A Tour of Selected Building Stones of the National Mall

Dr. Kenneth Rasmussen – Northern VA Community College

Image: View of Washington/drawn from nature and on stone; E. Sachse & Co., c1852. Library of Congress.

Site Map

Selected Building Stones of the National Mall: Site #'s from Geological Society of America (GSA) Annual Meeting Geological Field Trip led by K. Rasmussen and V. Martin (2015)

GSA sites we visit: #2 Capitol Gate Posts; #3 Haupt Fountains; #5 Capitol Gate House; #7 Org. of Amer. States; #6 Lockkeeper's House & 17th St. levee; REST ROOMS@WWII; #14 & 15 Jefferson Pier and Wash. Monument; LUNCH@HAUPT GARDENS; #16 Nat. Museum of Natural Hist.; #17 Nat. Gallery of Art (West Bldg.); #18 Peace Monument; #20 Nat. Museum of the Amer. Indian; #21 Arts and Industries Bldg; #22 Smithsonian Institution "Castle."

Brief Summary

The National Mall is a unique architectural annex to the urban geology of Washington, DC - a historic and old federal city located at the intersection of two distinctive geologic provinces. Our walking tour will consider some of the most noteworthy building stones used in the construction of the monuments, memorials, and buildings located on the central portion of the Mall, and the far-reaching geological stories they can tell to those who are willing to look more closely.

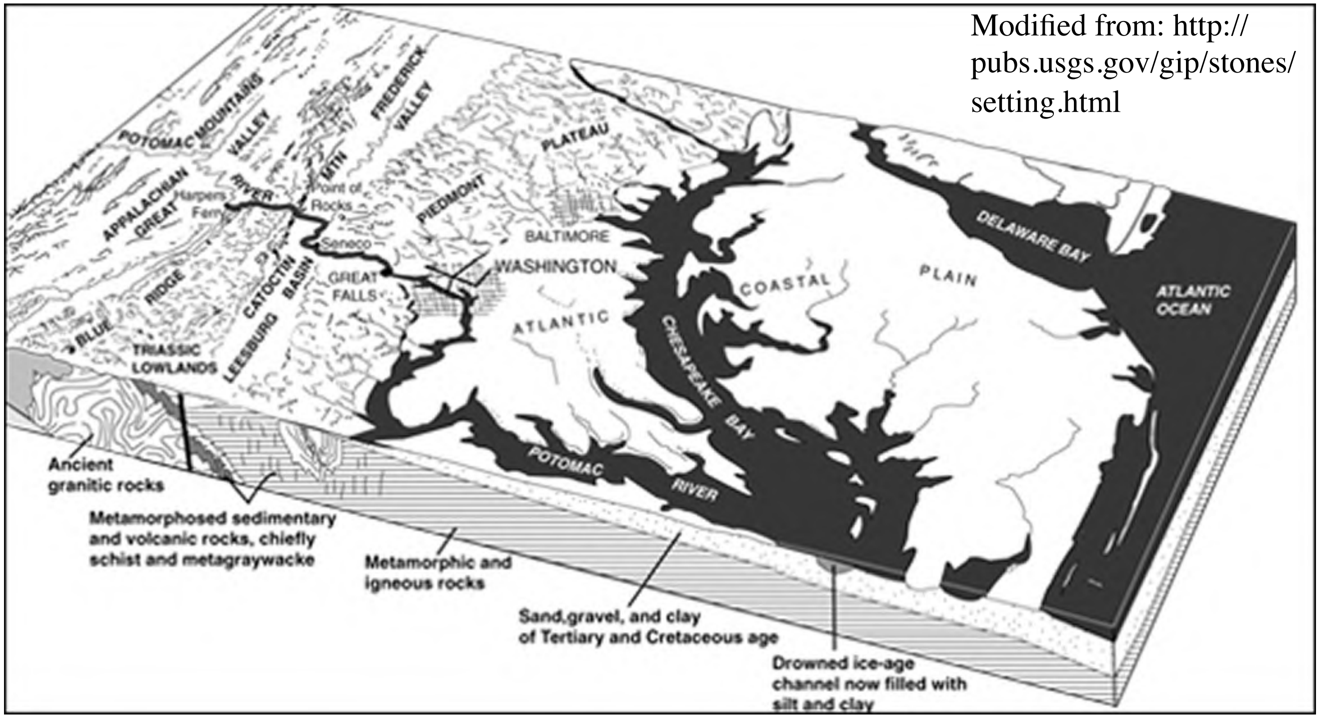
Trip Leader

Dr. Ken Rasmussen (krasmussen@nvcc.edu) is Professor of Geology and Oceanography at Northern Virginia Community College (Annandale Campus), where he teaches Physical Geology, Historical Geology, Oceanography, and a variety of field courses. His research has involved modern reefal cave communities in St. Croix, carbonate lagoons and Holocene sea-level rise in the Bahamas, stromatolitic reef development in Belize, and the Late Quaternary paleolimnology and paleoclimatology of Lake Issyk-kul, Kyrgyzstan.

Optional Background:

1) Annenberg Learner Interactives: "The Rock Cycle" (http://www.learner.org/interactives/rockcycle/index.html) - a simple discussion of the rock cycle (peruse "Introduction" through "Test Your Skills").
2) Chapter 5 "Weathering" (through Section 5.2.3) in this OER physical geology textbook: https://www.oercommons.org/courses/an-introduction-to-geology-free-textbook-for-college-level-introductory-geology-courses/view.
3) "Weathering" (https://www.nationalgeographic.org/encyclopedia/weathering/) - a short and instructive summary of the processes involved in the mechanical and chemical breakdown of rocks illustrated via an interesting photographic tour.
4) "The NIST Stone Test Wall" (http://stonewall.nist.gov/) - a very interesting and highly relevant ongoing rock-weathering experiment located at the National Institute of Standards and Technology in Gaithersburg, Maryland.
5) "Watching Our Stone Heritage Crumble" (http://www.geotimes.org/july07/article.html?id=geophen.html) - *Geotimes* article.
6) **"Touring the Capital Geology of Washington, D.C."** Bentley and Rasmussen *Earth Magazine* article from May 2019 regarding DC regional geology – both natural and urban. http://earth.nautil.us/feature/383/travels-in-geology-touring-the-capital-geology-of-washington-dc

Washington's Geologic Setting



Modified from: http://pubs.usgs.gov/gip/stones/setting.html

The Washington region includes parts of four physiographic provinces -- areas in which the rocks and topography are similar but differ considerably from those of the neighboring provinces. From east to west, these provinces are the Coastal Plain, the Piedmont, the Triassic Lowland, and the Blue Ridge. In addition, **the area on the Mall south of the Lincoln Memorial and Washington Monument to the Potomac River was originally swampland**, which was reclaimed by filling it with material dredged from farther down the river.

The **Atlantic Coastal Plain** borders the Atlantic Ocean and consists of gravel, sand, silt, clay, and marl. Deposition of these sediments began about 100 million years ago and continues to the present. The oldest rocks in the Coastal Plain are poorly consolidated gravel, sand, silt, and clay derived from the weathering of Piedmont rocks to the north and west that were carried to the Coastal Plain by south-flowing rivers. Younger rocks consist of sands and clays containing the minerals glauconite and mica, which were deposited in estuaries and on the Continental Shelf at a time when water covered the present Coastal Plain to depths up to 200 feet. The **Piedmont** province lies west of the Coastal Plain. Piedmont rocks in and near Washington, DC are crystalline metamorphic rocks that are quite hard and resist weathering; they contain veins of quartz and pegmatite and in many places have been intruded by igneous rock. These more ancient crystalline rocks (Neoproterozoic – Ordovician) can be seen most easily in valleys where soil cover has been stripped away.

