on south check wall as well; balustrades: posts have minor splits, rails have a few splits; split and spalling on balusters, cracked all the way to base (on 17th St. side); vehicles may hit balustrades; where the base is granite, may be differential thermal expansion and contraction or maybe damage during snow removal; the famous cracking and staining off the bronze statues

Repairs: splits patched with cement

Cleaning methods: hydraulic sandblasting in 1985 (staining reappeared by 1987) **Remarks:** The main building facing 17th Street was occupied by the Tafts, and Francis D. Millet, painter, at the time a member of the National Commission of Fine Arts, who lost their lives on the Titanic, April 15, 1912.

Renwick Gallery of the National Museum of American Art (formerly U.S. Court of Claims and Old Corcoran Gallery)

Location: 17th St. and Pennsylvania Ave., NW

References: No. 39 USGS (1998), No. 36 USGS (1975), No. 12 USGS (1999)

Named after: architect James Renwick

Construction history: Part of Smithsonian Institution. Completed in 1859, and designed by James Renwick, this building was originally constructed by William Corcoran to house his art collection which proved to be too large for the structure. The government took possession of the building during the Civil War. It at one time housed the U. S. Court of Claims and recently was restored to become part of the Smithsonian Institution. Plastic impregnated with crushed stone failed with discoloration and spalling off, so needed a covered walkway.

Building stones: Exterior, Triassic Belleville, NJ, sandstone; replaced in part with reddish cast synthetic stone in 1970

Riggs National Bank Building

Location: 1750 Pennsylvania Ave., NW

Construction history: This structure was built in the 1960's.

Building stones: Exterior, travertine, Italy; interior, fossiliferous Tennessee marble

O'Connor remarks: Note that the color of stone where it is protected from the weather is straw yellow; where weathered, it is a dead white.

Ronald Reagan Building and International Trade Center

Location: 13th and 14th Streets and Pennsylvania Ave., NW **Reference:** No. 7 USGS (1998)

Building stones: Exterior, Indiana limestone; interior, various granites, chunk of the Berlin Wall in the main entrance foyer (14th Street)

Remarks: The Ronald Reagan Building and International Trade Center is the second largest federal building in size—3.1 million gross square feet. Formal opening of the building was in the spring of 1998.

Second Division Memorial

Location: Ellipse, southwest edge **References:** No. 9 USGS (1975)

Building stones: Minnesota granite-gneiss

Remarks: An example of some of the oldest rock so far dated by the U. S. Geological Survey - 3.5 billion years old. Notice the distinctly different appearance achieved through polishing and rough-facing. How have the battles that this Army unit has engaged in since WWI and WWII been added?

State Department Building

Location: 23rd and C Streets, NW References: O'Connor (1995) Building stones: Sidewalk, Cold Spring, MN, granite and Texas sunset red granite; C St. flagpole, gabbro, crystals; window/23rd St. door facing, granite, swirl gray, matching panels

Supreme Court Building

Location: East Capitol and 1st Streets, NE **References:** No. 20 USGS (1998)

Building stones: White marble

Remarks: This building, the first permanent home of the U.S. Supreme Court, was completed in 1935. Its central portion is in the style of a Greek temple with Corinthian columns and enormous sculptured bronze doors.

Treasury Department Building

Location: 15th St. and Pennsylvania Ave., NW; S front at Alexander Hamilton Place, facing Sherman Park

References: No. 42 USGS (1998), No. 39 USGS (1975), No. 6 O'Connor (1989) **Construction history:** The present building is the third one to house the Treasury Department, two earlier buildings having been destroyed by fires. Designed by Robert Mills, it was begun in 1839, and the final portion was completed in 1869.

Building stones: Exterior, original part along 15th Street, Aquia Creek sandstone, VA; remainder, Dix Island, ME and Milford, MA, granites; foundation, Maryland crystalline rocks; patio, Seneca, MD, red sandstone, Catskill, NY, green sandstone, and concrete

U.S. Navy Memorial

Location: 800 block of Pennsylvania Ave., NW, in Market Square Park

References: No. 14 USGS (1998); No. 23 O'Connor (1989)

Building stones: Quebec, Canada, black granite, Rhode Island light-gray granite; patio,

Catskills, NY, green sandstone; border, Deere Isle, ME, lavender granite

Remarks: The oceans and continents on this massive globe (100 feet in diameter) were cut by computer-controlled water jets and glued together. The compass at the south entrance contains a mosaic of white marble, bronze, and polished black granite. The monument was dedicated in 1987.

Union Station

Location: Massachusetts Ave. and 1st Street, NW **References:** No. 18 USGS (1998)

References: No. 18 USUS (1998)

Building stones: Vermont granite

Remarks: Union Station was built to consolidate Washington's passenger train traffic into one location; it was opened to service in 1907. The station, modeled after the Baths of Caracalla in Rome, is 720 feet long; the waiting room is 1120 feet wide and 219 feet long, and the vaulted ceiling reaches 96 feet above the floor. A major renovation was completed in 1989, and the building now serves as National Visitor Center, in addition to being a terminal for train and subway service.

Vietnam Veterans Memorial

Location: Constitution Gardens, between Constitution Ave. and the Reflecting Pool **References:** No. 35 USGS (1998), O'Connor (1995)

Building stones: Black granite quarried near Bangalore, India; cut and fabricated in Barre, VT; sandblasted in Memphis, TN

Remarks: This is one of the few rocks on the Mall not quarried in the United States. It was quarried in India. The dark, black rock of the memorial is sometimes called "black granite," but the actual term is gabbro. Crystals are hard to see because of the polish, but if you look closely, you will see that many crystal faces reflect light. The walkway on which you are standing is made of the same gabbro as the memorial, but it is not polished. Maintaining the wall is posing some difficulties. The wall is developing many small cracks. Preliminary data suggest a thermal problem of solar energy on the south side and soil/groundwater temperature differences on the north side playing against rock slabs that are too thin. The young Asian American lady, Maya Ying Lin, that designed this monumental wall used the sun rise and set as a migration pass: sun hits the far west part of the wall in the morning, center at noon and sets on the east end of this simple southfacing V wedge.

Washington Monument

Location: Center of the Mall

References: No. 27 USGS (1998); No. 25 USGS (1975); No. 14 USGS (1999); Cohn (1995); O'Connor (undated notes)

Construction History: Pierre L'Enfant originally planned the placement of this monument to be along the east-west line of the Mall at the intersection of the north-south line passing through the White House. The Jefferson Pier—a small granite monument lies at this math spot. But the engineering geology won over a math plan. The site was the original shoreline for the Potomac.

Since estuarine sediment happens to have no adequate footing to support a monument at that math delineation, so the monument was erected east of the shoreline. Would you appreciate a leaning tower of Washington today if geology were not used? Designed by Robert Mills and begun in 1848, the monument stands at 555 feet 5-1/8 inches and is the tallest masonry structure in the world. Because of delays and complications, which included the theft of books and records of the Monument Society, the construction spanned 37 years and was not completed until 1885.

Building stones: Exterior, upper part, Cockeysville, MD, marble; lower part, Texas, MD, marble; four courses in between, Lee, MA, marble; interior backing, Seneca, MD, sandstone and Maryland crystalline rocks; foundation, Little Falls, MD, crystalline rocks **Repairs:** scaffolding removed October, 2000

Remarks: Why isn't it all the same color? Because the monument was built in three stages, using three different marbles. The first 152 feet are made of true marble from Maryland that is given the name "Texas" after the source quarrytown in Maryland. These first stones were emplaced from 1845-1854 when work was stopped due to lack of funds and the impending Civil War. Work started again in 1876, but it was found that the monument was tilting. Wider subfoundations were installed to a depth of 37 feet below ground level. Look for the small hill or rise to the monument: underneath are flying buttresses that were buried by the US Army Corps of Engineers. This work was completed in 1879. Four levels of Ordovician Age Stockbridge marble from Lee, Massachusetts, were then laid. It turned out that this rock cost too much, so the remainder of the monument was finished with a fine-grained marble with a few pale streaks, and which contain a significant amount of magnesium, from Maryland. (This one is called "Cockeysville," not "Texas.") "Cockeysville" is the geologic name for the Baltimore marbles and the original quarry which is still in operation at Cockeysville along I-83. The Baltimore marbles are part of the Baltimore gneissic nappe-dome tectonic wonders. Northern, central and southern Appalachian marbles weather differently, and you should easily see the color difference between the three marbles about one quarter of the way up. Differences in marble types can also be seen if you look east to the Capitol and view the two colors of marbles from wings to center. Finally, the monument was topped with a small pyramid of aluminum.