Creation of the National Mall

The creation and historical development of the three general park reservations within National Capital Parks-Central (listed as the National Mall, the Washington Monument Grounds, and West Potomac Park) are divided into two major periods: the Pre-McMillan Period of 1790 to 1900 and the Post-McMillan Period from 1901 to the present. From 1791, when Pierre L'Enfant first conceived of the National Mall as a grand-open promenade, to 1902, when the McMillan Park Commission officially presented their plan, the National Mall was in fact comprised of not one, but many separate individual parks and grounds. The history of National Capital Parks-Central may be divided into five major milestones with its development. They are as follows: the Pierre L'Enfant Plan of 1791, the Andrew Jackson Downing Plan of 1851, the McMillan Commission Plan of 1901-02, the Acquisition by the National Park Service in 1933, and the Mall Master Plan of 1966. From 1800 to 1900 there existed an almost constant deviation from Pierre L' Enfant's original vision and plan for the city's Federal Central Enclave. The one significant development during the nineteenth century within the context of the L'Enfant Plan was the building and completion of the Washington Monument. The Andrew Jackson Downing Plan of 1851 in fact represented a departure from the unified formality of the L'Enfant Plan in terms of its landscape architecture.

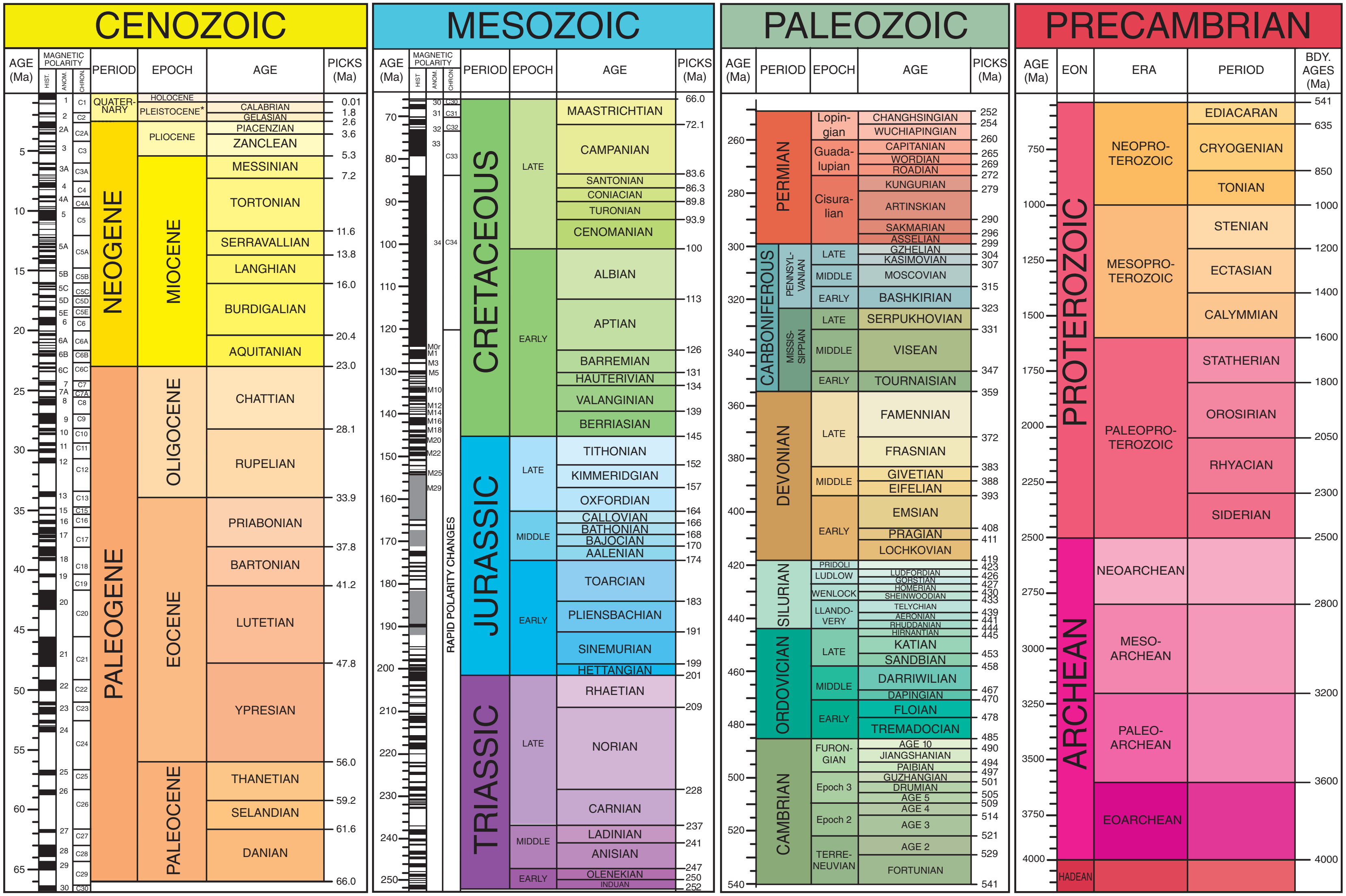
From 1902 onward with the McMillan Park Commission Plan and Report, the National Mall (Reservation #3), the Washington Monument Grounds (Reservation #2), and the newly created West Potomac Park (Reservation #332) symbolizes throughout the twentieth century a concerted effort and eventual triumph to return to and extend upon Pierre L' Enfant's original plan and vision for the city's Federal Central Enclave. Moreover, the McMillan Plan is significant because it represents the first effort at systematic comprehensive urban planning for a major city. The McMillan Commission consisted of a number of renowned and great classical-style architects and landscape architects. They are as follows: Daniel H. Burnham, Frederick Law Olmsted Jr., Charles Moore, Augustus Saint-Gaudens , and Charles Follen McKim. During the summer of 1901, the McMillan Commissioners traveled to numerous European cities in an effort to return to the original ideas and conceptions of L' Enfant's Plan. Upon their return to the United States in the fall of 1901, these men set about the task of what becomes known as the McMillan Commission Plan and Report. Their official proposal is presented to the American public in February of 1902. In the decades that followed, all subsequent developments and park master plans as well as general management plans under the National Park Service, National Capital Parks-Central have successfully adhered to the general principles of the 1901-02 McMillan Plan. Finally, adherence to the McMillan Plan's principles throughout the twentieth century has resulted in the creation of a unified park that is to be forever symbolized as a "Pageant to over 200 years of American History."

Modified from US National Park Service Website (2001)

Extent of artificial fill (shaded brown) in National Mall area

Geologic map of Washington West quadrangle, District of Columbia; USGS Geologic Map GQ-1748

GSA GEOLOGIC TIME SCALE v. 4.0



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*The Pleistocene is divided into four ages, but only two are shown here. What is shown as Calabrian is actually three ages—Calabrian from 1.8 to 0.78 Ma, Middle from 0.78 to 0.13 Ma, and Late from 0.13 to 0.01 Ma.

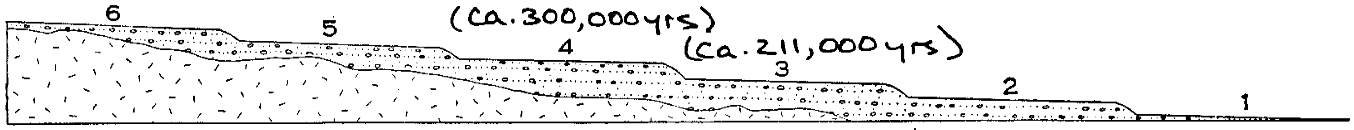
Walker, J.D., Geissman, J.W., Bowring, S.A., and Babcock, L.E., compilers, 2012, Geologic Time Scale v. 4.0: Geological Society of America, doi: 10.1130/2012.CTS004R3C.

The Cenozoic, Mesozoic, and Paleozoic are the Eras of the Phanerozoic Eon. Names of units and age boundaries follow the Gradstein et al. (2012) and Cohen et al. (2012) compilations. Age estimates and picks of boundaries are rounded to the nearest whole number (1 Ma) for the pre-Cenomanian, and rounded to one decimal place (100 ka) for the Cenomanian to Pleistocene interval. The numbered epochs and ages of the Cambrian are provisional.

REFERENCES CITED Cohen, K.M., Finney, S., and Gibbard, P.L., 2012, International Chronostratigraphic Chart: International Commission on Stratigraphy, www.stratigraphy.org (last accessed May 2012). (Chart reproduced for the 34th International Geological Congress, Brisbane, Australia, 5–10 August 2012.)

Gradstein, F.M, Ogg, J.G., Schmitz, M.D., et al., 2012, The Geologic Time Scale 2012: Boston, USA, Elsevier, DOI: 10.1016/B978-0-444-59425-9.00004-4.

Pleistocene Terraces of Virginia and Maryland

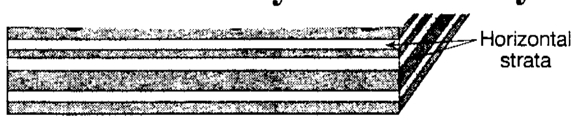


So-called Lafayette Plateau (420-300 ft.) (Reno Reservoir, Soldiers' Home, and Good Hope Hill)	200-foot terrace (Mt. Pleasant section and St. Elizabeths Hospital)	90-foot terrace (Large part of Washington, including Dupont and Logan Circles and Capitol Hill)	50-foot terrace (Upper Pennsylvania Ave. and F and G Sts., NW.)	25-foot terrace (Upper Constitution Ave., lower Pennsylvania Ave., and Mall)	Alluvial deposits and artificial fill (Lowlands along Potomac and Anacostia Rivers)
Correlated with the Bryn Mawr (?) and Brandywine terraces	Correlated with the Coharie and Sunderland terraces	Correlated with the Wicomico terrace (Capitol)	Correlated with the Penholoway and Talbot terraces (White House)	Correlated with the Pamlico terrace	

FIGURE 20.—Idealized arrangement of the so-called Lafayette Plateau and the more extensive terraces in the District of Columbia, giving approximate altitude of the terraces and places where they are well represented.

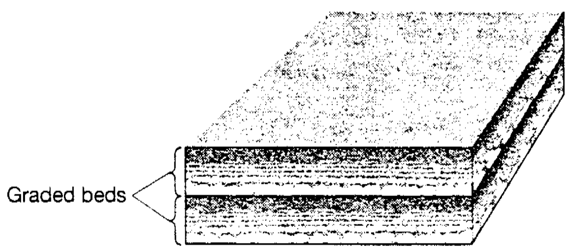
M.S. Carr (1950)

Common Primary Sedimentary Structures



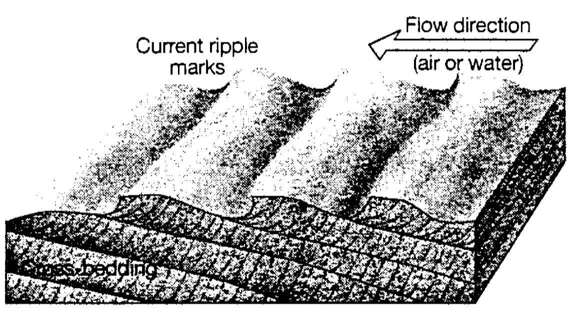
HORIZONTAL STRATA: Relatively flat *beds* (≥ 1cm thick) and *laminations* (< 1cm thick).

Horizontal strata *occur where sediments settle from a standing body of water or air; or where currents travel parallel to the surface on which sediments are accumulating.*



GRADED BED: Stratum that contains different sizes of sedimentary grains arranged from largest at the bottom of the bed to smallest at the top

Graded beds *form when a turbulent body of water full of sediment (flood, wave, river) suddenly loses energy and calms down. Large particles settle out before small.*

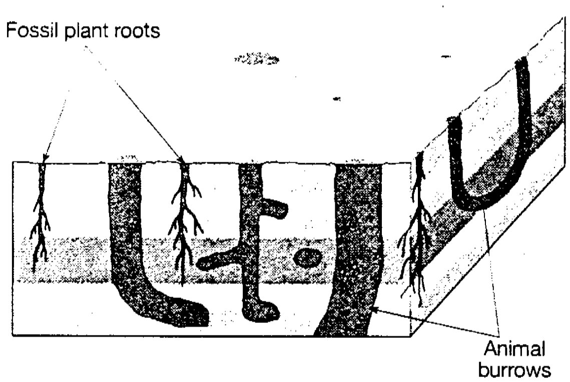


CURRENT RIPPLE MARKS: Asymmetrical ripple marks. The steep slope faces down current, and the gentle slope faces up current.

Current ripple marks *form in any environment where wind or water travels in one direction for some of the time: rivers, ocean currents, wind blowing sand dunes.*

CROSS-BEDDING: Inclined beds or laminations.

Cross-bedding *forms wherever there are wind or water currents.*



FOSSIL PLANT ROOTS: Root-shaped fossils that narrow away from the main branch.

Fossil plant roots *indicate ancient soil zones where plants once grew.*

ANIMAL BURROWS: All sizes of tunnels or tubes that cut into or across strata and maintain constant diameters with circular cross-sections.

Animal burrows *occur wherever burrowing animals live, in water or on land. The shape of the burrow may be characteristic of a particular kind of animal that lives only in a specific environment.*

AGI/NAGT (1999)

Common Rock Types/Geologic Ages/Quarry Locations

Building Stone ID	Geologic Age	Approximate Age	Quarry Locations
Alabama Limestone	Late Mississippian	335-325 mya	Colbert County, AL
Aquia Creek Sandstone (aka "VA Freestone")	Early Cretaceous	100-145 mya	Government Island, Stafford County, VA
Bangalore “Black Granite” Gabbro	Precambrian	?	Andhra Pradesh near Bangalore, India
Bethel, Vermont Granite	Middle Mississippian	ca. 335 mya	Bethel, Washington County, VT
Black Breccia Carrara Marble	L. Triassic -E. Jurassic	ca. 237-174 mya	Carrara, Tuscany, Italy
Breccia Stazzima Italian Marble	L. Triassic -E. Jurassic	ca. 237-174 mya	Tuscany, Italy
Carrara Marble	L. Triassic- E. Jurassic	ca. 237-174 mya	Carrara, Tuscany, Italy
Cockeysville, MD (dolomitic) Marble	Late Proterozoic-E. Ord.	ca. 544 mya	Cockeysville, Baltimore County, MD
Colorado "Yule" Marble	Mississippian	359-323 mya	West Elk Mts., Gunnison County, CO
Georgia “Cherokee” White Marble	Neoproterozoic	ca.544 mya	Pickens County, GA
Kasota (dolomitic) Limestone	Early Ordovician	ca. 485-470mya	Scott County, MN
Leesburg Conglomerate, MD (aka Potomac “Marble")	Late Triassic (Norian)	ca. 209 mya	Montgomery / Fredrick Counties, MD
Lee, MA Marble (aka Sheffield Marble)	Cambrian-Ordovician	ca. 541-470 mya	Lee, Berkshire County, MA
Maine Blue Granite	Mid-Late Dev	ca. 393-359 mya	Eastern Maine
Milford, MA (pink) Granite	Neoproterozoic	ca. 600 mya	Milford, Worcester County, MA
Minnesota "Montevideo” Granite Gneiss	Archean	ca. 3.5 bya	Redwood/Renville Counties, MN
Mount Airy, NC, Granite	L. Dev- E. Mississippian	ca. 360 mya	Mt. Airy, Surrey County, NC
Pennsylvania (black) Diabase	Early Jurassic	ca. 200 mya	Lebanon / York Counties PA
Poultney, VT (green) Slate	Cambrian	505-544 mya	Poultney, VT
Radio, aka Champlain Black “Marble” (fossiliferous limestone)	Middle Ordovician	470 -458 mya	Near Lake Champlain, VT
“Richmond” Granite (= Petersburg Granite)	Late Mississippian	ca. 330 mya	Richmond, VA
Salem (Indiana) Limestone	Mississippian	359-323 mya	Bedford/Laurence Counties, IN
Seneca Creek (Manassas) Sandstone, MD	Late Triassic (Norian)	ca. 209 mya	Seneca Creek, Montgomery County, MD
Shelburne (Vermont) White Marble	Early Ordovician	485-470 mya	Rutland County, VT
Sylacauga (Alabama) Marble	L. Cambrian- E. Ordovician	500-470 mya	Talladega County, AL
Swedish Gabbro	Proterozoic	1.7 -1.5 bya	Sweden
Tennessee (light pink & tan) “Marble" (= Holston Fm foss. ls)	Middle Ordovician	ca. 460 mya	Knox & Blount Counties, TN
Texas, MD marble	Neoproterozoic - E. Ord.	ca. 544 mya	Texas, Baltimore County, MD
Texas "Sunset Red" Granite	Proterozoic	?	Marble Falls, TX
Unakite	Neoproterozoic	ca. 1 bya	Blue Ridge Mts., VA
Vermont Verde Antique “Marble" (= serpentinite)	Ordovician?	505-440 mya?	Rochester, Windsor , VT
Wissahickon Group metamorphics (aka Potomac "Bluestone")	Neoproterozoic - E. Ord.?	c a.650-470 mya?	Piedmont near Little Falls, MD
Woodstock Granite, MD	Ordovician	ca. 444 mya	Western Baltimore County, MD