Washington National Cathedral

Location: Massachusetts and Wisconsin Aves., NW References: Jan Delburto, Washington National Cathedral Building stones: Building, Indiana limestone; statues, higher grade of limestone for easier cutting; high alter, stones from Jerusalem; floors, various marbles from Candoro Marble Co.

White House

Location: 1600 Pennsylvania Ave., NW

References: No. 41 USGS (1998), No. 38 USGS (1975), Moore and Jackson (1989) (p. 17) **Construction history:** Designed by James Hoban and begun October 13, 1792, the White House was the first public building to be erected in Washington. First occupied by President and Mrs. John Adams in 1800, the interior was rebuilt, 1948-52, by the Commission on the Renovation of the Executive Mansion.

Building stones: Exterior, Aquia Creek sandstone, VA, refinished with Maryland marble and other marbles; fence base, Montgomery County, MD, crystalline rocks; fence capping, Aquia Creek sandstone, VA, replaced by stone removed from east front of Capitol after renovation.

Willard Hotel

Location: 1400 block of Pennsylvania Ave., NW, N sideReferences: No. 8 O'Connor (1989), O'Connor (1995)Building stones: Woodstock granite from MD; new additions, Mason gray granite, NHRemarks: The Men's room marble and stairs have fossils.

Zero Milestone

Location: Ellipse, north edge

References: No. 1 USGS (1998), No. 1 USGS (1975)

Building stones: Milford, MA, granite and gneiss

Remarks: Designed by Horace W. Peaslee, the Zero Milestone is a substitute marker for a column planned by L'Enfant. The column was to be placed 1 mile east of the Capitol, "from which all distances of places through the continent were to be calculated." Today's marker provides a point from which distances may be measured on highways of the United States radiating from Washington.

O'Connor (1998): One of the most important uses of stone is to mark property lines. For example, when the 100 square mile area of D.C. was surveyed, Benjamin Banneker astrosurveyed in each stone marker at each mien point around the perimeter. There were 40 stones in total which are all in place today. They were carved from a type of rock called the Aquia Creek Sandstone or Virginia Freestone.

The stone in front of you is different. This is called the Zero Milestone because it takes the place of the decorative marker planned by L'Enfant to be placed one mile east of the capitol. His hope was that the stone would be a reference point for determining the positions of all other points on the continent. Today, the marker is used simply as a reference point for measuring the highway distances radiating from Washington, D.C.

The age of the rock is Precambrian. Most rocks that old have experienced enough temperature and pressure to have been metamorphosed. Look closely at the rock. There are many localized bands of darker color that give the rock a "plastic" or "flowing" appearance. You should notice that the rock is coarse-grained, i.e., you can see individual crystals of different minerals. The light-colored mineral is mostly orthoclase feldspar, while the dark flecks are the mineral, biotite. Now look at the letters cut into it. They were once quite sharp. Now they are rounding, showing the effects of weathering on site.

BUILDING STONES OF OUR NATION'S CAPITAL (USGS, 1998, and Jim O'Connor, undated manuscript)

The buildings of our Nation's capital serve as a unique geologic laboratory, exhibiting various types of rocks quarried not only in many parts of the United States but throughout the world as well. The rocks used as building stones in the architecture of Washington, D. C. tell an interesting geologic story and are markedly significant witnesses to the city's growth and development.

Architectural stone has always been chosen with three criteria in mind: it must be pleasing to the eye; it should be easy to work; and it must be durable. Today it is possible to obtain fine building stone from virtually anywhere in the world; the visitor to Washington can see buildings constructed of limestone from Indiana, granite from New England, and marble from Italy. In the early days, however, the builders of the city had to rely on local building materials. The decisions of these early builders, guided by the types of building stones available locally, influenced the styles of architecture that are seen today in many of the Capital city's federal buildings. This booklet describes the occurrence and the appearance of the building stones used in Washington, and includes a map and a walking guide to permit the interested citizen to see for himself the variety of stones used in the construction of his Capital.

In order to show what types of building stones were available to the early builders of the Capital, it is necessary to review briefly the local geology, for geology had a definite influence on the early architecture. The Washington metropolitan area lies in parts of four physiographic provinces; that is, areas in which the rocks and topography are similar throughout, and which differ considerably from those of the neighboring provinces. These provinces are, from east to west, the Coastal Plain, the Piedmont, the Triassic Lowland and the Blue Ridge. The geologic nature of these provinces determined the type of stone invaluable to Washington's early builders.

The Coastal Plain province extends along the Atlantic and Gulf Coasts from northeastern New Jersey to Mexico. It is a gently undulating plain that rises gradually westward from the coast to as high as 400 feet near its western edge. It is underlain by gravels, sands, silts, clays and marls of late Mesozoic and Cenozoic age deposited beginning about 100 million years ago and continuing to the present time. The Coastal Plain is marked by broad tidal estuaries, which in the Washington area include the Chesapeake Bay and the Potomac and Anacostia Rivers.

The oldest sediments of the Coastal Plain, which crop out along the western edge of the province, are poorly consolidated gravels, sand, silts and clays deposited by a series of south-flowing rivers. These sediments were derived from the weathering of the Piedmont rocks to the north and west, and dip southeast at an average of 80 feet to the mile, passing eastward under the younger formations. The younger formations are the glauconitic and micaceous sands and clays of the Late Cretaceous, Paleocene, Eocene and Miocene age, deposited in estuaries and on the continental shelf in water that was generally less than 200 feet deep. In Pliocene time (between 10 million and 1 million years ago), a large south-flowing river system developed. This system deposited extensive alluvial fans now exposed in central and southern Prince Georges County, Maryland, as gravels, sands and clays that cap the uplands. In Pleistocene or Recent (Holocene) time (from about 1 million to less than 10,000 years ago), these fans were up lifted and rivers such as the present-day Potomac began cutting down to their present levels leaving behind terraces of gravel at various elevations.

The western boundary of the Coastal Plain, where it joins the Piedmont, trends northeastward across the Washington metropolitan area. The physiographic boundary corresponds to the Fall Line, a line connecting points on adjacent rivers and streams where they pass from the more resistant rocks of the Piedmont to the more easily eroded sedimentary deposits of the Coastal Plain. It is here rapids or falls form. The width of the zone in which rapids occur ranges from less than a mile to as much as 12 miles, but the Fall Line is drawn joining the lowest falls on each river or stream.

The Piedmont province is west of the Coastal Plain; it is a belt of rolling hills that extends from southern New York to Georgia. Elevations range from near sea level along the major drainages at the Fall Line to as much as 1,000 feet in the west. Rivers in the Washington area, such as the Potomac and the Patuxent, flow southeast across the province in steep-walled valleys as much as 400 feet deep. The Piedmont is 25 to 140 miles wide; due west of Washington, D.C., it is about 40 miles wide.

The Piedmont rocks near Washington are highly resistant crystalline schists and gneisses ranging in age from late Precambrian to Ordovician (600-450 million years old) that have been intruded by igneous rocks and veins of quartz and pegmatite. The best exposures of the crystalline rocks are in valleys, where the rocks have been stripped of soil cover by erosion. On the uplands the crystalline rocks are weathered to saprolite, a decomposed, porous, spongy, redbrown material, as much as 200 feet thick. The final product of weathering, which is seen on the surface throughout much of the Piedmont, is a sticky, micaceous, sandy and silty clay, generally having a reddish color.

The buried surface of Piedmont rocks on which the Coastal Plain sediments rest dips southeast at an average inclination of about 50 feet to the mile; in the Washington metropolitan area the dip is steeper, about 125 feet to the mile. Thus the same metamorphic rocks seen in the valley of Rock Creek and along the Potomac are 200 feet below sea level at the Capitol, 1,700 feet below sea level at the southeastern edge of the Washington metropolitan area in Prince Georges County, Maryland, and as much as 8,000 feet below sea level at the Atlantic Ocean.

The Triassic Lowland province is a gently rolling plain broken by long low ridges. The province extends southward in an almost continuous belt 10 to 30 miles wide from the west side of the Hudson River in northern New Jersey to Virginia. The Triassic rocks, deposited about 200 million years ago, are red shales and, red and gray sandstones, and conglomerates, which weather to a reddish soil. These sedimentary rocks are as much as 1,500 feet thick, and have been intruded by traprock (resistant fine-grained database and basaltic dikes and sills). The Triassic rocks dip 2° to 25° west and are broken by numerous north-trending, steeply dipping faults. At the western edge of the basin in which the Triassic rocks were deposited, a series of alluvial fans, now lithified, were deposited. These are made up of rounded to angular masses of limestone and quartz and quartzite that range in size from sand grains to boulders as much as a foot in diameter, cemented by calcite.

The Blue Ridge province, lying west of the Triassic Lowlands, is a region of valleys and ridges underlain by folded metamorphic and igneous rocks that extend southward from southern Pennsylvania to Georgia. In the Washington metropolitan area, the rocks of the Blue Ridge consist predominantly of granite, greenstone (metamorphosed from basaltic lava flows), and quartzite. Sharp, north-trending ridges, formed mostly by resistant quartzite, rise more than 1,000 feet above sea level. Many of the rivers and streams pass through these ridges in steep-walled canyon. The ridges are separated by broad valleys, which are generally underlain by less resistant limestone.

The early settlements in the Washington area were established at the head of navigation of the Potomac River near the Fall Line. It was here that cargo was unloaded for transport inland and produce from the Piedmont was loaded for shipment to distant markets. In addition, the crossing of the Potomac, either by bridge or ferry, was at the Fall Line; therefore, the first major overland north-south transportation route was along this line. At the time of the industrial revolution, manufacturing was attracted to the Fall Line settlements because water power was readily available. The early Fall Line settlements in the Washington area were Alexandria, Virginia, Bladensburg, Maryland, and Georgetown, now D.C., which were founded as ports. Laurel, Maryland, at the easiest crossing of the Patuxent River, was also a manufacturing town utilizing the power of the falls.

Besides the influence in determining the site for the city of Washington, geology has had a powerful influence upon the type of building materials from which the city was built. The abundance of brick clay obtained from the weathered Piedmont rocks and from the sediments of the Coastal Plain was, for example, a determining factor for the form of the earliest buildings in the area. Brick made locally continues to be one of the major building materials in the metropolitan area.

The earliest building stones used by the settlers were the schists and gneisses of the Piedmont which were quarried from outcrops along the Potomac River. These rocks, locally known as "Potomac bluestone," are still quarried west of the city in Montgomery County, Maryland.

In colonial days the first solid ground on the marshy north shore of the Potomac, just north of where the Lincoln Memorial is now, was an outcrop of Piedmont rocks which jutted out into the river. This promontory served as the starting point for surveys establishing property lines for the early settlers. On several old maps it is labeled "Key of All Keys," and for many years it bore a surveyor's benchmark. Its more popular name was Braddock's Rock reportedly because General Braddock and his red-coated soldiers accompanied by Lieutenant Colonel George Washington landed there in 1755 on their ill-fated journey to Fort Duquesne.

In time Braddock's Rock became a quarry. It is said to have furnished stone for the foundations of both the White House and the Capitol. Later, stone from Braddock's Rock was used in the construction of the Chesapeake and Ohio Canal. About 1832, when the canal was extended below Georgetown to connect with the Washington City Canal, nearly all that was left of the original outcrop of Braddock's Rock was blasted away. The riverside swamps have long since been filled and the land raised above the level of the original surface. All that remains of Braddock's Rock can still be seen enclosed in a circular granite-lined well south of the grounds of the old Naval Hospital, amidst the approach ramps to the Theodore Roosevelt Bridge. An iron grill covers the top of the well, and a ladder leads down to the rock, which is about 16 feet below the present land surface and is usually covered by several inches of water.

Many other quarries supplied schist and gneiss to the city. One of the most important was the Little Falls Quarry on the Maryland shore of the Potomac just beyond the District of Columbia. Much of the stone for the foundations and the backing for the marble of the Washington Monument came from this quarry. An engraved stone from the Little Falls Quarry appears among the odd assortment of commemorative stones from all over the world that line the interior walls of the monument.

One of the oldest remaining houses in the Washington area, the Old Stone House at 3051 M Street, NW, in Georgetown, is made of this rock. The house was built in 1765 by Christopher Lehman, a cabinetmaker. A good example of pre-Revolutionary architecture, this historic house is now open to visitors.

The foundations of an even older building, constructed about 1760 of this same crystalline rock, have been preserved intact in a brick warehouse at 1000 Wisconsin Avenue. The present structure known as the Dodge Warehouse after its early owners and the adjoining small building fare among the few late 18th century commercial buildings of Georgetown that are still extant.

The most impressive stone structures that were built in Georgetown were the canal works. These were predominantly of Piedmont crystalline rock. They included the walls and locks of the Chesapeake and Ohio Canal, the bridges over it, and the abutments and piers of the Aqueduct Bridge which carried canal boats across the Potomac to the Alexandria Canal on the other side of the river.

The Aqueduct Bridge was begun from the Virginia side of the Potomac in 1833, the same year that work started on the Alexandria Canal. After much delay and mishap, rock bottom for the first pier was reached in December 1834 and 8 months later this pier was completed. In 1840 the last of the eight huge piers of the bridge was finished with stone from the Little Falls Quarry a few miles upstream from the bridge. The massive double-arched abutment on the Maryland shore was constructed of the same stone by the Chesapeake and Ohio Canal Company.

In a belated move toward economy, the superstructure of the bridge was built of wood instead of iron, with wooden trusses supporting the "I" load between the piers. The bridge was opened on the 4th of July, 1843, just 10 years after the work began.

During the Civil War this strategically located bridge was controlled by the Union Army. The aqueduct was drained and the bed used as an ordinary bridge. After the war the superstructure was rebuilt several times, first with wood and then with iron. The bridge was used for a time as a railway bridge by the Washington and Old Dominion Railroad. The bridge was abandoned in 1923 and in 1962 the piers were blasted out to a depth of 12 feet below the waterline. Only the massive north abutment and a part of the pier nearest the Maryland shore are extant, and can still be seen upstream from Key Bridge.

In Georgetown the walls and locks of the Chesapeake and Ohio Canal, and one of the original bridges crossing it, are preserved. The bridge, built in 1831, carries Wisconsin Avenue (formerly High Street) across the canal. It is of local crystalline rock faced with blocks of Aquia Creek sandstone, another of the important building stones in early Washington.

Aquia Creek sandstone was most in demand for Washington's public buildings between 1790 and 1840. It was used for the White House and for the older parts of the Capitol, the Treasury Building and the Old Patent Office. Aquia Creek sandstone is of lower Cretaceous age. It is an unusual stone composed principally of quartz sand and pebbles, and clay pellets, cemented together by silica. The sandstone received its name from Aquia Creek in Stafford County, Virginia, near where it was quarried. The sandstone is unique in that only here are the Coastal Plain sediments cemented sufficiently to be useful as a building stone. This stone is also called Virginia freestone, a term applied to sandstone that splits with equal ease into any desired direction and dresses easily due to incomplete cementation of the sand grains. Aquia Creek sandstone was ill suited for use as building stone because it was full of troublesome flaws. Its popularity was due simply to the lack of a better building material in the Washington area, and to the fact that the stone was easy to carve. Furthermore, the quarries were situated near water transportation, the best available at that time, about 40 miles from Washington on the Virginia shore of the Potomac. Because of these factors the poor quality of the stone was overlooked.

In February 1807, Benjamin Latrobe, second architect of the Capitol, gave a detailed account of the Aquia Creek sandstone in an address to the American Philosophical Society. He

listed the components of the stone as sand, . . . generally sharp; clay, in nodules; rounded pebbles of quartz, sandstone, and granite; . . . pyrite or lumps of marsh mud mixed with sulphat (sic) or sulphuret of iron, efflorescing in the air; nodules of iron ore in sand . . . (which) . . . dissolve in air and water, and stain the stone disagreeably . . .; wood . . . from trunks and branches of trees of large size, to small twigs . . . at places entirely carbonized, or the wood carbonized and the bark fiberous so that it appears as a net, or the bark fiberous and the wood friable, or the wood replaced by pyrite, which effloresce in air. He mentions that, the color of the stone varies from white to a dark rusty tint . . . the degree of hardness is very various. When moderately hard, its fracture is rough and irregular, when very hard, concave and even, when breathed upon, it has a strong earthy, and somewhat hepatic smell.