Site#1: National Museum of American History

Construction date: 1964

Original architects: Steinman, Cain, and White

- originally “The Museum of History and Technology”; deemed an “architectural failure” by some critics
- original design of precast concrete rejected by Commission of Fine Arts in favor of outer “curtain wall” design of ca. 21,100 TN “marble” panels; steel girder framework designed to carry live load of 732 kg/m^2
- current-swept, tropical marine carbonate deposition (bioclastic packstone); differential weathering of stylolites, fossils, and sparite cement
- TN “marble” also: Lincoln statue base & (polished) floors, National Gallery of Art exterior (west & east), NASM exterior, US Capitol East Vis. Ctr.

A: Exterior, stair walls: Tennessee light pink “marble” (Holston Fm., foss. limestone), Midl. Ord. (ca. 460 mya)
B: Const. Ave. fountain, plaza: Minnesota “Montevideo” granite gneiss, Archean (ca. 3.5 bya)

3-inch-thick panel

Weathered stylolite in staircase wall

12.5x; 9.35 mm field; ppl

Site#2: Capitol Gateposts

Construction date: 1828 Original architect: Charles Bulfinch

- original location at Capitol (grazing-cow control!), saved & moved here (NW 15th & Constitution Ave., among others, in 1880)
- "VA Freestone" (easily worked) from a local quarry 46 mi south in Stafford County, VA, just off Potomac River (L'Enfant purchased Wigginton's Island on Aquia Creek for federal gov't in 1791) – now Government Island Park and Historic Quarry
- variable quality (porous) arkosic (approx. 30% feldspar) sandstone, variable grain size (sand/gravel), silica & hematite cement, cross bedded, quartz and clay pebbles
- note high degree of weathering/spalling, cement patches indicate rapid surface loss; chisel marks show past downtown floods (post & Gate House at NW 15th St.)
- Aquia Creek SS also: White House (painted), Capitol (main- painted/mbl-clad), National Portrait Gallery, DC boundary stones

A: Aquia Creek Sandstone (aka "Aquia Stone" or "VA Freestone"), Potomac Group, E. Cret. (ca. 145-100 mya)

Cross bedding, spalling

Quartz and clay pebbles

High-water chisel marks

Historic images showing Bulfinch’s 1828 Capitol Gate Posts

“Balloon View of Washington, 1861”. Wood engraving, hand-colored, by Unidentified, after Jacob Wells, Harper's Weekly. Photograph courtesy United States Senate, Washington, D.C. http://www.senate.gov/artandhistory/art/common/image/Ga_exterior_38_00002.htm

Scene at Pennsylvania Avenue entrance to Capitol grounds on daily adjournment of Congress; Harper's Weekly, publ. Apr. 28. 1866. Library of Congress Prints and Photographs Division (http://www.loc.gov/pictures/item/2010652198/)

Site#3: Haupt Fountains

Construction date: 1967

Original sculptor: Gordon Newell and James Hunolt

- gift of Enid Annenberg Haupt, built at request of Lady Bird Johnson
- single, 55-ton blocks of high-grade “Montevideo” granite gneiss (aka “Rainbow Gneiss”), shipped by rail from SW MN (Morton, MN)
- 3.5 bya rock – one of the oldest in North America, and certainly the oldest stone used on the National Mall
- high grade metamorphic with some partial-melting (migmatitic); quartzo-feldspathic, biotite banding, large pink K-feldspar phenocrysts; patches of tonalite gneiss
- note polished and rough facing; suffers little weathering; overhang demonstrates crystalline rock’s ability to withstand shear forces
- Montevideo also: Second Division Mem., Amer. Hist. Museum fountain/plaza, Sculpture Garden, Police Headquarters (Balt., MD)

A: Minnesota “Montevideo” granite gneiss, Morton, MN, Archean (ca. 3.5 bya)

Durable; extreme shear strength

Gneissic banding, tonalite patches

Field image of tonalite gneiss layers

Washington, DC Curb Replacement

Replacement of existing concrete curbs in Mall area: begun by at least 2002

May, 2002

May, 2002

Plow abrasion? Oct. 2015

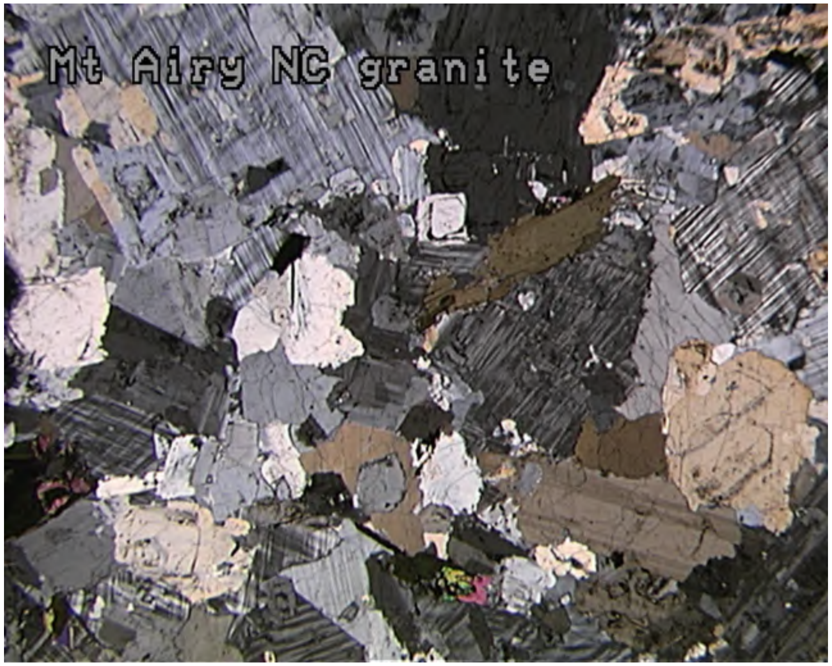
• more durable crystalline (igneous) rock from world's largest open-face quarry in Mount Airy, NC

• costs $45 per linear foot (VS $25 for weaker concrete; 2007)

• Mt. Airy also: NMNH attic, Lincoln reflecting pool, West Capitol steps

A: Mt. Airy white granite, Mt. Airy, NC, L. Dev. – E. Miss. (ca. 360 mya)

http://www.washingtonpost.com/wp-dyn/content/article/2007/04/14/AR2007041400598.html