Latrobe pointed out that the size of the sandstone blocks sent to Washington was limited to 4 tons because of transportation difficulties. The best quarry was 2 miles southwest of Aquia Creek, where the rock contained no joint "... horizontal or perpendicular, and columns of any size, not exceeding 15 feet in diameter, might be got out of it, if they could afterward be removed" The stone was used successfully in the construction of the Capitol and other early public buildings, but it was soon found that the stone was so inferior that much of it had to be painted or replaced soon after it was installed.

Aquia Creek sandstone was also used in the boundary stones of the District of Columbia. The cornerstone, marking the southern limit of the Federal City, was set in place by Pierre L'Enfant at Jones Point, Alexandria, Virginia, in April 1791. This stone and all but a few of the 40 original boundary stones of the 10-mile-square District may be seen near their original locations. The sides are engraved to show the jurisdiction of the United States, of the States of Virginia and Maryland, the year, and the magnetic declination of the compass. Some of these stones are badly weathered, even though they are only 4 feet long by 1 foot square and, therefore, small enough to have been cut from the hardest and soundest part of this "exceedingly various" Aquia Creek sandstone.

The best places to see the stone, as it was used indoors, are the older parts of the Capitol and the Old Patent Office. The sandstone gallery of the Old Patent Office with its plain squat columns is particularly impressive. In the Capitol Building, Aquia Creek sandstone may be seen in the walls and columns of the rooms adjoining the rotunda. Latrobe's graceful Little Rotunda tobacco column colonnade in the Senate wing on this floor is especially attractive. Downstairs, the simple Doric sandstone columns of the crypt have a brownish cast, while the famous cornstalk columns in a nearby entrance hall are decidedly gray. Latrobe was especially proud of his original design for these six small cornstalk columns, but even for these he was unable to obtain unflawed stone from the Aquia Creek quarry.

An outstanding example of unpainted Aquia Creek sandstone still in use outdoors is the original section of the Old Patent Office. This part of the building, with its pedimented Doric portico copied from the Parthenon and built between 1836 and 1840, was designed by Robert Mills who served for a time as Architect of Public Buildings. The rest of the building, which was built during the 1850's and 1860's, is of marble from Cockeysville, Maryland, in the Piedmont province. On each facade there is a marble portico to match the older sandstone portico on the south. The warm brownish tones of the sandstone contrast with the cold grays and whites of the marble. On the whole, the flaws in this sandstone are minor. They have been repaired, and the facade and the great portico look reassuringly sound.

Mills was not in favor of using Aquia Creek sandstone for either the Patent Office or for the Treasury Building on which he was working at the same time. He respectfully urged granite," but Congress chose "the least costly of the cut stone materials, and therefore, the freestone was selected for the two buildings."

The part of the Treasury Building built by Mills--the middle of the east facade along 15th Street, NW, with its long Ionic colonnade and the central corridor--was completed in 1842. The other wings, which are of Maine granite, were built between 1855 and 1869. The columns of the later wings are granite monoliths, quarried on Dix Island, Maine, and brought to Washington in sailing vessels. Each of these 30-ton columns was set in place by block and tackle and a team of 16 oxen. The columns were designed by Thomas U. Walter, who was the architect for the great iron dome and wings of the Capitol. For years the east facade of the Treasury with its sandstone columns stood in incongruous contrast to the gray granite of the newer wings. Finally, in 1907, the sandstone facing and the columns of the east front were replaced with granite from Milford, Massachusetts, which closely resembles the Maine granite. The weathered drums of the original columns were placed in the land fill for the new ground where the Lincoln Memorial now stands.

Poor quality Aquia Creek sandstone was used in the Capitol gate-houses and gateposts built by Charles Bulfinch about 1829. These structures show how "treacherous" this stone can be when left exposed to the elements. They were moved from the Capitol grounds in 1874. Some are on Constitution Avenue near the Washington Monument; one gatehouse and three gateposts are located at 15th Street and Constitution Avenue, NW, and another gatehouse farther west at 17th Street, NW. Two more of the gateposts are in Fort Totten Park in northeast Washington.

"Calico Rock," the common name for Potomac marble or Potomac breccia, is the most striking building stone quarried around Washington. This stone was deposited in a series of alluvial fans in the western edge of the Triassic Lowland province along the eastern slope of the Blue Ridge Mountains in Maryland and Virginia. It is predominantly limestone and quartz pebbles and fragments of many colors from sand grains to cobblestones up to a foot across cemented together in a calcareous matrix. Samples of this marble-like conglomerate or puddingstone from various localities show marked differences in color. John Latrobe, Benjamin Latrobe's son, gives an account of cutting and polishing a piece of this stone with his father and being delighted with its markings and variegations of pure white, blue-gray and black. Another writer describes this stone as "red, white, brown, gray, and green, with every intermediate shade." The "Calico Rock" in the Capitol is predominantly gray, but the gray matrix shades to a rich reddish brown. The inclusions are gray, beige, yellow, black, white, brown, orange, and reddish brown in an indescribable variety of combinations. White calcite veins accentuate the effects of the different colors.

Potomac marble was first reported in 1815 by Benjamin Latrobe who was then hard at work restoring the burned Capitol. The following year a supposedly inexhaustible supply was discovered. Latrobe described this stone as a very hard but beautiful marble answering every expectation "not only of its beauty but of its capacity to furnish columns of any length, and to be applicable to every purpose to which colored marble can be applied."

Arrangements were made for quarrying Potomac marble for the interior of the Capitol. The 20-foot columns for the Old Hall of Representatives (now Statuary Hall) were to be "procured each in a single block should transportation be found convenient." Until the Chesapeake and Ohio Canal was finished the huge blocks were brought overland from quarries near Point of Rocks, Maryland, 6 miles west of Washington. This was a tremendous task, but transportation was not the only problem. The beautiful conglomerate proved extremely difficult to work. The hard pebbles tended to break away from the softer matrix in which they were embedded, so the stone had to be carefully fashioned with saws and abrasives. An apparently perfect block often contained flaws and would fall to pieces in working. Latrobe became so discouraged by the difficulties and delays that he suggested substituting Aquia Creek sandstone as a poor second choice. The city commissioners refused, however, and the work continued. The columns of the Old Hall of Representatives were not finished until 1818, a year after Latrobe had been replaced as Architect of the Capitol by Charles Bulfinch. These columns are worth studying both for the stone itself, with its varied and richly colored inclusions, and for the long story of frustration the columns reveal. Instead of the monoliths envisioned by Latrobe, the columns are made up of drums of irregular lengths. No two columns are divided in the same way; each seems to have been treated as an individual problem. The patches covering the spots where pebbles broke away serve as a further reminder of the painstaking labor expended on these colorful columns.

During the "brownstone era," from about 1840 to about 1880, red Seneca sandstone was extremely popular in Washington. This stone of Triassic age crops out along the Potomac River from Seneca to Point of Rocks, Maryland. The major red sandstone quarries are situated near the mouth of Seneca Creek. Red Seneca sandstone ranges from reddish brown through cinnamon to a deep purplish brown. It is brightly colored and fairly easy to carve when cut but darkens and hardens on exposure to air. The Seneca sandstone quarried for the Smithsonian building was described originally as lilac gray; now it is a dark red. Seneca sandstone is generally fine grained and uniform; it is not shaly and does not scale when exposed to weather. However, for best results this stone must be laid parallel to the bedding plane. If laid on edge the bedding tends to flake or chip away.

Several quarries supplied this red sandstone to the city, but the best known one was situated about 20 miles up the Potomac on the Maryland shore just west of Seneca Creek. The remains of the quarry and of the adjacent Seneca Basin, where canal barges were loaded with stone for shipment up or down the canal, may still be seen. The ruins of a quarry building, which housed saws and machinery for finishing the stone, stand nearby. This building belonged to the Seneca Sandstone Company, which began operations in 1850 and supplied stone for many buildings in Washington. About 1875 the popularity of brownstone began to diminish and business declined. In 1889 floods washed out the canal, and the quarries remained idle for 2 years. Soon after the canal reopened and operations were resumed, the better quality stone was depleted. The stone that remained had a tendency to "shale off so" and the company and its quarries closed.

The masonry locks of George Washington's "Pawtomack" Canal at Great Falls, Virginia, are largely constructed of this red sandstone, as are many of the locks, lockhouses, and other structures of the Chesapeake and Ohio Canal, built between 1828 and 1850. The three-arched aqueduct that carries the C & 0 Canal over Seneca Creek is built of this stone cut near the site.

Seneca sandstone was also used for some of the backing for the marble of the Washington Monument. The first important government building to be constructed of Seneca sandstone was James Renwick's turreted main building of the Smithsonian Institution with its carved detail. This building, in the romantic style, was constructed between 1847 and 1857. Seneca sandstone is also prominent in the Capitol floors and Rotunda door frames.

Marble replaced sandstone as Washington's most popular building stone. It came from quarries in the Piedmont province at Cockeysville and Texas, Maryland, just north of Baltimore. The Cockeysville marble is fine grained and rich in magnesium. It is a clear white stone with a few pale streaks or bands which give an effect of pale gray. The Texas marble is white and coarser grained and is nearly pure carbonate of lime. Some specimens of both marbles contain veins and pockets of mica and pyrite. On exposure the pyrite tends to oxidize. This disintegration causes discoloration of the stone.

Both Texas and Cockeysville marble were used in the construction of the Washington Monument. But construction problems, not the scarcity of building materials, offered the principal difficulty to erecting this national landmark.

According to the city plan drawn up by Major Pierre Charles L'Enfant, the planner of the City of Washington, the site for the Washington Monument was the intersection of an east-west line through the center of the Capitol and a north-south line through the center of the White House. This site was quickly abandoned when it was found to be impossible to establish an adequate foundation for the monument at that point. Instead the monument was built east of the original location; a small stone marks the original L'Enfant site. The first 152 feet of the monument, built between 1845 and 1854, is faced with Texas marble. When funds were depleted, work stopped. When construction was about to resume in 1876, the builders discovered that the foundations were inadequate and that the monument was sinking and tilting. To stabilize and straighten the monument, widened subfoundations were added which reached down nearly 37 feet.

In 1879, work recommenced on the upward projection of the monument, and four courses of white marble from Lee, Massachusetts, were laid just above the Texas marble. However, it was too costly so the upper part of the monument, which was finally completed in 1884, is marble from Cockeysville, Maryland. The three kinds of marble used in the monument may be visually distinguished by their differences in color.

Cockeysville marble was also used for the monolithic columns of the Capitol extension, which was erected between 1851 and 1865. The white Maryland marbles were the first building stones to be shipped in quantity into Washington by rail. After 1840, as the expending railway system increased the availability of stone from other parts of the country, the use of local building stone declined, though Seneca sandstone continued to be shipped down the Chesapeake and Ohio Canal until the 1890's.

Marble from government-owned quarries in Hawkins County, Tennessee, was used in many buildings in the capital, most notably in three interior stairways of the Capitol Building around 1855. Marble from Lee, Massachusetts, was used for the two wings of the Capitol in the mid-1850's. At this same time, granite quarried at Dix Island, Maine, was shipped by sea to Washington and was used for facings and columns in the Treasury Building. Granites mainly from New England, Georgia and North Carolina, and marbles from Vermont, Tennessee and Georgia were used for government buildings almost exclusively from Civil War times until the First World War.

At the turn of the century limestone of Mississippian age (about 345 million years old) from near Bedford, Indiana, was introduced. The first government building to be faced with this stone was at 18th and F Streets, NW, that now houses the General Services Administration and until 1974 was the headquarters of the U. S. Geological Survey. Indiana limestone continues to be the workhorse of the building stones of official Washington.

Minnesota granite, rarely seen in Washington's government buildings before World War II, is now being utilized with increasing frequency. This material is used extensively as steps and trim around the Museum of History and Technology, as fountains in the Ellipse on Pennsylvania Avenue and as facing for the ground floor in the Civil Service Building. Some of these granites are believed to be the oldest rocks in North America; their age, as determined by the U. S. Geological Survey, is about 3.5 billion years.

Among other building stones used in Washington is white marble from Carrara, Italy, which has been used in statuary such as the Peace Monument at Pennsylvania Avenue on the west side of the Capitol. The Italian government made a gift of 3,000 tons of this marble for use as facing for the Kennedy Center for the Performing Arts. Travertine marble from Italy is used as facings and trim for office buildings, such as those on the south side of Pennsylvania Avenue, between 17th and 18th Streets, NW. Currently a popular type of facing for many office buildings, it consists of fragments of quartz and other rock imbedded in concrete. While these precast units cannot be properly classed as building stones, they do indicate a trend of future building materials.

STONE SLEUTHING (by J.V. O'Connor, 3/29/98)

- 1. Stones tell stories. The story of the earth is written in the language of geology, a language with an "alphabet" of minerals and fossils whose "words" are rocks. The buildings of Washington, DC, and virtually every community, are monumental textbooks.
- 2. Building stones (and man-made aggregates) are readily available as instructional tools and for study literally in one's backyard with little or no major economic impact. From curbstones to sidewalks, apartment buildings to school buildings, and public libraries to places of worship, stones are everywhere
- 3. Building stones appeal to all ages, both genders, all education levels, and all residence locations. Properly presented, building stones appeal to just about everyone, including those who think that they do not like science.
- 4. Buildings offer pathways to interdisciplinary learning of science, history, art, mathematics and language arts, crossing over cultural and ethnic boundaries.
- 5. Building stones present opportunities to introduce simple observational and interpretive techniques and skills that scientists use in their research for gathering and weighing evidence and reaching conclusions.

The exteriors and interiors of buildings can serve as focal points for investigations (under both inclement and fair weather conditions) into the geologic history and setting of an area, the origin and physical characteristics of the rocks used for building stones, the factors that influence the selection of various types of stone for particular purposes, and the effects of weathering and erosion on different types of stone. Carving and masonry work also can be explored.

Every building is a unique "museum" and geological "outcrop" that not only displays the important features of various stones and the geologic environment in which they were formed, but also serves as an historic witness to a city's growth and to the development of its architecture.

The study of building stones offers opportunities for people to learn about nature and their place in it, inspiring them to be more aware of their immediate environment. Going beyond the acquisition of facts, it involves people in the process of science and presents opportunities for them to apply not only knowledge acquired in school but also informal, educational experiences. Perhaps more importantly, studying building stones encourages a fascination for learning rather than a preoccupation with knowing.

NATURAL HISTORY MUSEUM PROJECT (by J.V. O'Connor, 5/13/98 draft)

EXPLORING PILLARS--SLEUTHING THE STONES

The stone pillars around the rotunda provide an excellent opportunity to investigate and explore the value of stone. Simple questions lead the participant into a new world of observing, measuring and inquiry. The simple tasks may be done individually or in a group. The following questions and activities are an example of how one stone setting may be used to foster a variety of education standards and life long learning skills.

GO UP TO ANY PILLAR AROUND THE ROTUNDA & CHECK IT OUT:

Are the pillars one piece?

What do you see when you look at your chosen column?

Walk around your column and observe how they change top to bottom for 360 degrees. How did they polish these columns without the chunks falling out?

What are the shapes of the chunks? How big are the chunks? Are they mostly the same size? Are the white chunks oriented in any way? Compare the other three columns in your area. What is in between the white chunks? What is the percent of white chunks to the fill/cement? How would you measure the circumference and diameter of the pillars with a ruler or string? Are the second and third floor pillars the same size?

STONE IS ROCK THAT YOU PAY MONEY FOR.

Where do you think this stone came from? If it came from Europe, how did it get to DC?
How do you know the rock all came from the same quarry?
Do you consider this stone beautiful? Why or why not?
What is the name of the virgin-white artistic marble from Italy? Did the builders and architect of this building consider this stone as eye-catching?
What was the purpose of putting this patterned rock out front of the halls?
The museum is oriented by compass (entrance doors are north/south)-the column structures are then oriented to the compass: Do you know which set of columns are west/east?
What structures are in the four corners (NE, NW, SE, SW)?
What is the base of each column made from?
How did the architects use stone patterns on the floor to guide and awaken you?
Which stone attracts your eyes more: the column or the base?