12.5x; 9.35 mm field; xn

Site#4: Second Division Monument

Construction date: 1936 Original sculptor: James Earle Fraser

- tough, old, beautiful granite gneiss honors the WWI dead of the Army's 2nd Infantry Division (the "Indianhead" Division)
- gold leaf against polished red stone; wings added in 1962 for later events (WWI and Korea) at request of Gen. Maxwell Taylor
- migmatitic, quartzo-feldspathic gneiss; biotite banding, large pink K-feldspar phenocrysts
- note difference in "glorious and airy" mood of this memorial (dedicated by FDR, 1936) VS the more somber Vietnam Veterans Memorial (dedicated 1982)
- note span across top handled by tough, crystalline rock; very durable – only weaknesses are seen at weathered edges, loosened mortar
- Montevideo also: Haupt Fountains, Amer. Hist. Museum fountain/plaza, Sculpture Garden, Police Headquarters (Balt., MD)

A: Minnesota "Montevideo" granite gneiss, Morton, MN, Archean (ca. 3.5 bya)

Site#5: Capitol Gatehouse

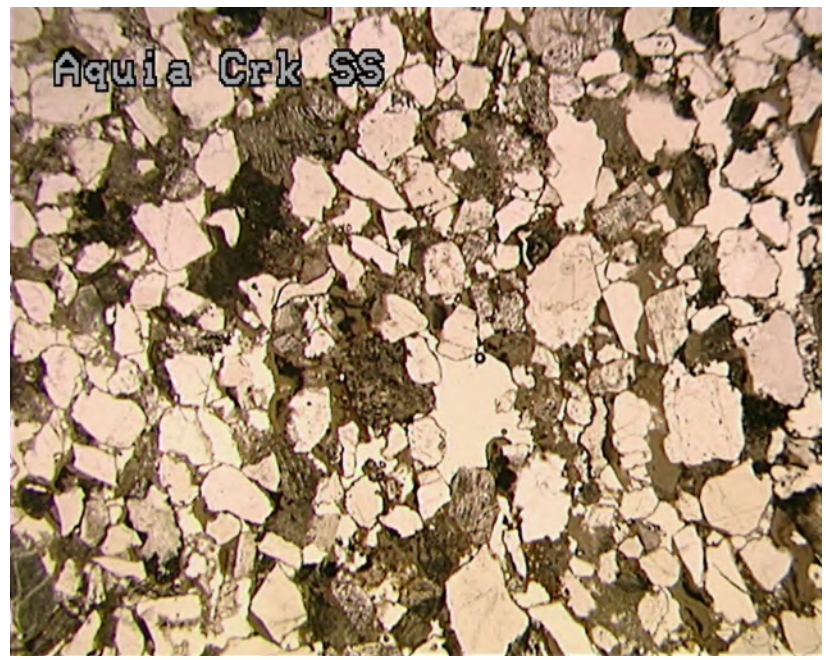
Construction date: 1828 Original architect: Charles Bulfinch

- moved to 17th St. from original Capitol location in 1874; first stone used in Federal City; barge transport, nearby source, poor durability & maintenance
- variable quality (porous) arkosic (approx. 30% feldspar) sandstone, variable grain size (sand/gravel), silica & hematite cement, iron oxide highlights cross bedding, quartz and clay pebbles, scour and fill structure (see at SW block)
- original sedimentary environment = Piedmont-edge alluvial fan
- compressional stability only when load directed perpendicular to bedding planes – note cracks in rear lintel, columns
- Aquia Crk SS also: White House, Capitol (main bldg), Gate Posts

A: Aquia Creek Sandstone (aka “Aquia Stone” or “VA Freestone”), Potomac Group, E. Cret. (ca. 100-145 mya)

X-beds, textural variations

Scour & fill structure



12.5x; 9.35 mm field; ppl

Site#6: Lockkeeper’s House

Construction date: 1833

• *in situ* shelter of Washington City Canal (WCC) lockkeeper from 1835 to 1855(canal ran north of Mall from Capitol, past White House); original position jutted into 17th St., then moved 50 ft. in 1915, and 30 ft. in 2017 to present position (note dark markers)

• house at west end of Tiber Creek (transformed into WCC in 1815); lock joined WCC with southern extension of C&O canal; Tiber Creek originally flowed west from Capitol Hill area toward Potomac, then WCC, later B. St., and then Constitution Ave.

• WCC a low-lying, stagnant cesspool by 1870 (open sewer); reclamation of marshy, western Mall in 1871-1880, dredge-fill continued through early 1900’s “MacM. Plan”

• Piedmont rocks (gneiss, schist, metaconglomerate – note boulder with qtz pebbles) used since 1700’s; see flecks of biotite, garnet, pyrite; Iapetan sedimentary protoliths

• Potomac “Bluestone” also: Braddock’s Rock, Georgetown’s Old Stone House, foundations of White House, SI Castle, Wash. Monument, Lincoln Memorial

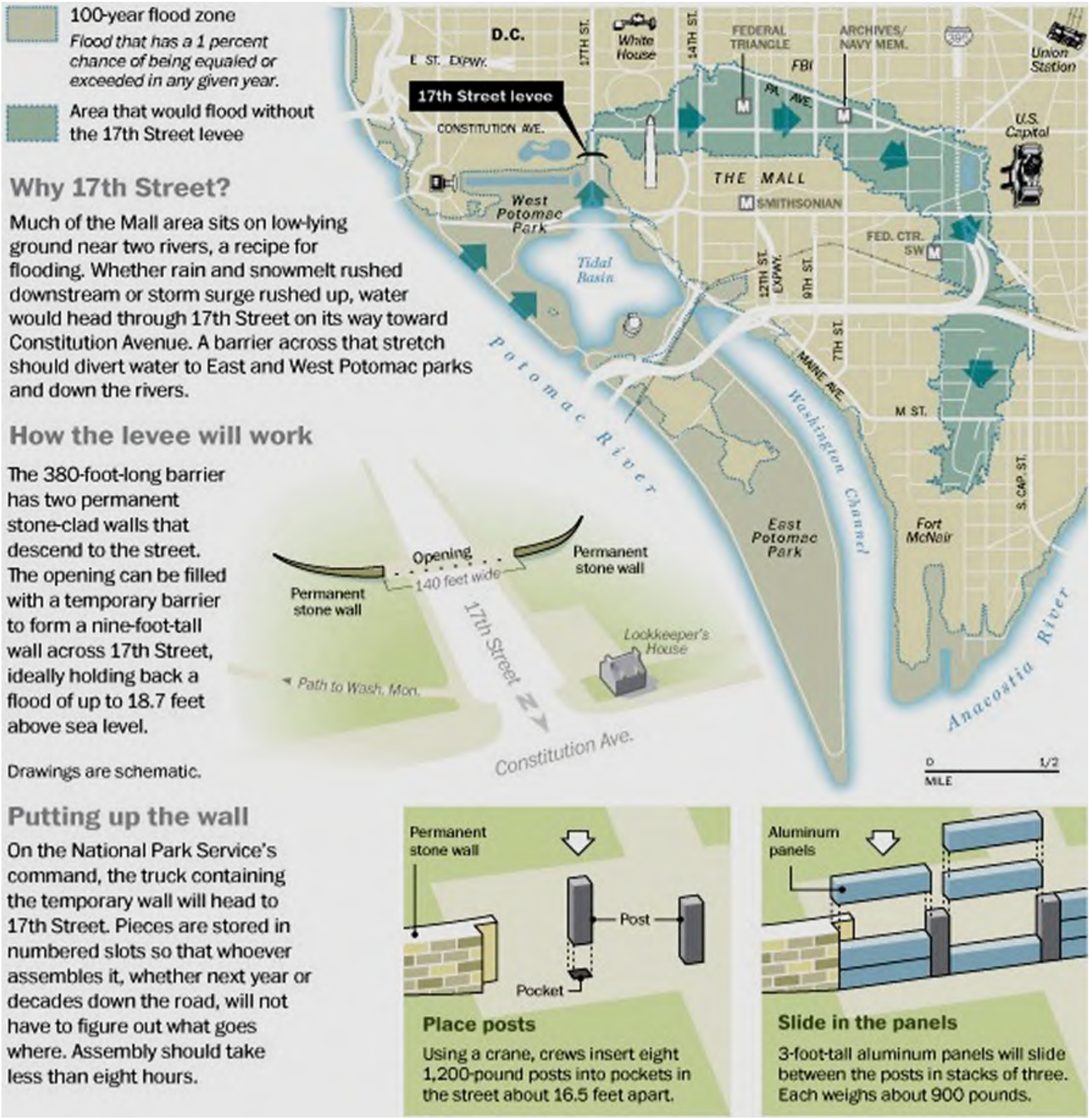
A: Various “Wissahickon” metamorphics (Sykesville Fm, or Potomac “Bluestone”), Neoprot.- E. Ord.? (ca. 650-470 mya?)