Are the Greek style columns the same on all three floors? What are the styles?

(Need diagrams of Ionic, Doric and Corinthian)

What kinds of columns are at the outside entrances-did you look when you came in??

ROCK IS A SOLIDIFIED ANCIENT ENVIRONMENT--GEOLOGISTS MUST UNRAVEL THE ENVIRONMENTAL STORY OF THAT PARTICULAR ROCK

Name some natural environments where you would find large angular chunks of broken rock or sediments:

Which environment do you think this rock represents?

Try to name the rock that the white chunks came from:

From the maroon/brown color of the fill in the matrix: what chemistry is involved?

There are three large sizes of sediment called gravel: pebbles, cobbles, & boulders.

(Need a list of the real math sizes and the names of the scales/triangles)

Do you know the name of the sedimentary rock when gravel sizes are glued together to form a sedimentary rock?

What does the word CONGLOMERATE mean?

Is that a good name to describe the column rock unit?

Why would the British call this kind of stone: PUDDINGSTONE?

When CONGLOMERATES have angular chunks instead of rounded pieces, this rock receives another name: BRECCIA which is from Italian.

How do you know that these chunks of sediment were not transported very far?

If you blew out a wall in a quarry, would you get these kinds of chunks at the bottom?

How would you tell how old these chunks are versus the rock?

What did you discover that we did not question you about?

HOW TO USE THE GREAT URBAN OUTCROPS: INVESTIGATIONS OF BUILDING STONES (by J.V. O'Connor, 1985)

ABSTRACT:

The walls and floors of the cityscape are ideal field exploration sites close to all city schools. The native and imported geology of each stone provides a myriad of educational opportunity and research for students of all ages. The difference in hard and soft stone yields a variety of art and architectural forms. Native and imported stones lead to geography and economic investigations. The stone itself leads to investigations in chemistry, geology, climatology, biology of fossils and paleoecology, plus physics. Math is easy with measurements and statistics of size and shape. Mapping and plotting exercises as one traverses the main street of any city in our most underutilized field trip on this planet. Observe the bedrock of human habitats.

CAUTIONS:

Doorways or walkways should remain open to normal traffic. Unnecessary tampering with rock should be avoided. Inform the owners that you will view their stones.

TOOLS:

Hand lenses, squirt bottles, petrographic window, pencil, clipboard, ruler

STONEWALLING—SUGGESTED ACTIVITIES:

- 1. Investigate positioning of layers vs. faces-find the layers/faces
- 2. Count the variety of colors and search for causes
 - a) Color in sun vs. shade
 - b) Color wet vs. dry
 - c) Stains vs. weathering discoloration
- 3. Ingredients of the stone.
 - a) Massive vs. chunky
 - b) Grains vs. blobs
 - c) Fossils or minerals
- 4. Uses of the stone
- 5. Decay and disintegration of the stone
- 6. Name of the stone
 - a) Commercial or economic vs. geological
- 7. Geography of the stone
 - a) Where did it come from?
 - b) How did it get there?
- 8. Age of the Stone
 - a) Geological vs. at site (cornerstone)
- 9. Special features of the stone: fingerprint characteristics
- 10. Size and shape of the blocks
- 11. Environmental origin of the stone
- 12. Petrographic window analysis

- a) Rank amount and percent of each colorb) Measure size and shape of crystals, grains or fossils
- 13. Touch and feel
- 14. Drawing the wall to scale
- 14. Drawing the wan to scale
 15. Tool marks from the mining or dressing processes

 a) Drilling
 b) Cutting
 c) Dressing

 - d) Post-art

BUILDING STONES: HOW TO INVESTIGATE CITY OUTCROPS (by J.V. O'Connor, 1995)

Most cities, towns and villages have stone buildings. Each architectural masterpiece is a living outcrop. Each stone succumbs to the processes of earth science. In exploring each stone building, there are numerous geosecrets to uncover. Search the stones like reading the pages of a novel. Learn to read between the lines.

What is a stone? Stone is rock that your pay money for. There are two general types: crushed stone and dimension stone.

CRUSHED STONE is usually found as aggregate in sidewalks and streets as the ingredients or sediments in concrete and asphalt mixes. This kind of stone appears in gravel walkways, driveways and shoulders or landscape areas around trees and scrubs.

DIMENSION STONES are large blocks that serve as curbstones, tombstones, statue stones and building blocks or slabs for churches, museums, banks, offices, schools, bridges, and homes. MOST BUILDING STONES ARE DIMENSION STONE. Each city has traditional period stones. Which stones are keyed to your town?

Exploring the following dirty dozen contrasts will expose the tremendous educational potential for buildings as outcrops. Learn numerous skills by reading the stones:

THE DIRTY DOZEN CLUES TO INVESTIGATING BUILDING STONES:

- 1. Assessing color characteristics: wet or dry; in sunlight or shade
- 2. Measuring ingredients: fossils, crystals, sediments, layers or features
- 3. Identifying geology: rock types and classes; geonames and economic names
- 4. Recognizing types of tool marks: e.g., chisels, wires, drills
- 5. Categorizing decay of stone: effects of physical and chemical weathering
- 6. Calculating geometry: shapes and sizes, volume, mass/weight
- 7. Comparing inside & outside stones: soft or hard
- 8. Sensing stone finishes: polished and unpolished stone, fired
- 9. Searching the origin & source: native and exotic-imported; geography of each stone; geologic age of each stone
- 10. Recording uses of stone: buildings, art, transportation, gardens, walls
- 11. Testing natural vs. artificial stone: fad versus fake stone
- 12. Sketching aesthetics—pillars of the community: what style is it? Classify cute and ugly stone; sculpturing or architectural forms

FIELD TOOLS FOR INVESTIGATION:

- 1. Water squirt bottle
- 2. Hand lens
- 3. Pencil & clipboard
- 4. File card with square hole (petro-window)

- 5. Paper for notes
- 6. Small ruler (could be on file card)
- 7. Camera or video (optional)
- 8. Map with area to visit/plot stones

EDUCATIONAL REMINDERS:

- 1. Seek permission to enter and use buildings beforehand
- 2. Entrance ways should always remain open-allow pedestrians to pass freely
- 3. Caution against sampling or disturbing stone inside or out (public/private)
- 4. Graffiti is to be avoided—even the measurement of tick marks

MAGMA ON THE MALL (by J.V. O'Connor, 1995)

How to Investigate and Explore Plutonic Igneous Rocks

- 1) Calculate the percent of colors
 - a) Review your rock forming silicate minerals for plutonic igneous rocks
 - i) Light colors: whites, grays, clear, pinks
 - (1) Colors translate to minerals such as quartz, muscovite mica and feldspars: Orthoclase (K); Plagioclase (Ca-Anorthite, Na-Albite, etc)
 - ii) Dark colors: blacks and greens (watch for rusty weathering)
 - (1) Yield minerals: biotite mica, amphiboles (hornblende); pyroxenes (augite); olivines
- 2) Observe & measure grain size (two aspects to judge)
 - a) Size scale of igneous coarse grains:
 - i) -1 mm = fine
 - ii) 1-5 mm = medium
 - iii) 5-30 mm = coarse
 - iv) +3 cm (30 mm) = very coarse
 - b) Grain size = granularity
 - i) Equal or nonequal size grains (color or mineral name)
 - ii) Uniform large crystals (phenocrysts) in the rock sample
 - (1) Actual grain size
 - (2) Same size or distinct range for the major constituents (minerals)
- 3) Investigate crystal shapes in the rock
 - a) Whole crystal (euhedral), semi-crystal (subhedral), blob (anhedral)
 - i) Euhedral = bounded on almost all sides with characteristic crystal faces
 - ii) Subhedral = bounded by some characteristic crystal faces
 - iii) Anhedral = surrounded by no characteristic crystal faces
 - iv) For example, a typical true feldspar crystal is shaped like a rectangle
 - b) Crystal arrangement and shape = rock fabric
 - i) 3-D skeletal, dendritic, embayed, parallel, curved, branching
 - ii) clots = glomerocrysts
- 4) Recognize crystal zoning from core to rim:
 - a) Normal = high to low temperature
 - b) Reverse = low to high temperature, based on minerals
 - c) Continuous = gradual change in chemical composition
 - d) Discontinuous = abrupt change in chemical composition
- 5) Study role of groundmass or matrix in plutonic rocks
 - a) Textures: oriented, aligned or directed, e.g., flow, parallel growth, comb, orbicular, intergrowth, radiate, overgrowths (corona), rapakivi
 - i) Coronas are reaction rims
 - ii) Poikilitic texture = large crystals of one mineral enclose smaller crystals of another mineral
 - (1) Host crystal is called oikocryst
 - (2) Enclosed crystal is chadacryst
 - (3) Ophitic texture = chadacrysts are elongated

Magma Evolution: Origins and Ideas through Time

- 1) Crystal melt relationships in lab/field
- 2) Phase rule for crystallization
- 3) Eutectic crystallization
- 4) Incongruent melting
- 5) Crystallization in solid series solution
- 6) Assimilation
- 7) Crystal floating vs. crystal settling
- 8) Crystal mush and filter pressing
- 9) Bowen's continuous and discontinuous reaction series
- 10) Magmatic differentiation:
 - a) Fractionation
 - b) Ionic migration
 - c) Liquid immiscibility

GEOLOGIC DESCRIPTIONS OF A SELECTION OF WASHINGTON'S PRINCIPAL BUILDING STONES (USGS, 1998, and J.V. O'Connor, undated ms)

SANDSTONE

Virginia--Aquia Creek, Stafford County. Brown to light gray, rounded, coarse to fine grains of quartz, cemented with silica and containing scattered pellets of clay as much as 1 inch in diameter. Cretaceous age. Example: Crypt and Rotunda of U. S. Capitol Building.

Maryland--Seneca Creek, Montgomery County. Red, reddish brown and gray, coarse- to fine-grained angular quartz, with some fragments of feldspar and mica. The fine-grained material proved to be the most durable building stone. Triassic age. Example: Original Smithsonian Institution Building.

LIMESTONE

Indiana--Bedford, Lawrence County. Stone called Bedford limestone from Bedford, Indiana, or oolitic limestone because of the rounded grains of calcite which resemble fish eggs. Some shell fragments are also present. Color ranges from light tan buff to nearly white; texture, firm and compact. Mississippian age. Example: Washington National Cathedral. Department of the Interior Building.

Alabama--Colbert County. Similar to Indiana limestone. isolated shells and other fossils. Mississippian age. Walls of the National Gallery of Art.

MARBLE

Maryland--Texas, Baltimore County. White, coarse-textured calcite marble. Precambrian age. Example: base of the Washington Monument.

Maryland--Cockeysville, Baltimore County. White to light-gray dolomitic marble of medium texture. Precambrian age. Example: upper part of the Washington Monument.

Massachusetts--Lee, Berkshire County. White to light gray, medium fine grained. Ordovician age. Example: exterior of Senate and House wings of the Capitol.

Tennessee--Knox and Blount Counties. Pink, light pink and gray, fine textured. Stylolites, locally known as crowsfeet, cut the beds. These wavy, thin, dark lines represent a break in the deposition of the marble. Ordovician age. Example: National Gallery of Art.

Tennessee--Hawkins County. Coarse, dark chocolate to red with white streaks and masses, some of which are fossils. Ordovician age. Example: stairways in the Senate and House wings of the Capitol.

Vermont--Rutland County. Most popular: fine grained, snowy white. Other types: light blue-gray, and black with highly contorted stylolites. Some white varieties are saccharoidal (sugarlike). Ordovician age. Example: DAR Memorial.

Colorado--West Elk Mountains, Gunnison County. Pure white, fine grained, containing scattered grains of pyrite. Excellent building stone. Mississippian age. Examples: exterior of the Lincoln Memorial, Tomb of Unknown Soldier.

Georgia--Pickens County. Coarser grained than Vermont white marble, blotched with black and gray, but otherwise similar to the Vermont stone. Precambrian age. Example: east-central front of the Capitol.

GRANITE

Massachusetts--Milford, Worcester County. Light pinkish to greenish gray, medium to coarse textured. Flakes of biotite mica give the granite a black spotted look. Some banding, attributed to flow structure, makes the granite locally gneissic. Precambrian age. Example: First Division Memorial, E Street at 17th Street, NW.

Connecticut--Stoney Creek, New Haven County. Coarse grained granite, with large pink feldspar crystals in a gray mass of smaller crystals. Precambrian age. Example: exterior of Freer Gallery.

Vermont--Barre, Washington County. Gray to white, medium to fine grained. Contains about 65 percent feldspar, 27 percent quartz, and 18 percent biotite mica. Ordovician age. Example: steps to the west front of the Capitol.

Minnesota--St. Cloud District, Stearns and Sherburne Counties. Red, medium- to coarsegrained red (oxidized) potassium, feldspar crystals average about 1/4 inch in diameter and make up about 75 percent of the rock. Hornblende and biotite make up the remainder of the rock. Precambrian age. Example: exterior and first floor of Civil Service Building.

Minnesota--Redwood and Renville Counties. Three types of building stone occur here: greenish-gray, medium-grained biotite gneiss; pale pink biotite granite or quartz diorite; and a granite gneiss, which has distinct banding and contains black knots of biotite and large isolated feldspar crystals. Precambrian age. Example: Fountains on the Ellipse at Pennsylvania Avenue.

North Carolina--Mr. Airy, Surry County. Very light gray, almost white biotite granite of medium texture. Biotite is unequally distributed; some rock contains almost no biotite. Precambrian age. Example: Arlington Memorial Bridge.

FORMS OF STONE DEGRADATION (from Doe, 1981, and McGee, 1990)

A. Inherent vice

1. Mineral content (pyrite, clay)

2. Locked-in stresses (tectonic)

B. Pollution (anthropogenic) (results in dissolution and alteration)

1. Acidity (carbonic, sulfuric, and nitric acids)

- 2. Others (SO2, N-compounds, car exhaust, etc.)
- C. Pollution (natural) and weather (results in dissolution and alteration)
 - 1. Biologic (algal growth, organic acids)
 - 2. Volcanogenic and coal combustion
 - 3. Freeze-thaw
 - 4. Hail, wind driven particulates
 - 5. Natural carbon dioxide, water (average rain in DC pH 4.2-4.4)
- D. Processing
 - 1. Fabrication (turning, carving)
 - 2. Cleaning (sandblasting, etc.)
- E. Construction and Treatment
 - 1. Subsidence
 - 2. Coatings
- F. Vandalism and carelessness

dissolution= $CaCO_3 + 2H + = Ca^{2+} + H_2CO_3$ alteration= $CaCO_3 + H_2SO_4 + 2H_2O = CaSO_4$. $2H_2O + H_2CO_3$

JIM O'CONNOR AND THE NOTES HE NEVER PUBLISHED

O'Connor on O'Connor (oral commun., June, 1999)

The USGS hired me because I was doing the educational programs. I was hired by Chuck Withington. He retired, and I joined the Director's office. MPES (Minorities Participation in Earth Science) was the first issue.

I went to Boston College, which was the New England training center for the old NSF program on teacher training. Jim Skehan was my advisor and a big Jesuit for the northeast area. I was the golden boy—running it as a super grad assistant. I got into the non-science major crowd—the educational and business school crowd, and running labs. Lots of people who had no background and were scared of science but needed it. Public education and teacher education were the thrusts. But first I got an MS on a thesis about the plutonic and igneous history of New England coast; I got to see all the beaches, which made me a coastal/marine sciences person.

Lost information about Washington, D.C. (O'Connor, oral commun., June, 1999)

1) Most of the really fantastic information never gets formally published and gets lost. The Piney Branch sewer line: they dug the sewer line and then threw out the data. A huge major trunk sewer creates a big disturbance. Winston (1996) did Barney Circle for the Barney Circle freeway. Most science is bootlegged under city grants and environmental assessments; it doesn't get published but reports are written. These are impossible to get hold of; the city doesn't save the reports and they don't go to City Library in Washington. They are written for engineering and management and then tossed because it isn't needed anymore. The work is not being used as an applied science. For example, everyone collects groundwater data, how much you pump to keep places dry. This is free data and super-useful. But if you pay for it, it is your data, you don't have to share it. And the lawyers say: don't give data away because they can come and haunt you.