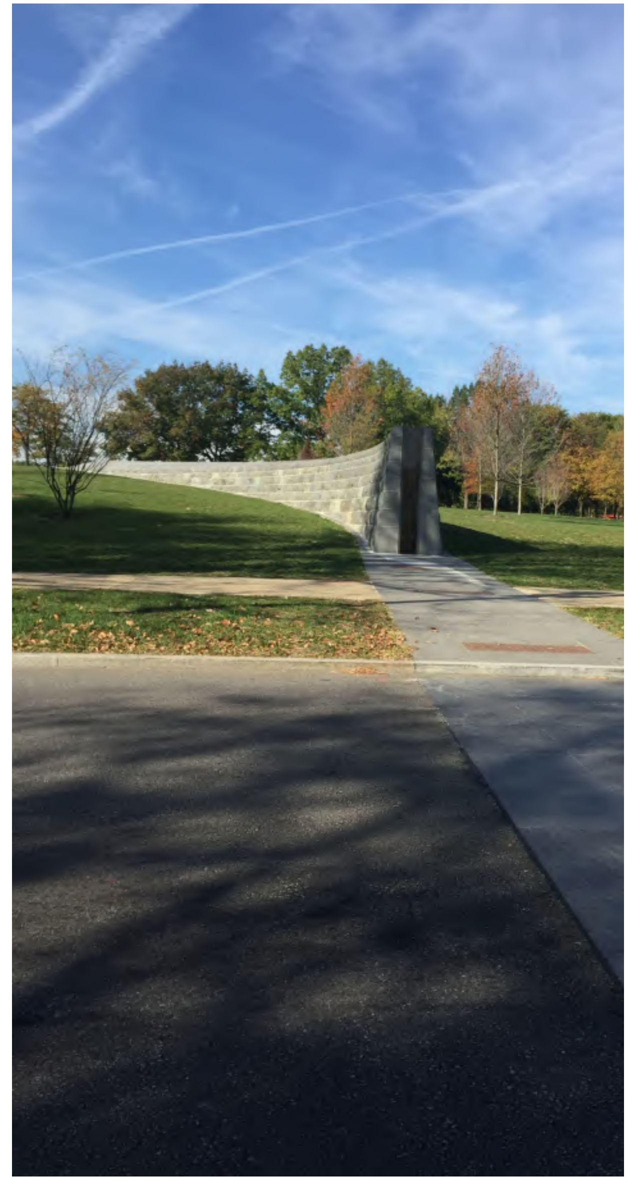
Durable, variable color, sedimentary protoliths; failed mortar

L’Enfant Plan, Washington, 1792

http://www.loc.gov/item/88694159/

17th Street flood levee: "A Wall On The Mall", Washington Post, May 16, 2013





Blocks of greenstone and diabase. See: "National Mall flood levee project nears initial testing phase after three year delay", WaPo 9/16/14

Site#7: Organization of American States

Construction date: 1908-10

Original architects: Albert Kelsey & Paul Cret (Fed also)

- originally called “Pan American Union Building”; Andrew Carnegie funded, dedicated by 27th president Wm. H. Taft
- courtyard balustrades show extreme chemical weathering of very coarse, granoblastic marble; surface dissolution, gypsum alteration
- ubiquitous calcite (low-temperature) deformation twins; multiple, x-cutting directions; reverse fault evidence; tremolite
- interior includes beautiful limestone collapse-breccia columns, Rudistid ls pedestals, central courtyard “Peace Tree” (see on weekdays)
- Georgian marble also: Federal Reserve, Lincoln statue

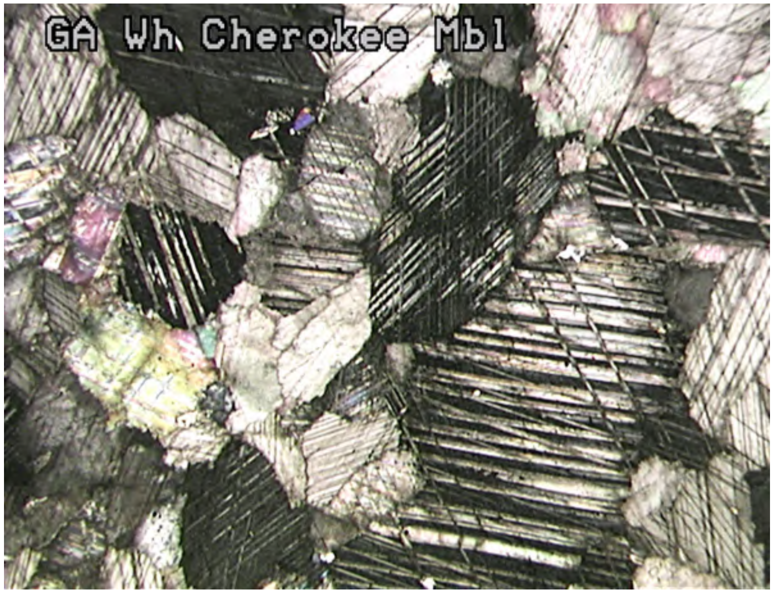
A: Terrace, exterior, balustrades, lamp pedestals: Georgia “Cherokee” white marble, Neoproterozoic

B: Steps & terrace detail: Tennessee dk & lt pink “marble” (Holston Fm., foss. limestone), Mid. Ord. (ca. 460 mya)

C: Courtyard table: hydrothermally altered limestone breccia

Degraded balustrades

Power-washing shaded area



12.5x; 9.35 mm field; xn

Site#8: Simon Bolivar Statue (Gift of Venezuela)

Construction date: 1958

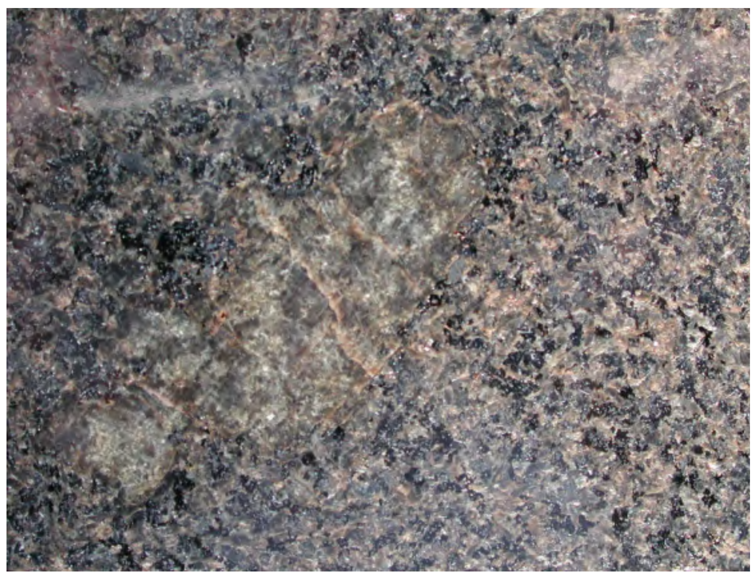
Original sculptor: Felix De Weldon (Iwo Jima statue also)

- Proterozoic gabbro (dark, pyroxene-rich; coarse/phaneritic texture) from Swedish part of Baltic Shield
- mafic composition records crystallization at high temperatures deep within earth, associated with rifting
- note occasional, large xenocrysts of Ca- plagioclase feldspar in darker, pyroxene-rich background
- gabbro elsewhere on Mall: Vietnam Veterans Memorial wall, base of Thomas Jefferson statue

A: Pedestal: Swedish gabbro (likely Loftahammer gabbro of Fennoscandian Shield, Proterozoic (1.7-1.5 bya)

B: Terrace: Georgia "Cherokee" white marble, Neoproterozoic

Pedestal damage (5/30 – 10/17/15)



Feldspar xenocryst (field approx. 5 cm)

Damage to GA marble terrace

Site#9: Department of Interior (Main & South Bldgs.)