2) So everyone wants to do good science, but no one wants to share it because it might come back and bite you in the fanny. In academia, we are trying to make the world a better place; we have no problem collecting the data, but you can't have it. You gathered it for purpose A; but I can use it for purpose B, C, D, E, F, and G. We could have data for the whole city; all the Metro stuff is amazing and it is not scanned and not available. Furthermore, the consultants miss it. Now you know that if there is a subway underground, there was a lot of engineering. But with consulting, the less you have to do, the more money you can make. So they don't ask. The connections between the humans, therefore, are the only way the system works.

Arlington (O'Connor, oral commun., September, 1999)

Arlington was part of district from 1790-1840s. The old streets and the numbering system were from DC, but then adding on new streets was not done systematically. Military Rd. ran during the Civil War from Fort to Fort. The section in DC was straightened out.

The Army Corps of Engineers built Washington, D.C. (O'Connor, oral commun., May, 1999)

1) The COE built the bridges, named the bridges (like Kutz bridge), and many of the streets like Colonel Beach, superintendents of the city. There was a District Commissioner, but the head was always COE, who had control over the city, and had to approve everything.

 2) The rich people who lived in the area wanted fresh air and vacation places, like Cleveland Park. It was a big escape area. The bluff around the Cathedral became fashionable in the post Civil War era. They built big summer homes. For example, Lincoln went to the Soldiers Home.
 3) Washington was a territory, and this replaced the governorship system. Ulysses S. Grant III was the last Colonel to occupy the position in 1860's. They built the whole transportation system, the great planner—Shirley of Shirley Highway. They built the interstate and the subway, spearheading the subway design in the late 1950's.

4) Martin Gordon (COE) has written 4-5 books on the history—he is their historian; 75th or 100th anniversary; the Washington Aqueduct system; DC water system; every ten years get a story; pictures of building and dredging; there is fantastic data in the COE archives.

Earthquakes (O'Connor, 1989)

No earthquakes recorded in DC, but March 9, 1828, one recorded in Virginia by President John Quincy Adams

Fossils (O'Connor, May, 1999)

1) The brontosaur was found at the new National Geographic Bldg.

The Native American History of Washington, DC (O'Connor, oral commun., September, 1999)

1) **Trails:** River Road, Monococy Trail, Seneca Trail (there were Seneca's—Seneca Creek); they traveled down from Pennsylvania on the Monococy Trail into the Blue Ridge. There are lots of references. The COE and the natives didn't get along well; look on old maps, Maryland State Historical Soc have maps and web site on line—just Indian Trails; Virginia has one and each county has one; Steve Potter wrote two books on local natives—look in USGS library; stone pictographs at Great Falls (and in the Park Service brochure); at Fletcher's boat house and mouth of Indian Creek (troves of stuff)—ask Elisabeth Kroll from Parson Engineering, in Fairfax. The Indians died off in epidemics on the islands. There are lots of Powhatan stories in Steve's book; he ruled with iron fist. Powhatan was the Virginia side; there should be trails in northern Virginia.

2) Living sites: Huntley Meadows should have sites. Mason Neck would have had a lot of sites. You can still see what the land would have looked like because there are spots with no homes. It was like this 400 years ago, look over here what it looks like today; it is a terrace level, a high swamp; follow the 90 ft (the 30 m terrace) on all sides of the Potomac and on the other side of the river=Florida Ave, Frederick Douglas house in Anacostia, get the plateaus of swamp; if you are a native, find the semblance of the shoreline. To find the villages, and how big the Potomac was and how deep—a backwards approach to geomorphology; if the like it, the next step up (Teddy Roosevelt Is, the 40 foot terrace, the White House, Mason Neck, a big plateau. Another whole set of Indians. As sea level drops, a whole other set of Indians, 50,000-70,000 years different between the two. The 2 million is the beg of ice age, Florida Ave. 100 ft 30 m terrace, and base of Great Falls. The downtown terraces go to base of Great Falls and down again; 3) Mining: Indians mined quartzite and soapstone (great picture from William Holmes out of Smithsonian and Annals of Antiquity at the turn of century). The artist did Piney Branch

quarries, and Rock Creek quarries/quartzite workshops. He recreated and built stuff—wonderful black and white pictures of artifacts; fixing sewer pipes. Soapstone was just off Western Ave. at Fort Beard, 1 block in the NPS; E side of Park Street, all soapstone and poison ivy; the Indian quarry at Connecticut and Albemarle, Rose Hill quarry—a big high rise building now there, so it was urbanized out of existence. Clifton in S. Fairfax another big soapstone area, pictures of Indians there taking it from river bank. If you find soapstone in valley, they were there; they bartered it, made pipes, wedding gifts, and other gift giving. Articles showing Fairfax soapstone in TN, upstate NY; the quartzite was practical survival stuff. I don't think they used ironstone. Probably used it for medicines and for pigments. Another group of Indians, the coastal plain crowd came to the Fall Line for soapstone and quartzite. The Iroquois speaking Seneca came for fish, so some conflicts were probably present.

Science education (O'Connor, oral commun., September, 1999): All the neat little things people need to know, like now National Science Teacher's Association (NSTA) wants a unit on how to read the history of Washington, D.C. from utility covers on sidewalks. This is not threatening science; it's science education that everyone can do; something you can do—not pie in the sky. It makes you feel: "I can look at a street and see that." It's very useable and practical. Give them what they want; give them what they want to learn. Then they'll go home and use it; they'll know how to do it; they'll have a little understanding, and if you make it fun enough, you can share it with your neighbor.

Wars in Washington, DC (O'Connor, 1989)

 War of 1812—Fort Lincoln was a battle site when the British routed the defenders and marched on to burn federal buildings and the Navy Yard.
 Civil War—The battle of Fort Stevens was the only Civil War battle within the city.

James V. O'Connor Biography

(excerpts from D'V. Cohn, November 6, 1999, Washington Post Obituaries, p. B-6)

James V. O'Connor Dies; D.C. Geologist Led Tours of 'Neat Stuff' in the City,

James V. O'Connor, 55, the former geologist for the District of Columbia who made it his calling to educate people about the physical world around them, died Nov. 5 at his home in Kensington. He had esophageal cancer.

Mr. O'Connor, who was born in the Boston area, was a graduate of Boston College where he also received a master's degree in teaching. He came to the Washington area in 1970 for further study at the University of Maryland.

He was an instructor at Maryland before joining the U.S. Geological Survey, where he worked from 1972 to 1981. He was a physical scientist and national coordinator for a program to encourage more minorities to become earth scientists.

In 1976, Mr. O'Connor began teaching geology at the University of the District of Columbia, a career that lasted until 1997.... After that, he became a lecturer or adjunct professor at American University, Catholic University and George Washington University. In 1998, he was hired by the D.C. Department of Health as an environmental specialist in hydrogeology.

During his career at UDC, Mr. O'Connor also served as the official "state geologist" for the District, providing expertise to city officials and residents on problems such as a series of slow-moving landslides that damaged property in Southeast Washington. Mr. O'Connor trained for the Jesuit priesthood before deciding to become a scientist, and believed that his true calling was to instill in others the same passion he had for the natural world, especially its geology.

He led more than 300 science education workshops, and wrote dozens of course manuals and geologic guidebooks, many focusing on using the local environment as an outdoor classroom. Most District public school teachers have taken a class or tour with him, and he also held workshops for children at several D.C. public housing projects.

For years, he led tours for the Smithsonian Resident Associates; he also taught classes at the Audubon Naturalist Society and U.S. Department of Agriculture Graduate School. On his walking tours, Mr. O'Connor would point out fossils in building stones as well as paved-over features of the physical world, such as a former stream valley in downtown Washington. He could talk knowledgeably about street trees, city history and architecture as well.

"You don't have to go very far to see some neat stuff," he told a group of science teachers in June during a two-hour tour that covered only one city block because he had so much to show them. "Cities can be fun and it doesn't cost anything."

Mr. O'Connor was a past president of both the National Marine Educators Association and the eastern section of the National Association of Geoscience Teachers. He was president of the D.C. Environmental Education Consortium. He had served on the boards of the Audubon Naturalist Society and Discovery Creek Children's Museum, and on the editorial board of the Journal of Marine Education....

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