Construction dates: 1937 (Main); 1933 (South) Original architect: Waddy Wood

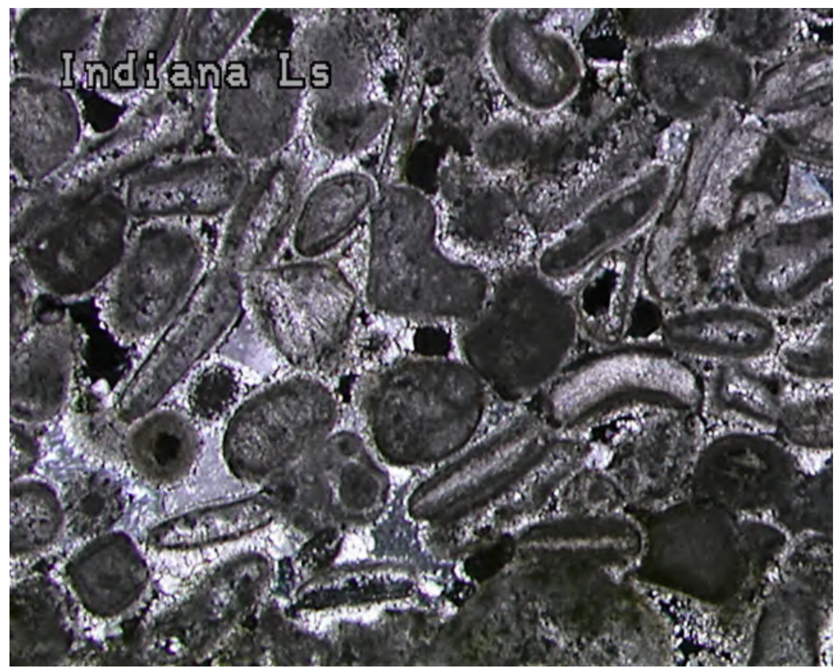
- Indiana Limestone is an extremely common, carvable, porous, yet reasonably durable American building stone
- weathers to show Mississippian-age trace and body fossils (especially crinoids, blastoids, bryozoans, forams) of shallow, tropical epicontinental sea called "Kaskaskia Sea" of Mississippian time; well-winnowed packstone/grainstone texture shows cross bedding
- best used above foundation level (compare south VS main foundations) where dramatic spalling pooled water, and biological weathering occurs
- Indiana LS also: exteriors of Federal Triangle buildings (including Reagan), National Cathedral, Lincoln Memorial interior, NMNH interior

DOI Main building

A: Exterior: Salem (Indiana) Limestone, Mississippian (359-323 mya)

B: Foundation of DOI main: Milford, MA pink granite, Neoproterozoic (ca. 600 mya)

Indiana LS, white-washing, south lot



100x; 1.2 mm field; xn

Fossiliferous limestone/biosparite of DOI South: echinoderm and bryozoan fragments, fecal pellets, fragmented and whole foraminifera (*Endothyra*), ostracods, gastropods, and brachiopods. Not shown here: abundant Callianassid trace fossils (*Ophiomorpha*) visible on weathered, darkened portions of DOI south building walls.

Biological weathering at damp base of stair wall, south building parking lot (below).

Site#10: Federal Reserve Building

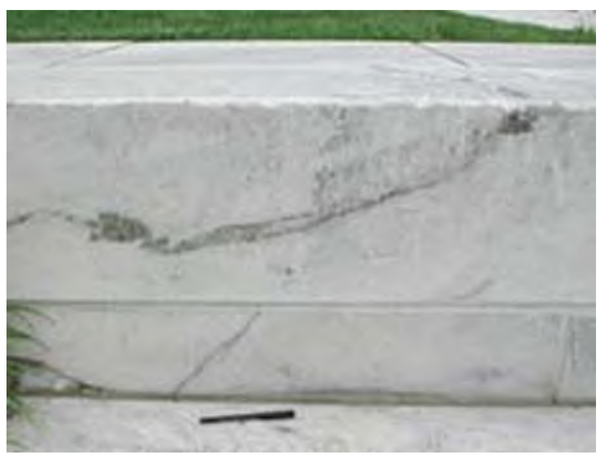
Construction date: 1936 (Depression-Era construction)   Original architect: Paul P. Cret

- rapid chemical weathering of coarse crystalline marble (ex. front steps)
- 3-part terrace walkways show relative durability of “hard” VS “soft” rock to chemical and mechanical weathering (granite, marble, diabase)
- Georgia marble also: OAS exterior & balustrades, Lincoln statue (interior), East front of Capitol
- “You’d hear old-timers say, during the depression, everywhere you looked along Constitution Avenue there were derricks putting up the marble buildings”

– Hubie Stockhausen, quoted in “With Our Hands”

A: Exterior facing, white steps, landscape walls: Georgia “Cherokee” white marble, Neoproterozoic
B: Exterior courtyard fountains: Pennsylvania black diabase, Gettysburg Basin, E. Jurassic (ca. 200 mya)
C: Exterior fountain walkways: various marble and basalt cobbles

Decorative but variable durability walk



Landscape wall with HT-mineral oxid.

Exterior courtyard PA diabase fountain

Coarsely crystalline Georgia "Cherokee" white marble

Weathered, coarsely crystalline Georgia white
marble steps; May, 2002 (before cement patching)

Site#11: Vietnam Veterans Memorial

Construction date: 1982 Original architect: Maya Ying Lin; Cooper-Lecky Partnership

• healing and contemplative in character, makes no political statement; “take a knife and cut open the earth, and with time the grass will heal it” (Maya Lin)

• black gabbro/peridotite (not “black granite”!): coarse, mafic, from magma close to mantle source; quarried near Bangalore, southern India; why so far from home?

• Bangalore-Barre-Memphis; about 494 ft. long; 140 inscribed, <u>south</u>-facing panels supported by concrete pilings driven approx. 35 ft. to Piedmont bedrock

• developing tiny cracks, perhaps cut too thin (3-inch-thick), variable cool soil VS hot rock temperatures, or general instability of gabbro at surface temp/pressure?

• Gabbro also: Simon Bolivar pedestal, Thom. Jefferson pedestal

A: Wall: “Bangalore black granite” (gabbro/peridotite) supplied by Rogan Granite Industries; likely from Andhra Pradesh region, near Bangalore, Karnataka, India, PreCamb.?

Beautiful, reflective, somber qualities; 58,272 inscribed names

Developing micro-cracks

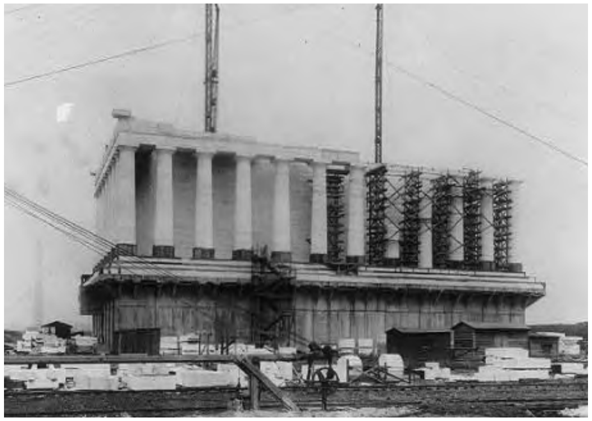
Site#12: Lincoln Memorial

Construction date: 1914-1922

Original architect: Henry Bacon; Daniel C. French (sculptor)

- fine, high-quality Colorado “Yule” marble (domestic equal of Carrara) used to construct exterior; cracking at foundation (some x-cut “fossil” cracks), altered stylolites; attempts to fill with cement patches visible
- Dissolution by acid (ca. 4.3 pH) rain = 1mm/60 yrs (approx., (O’Connor); spheroidal weathering seen on column edges; differences inside VS outside
- 175-ton, 28-piece Lincoln statue took DF & Piccirilli Bros. 13 years
- Colorado “Yule” marble also: Tomb of the Unknown Soldier

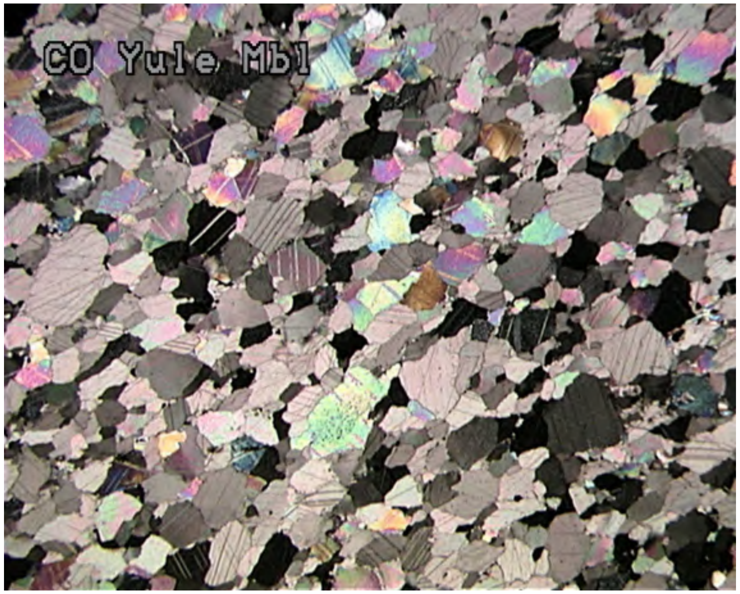
A: Reflecting pool: Mt. Airy white granite, Mount Airy, NC, L. Dev. – E. Miss. (ca. 360 mya)
B: Lower terraces: various cobbles (incl. Camb. Antietam Quartzite cobbles of E. Cret. Potomac Fm alluvial fan)
C: Foundation steps: Milford, MA pink granite, Precambrian (Neoproterozoic, ca. 600 mya)
D: Exterior tripods, statue base, floor: Tennessee light pink “marble” (foss. limestone), Mid. Ord. (ca. 460 mya)
E: Exterior, steps, columns: Colorado "Yule" marble (altered Leadville Ls), Miss. (359-323 mya)
F: Lincoln Statue: Georgia “Cherokee” white marble, Neoproterozoic
G: Interior walls, columns: Salem (Indiana) Limestone, Miss. (359-323 mya)
H: Translucent ceiling: Sylacauga (Alabama) marble, L. Camb. - E. Ord. (ca. 500 – 470 mya)



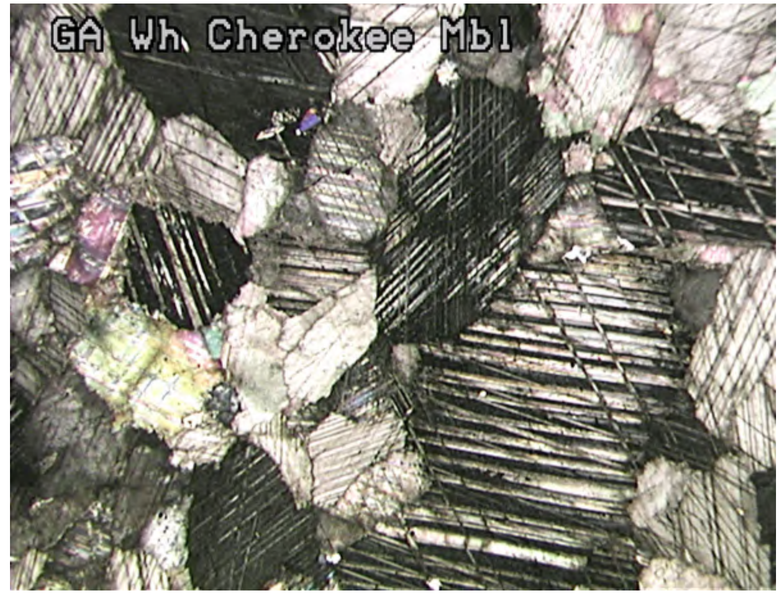
http://loc.gov/pictures/resource/cph.3b24529/

Foundation cracks, x-cut altered stylolites

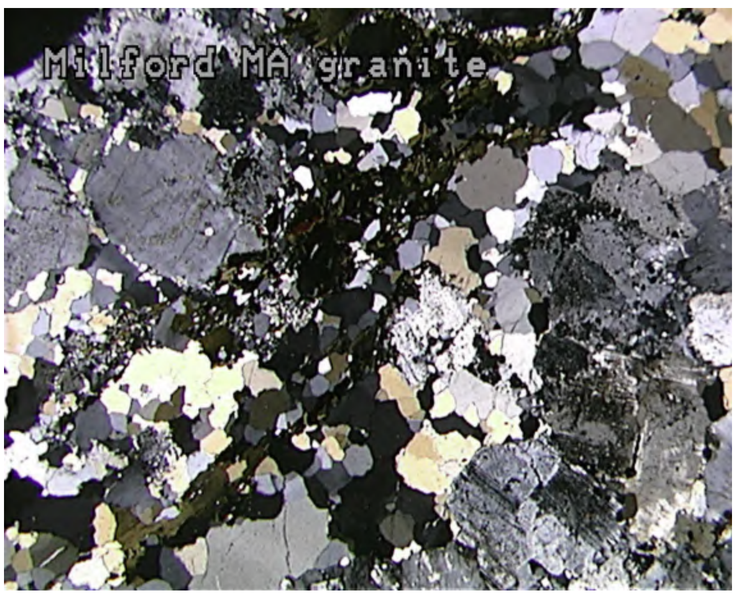
GA white mbl statue, x-bedded TN ”mbl” base



"Yule" mbl: 99.5% pure; 12.5x; 9.35 mm field; xn



Lincoln statue; GA mbl12.5x; 9.35 mm field; xn

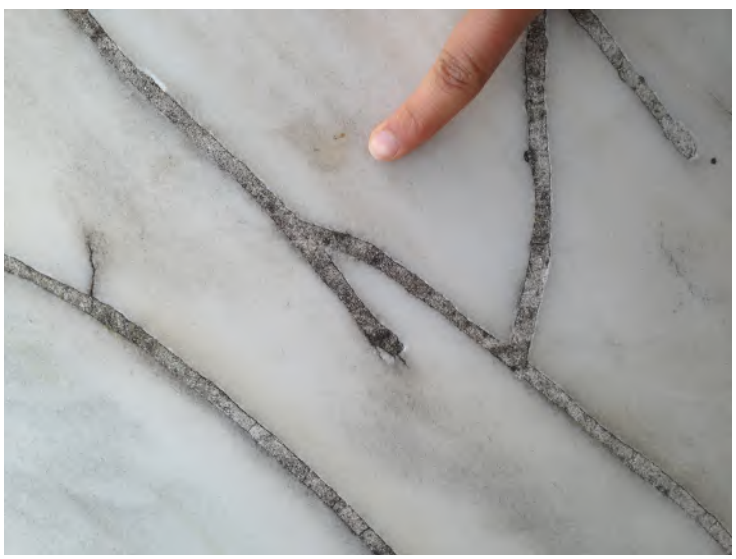


Found.; Mil. MA granite; 12.5x; 9.35 mm field; xn

Statue base/floors; 12.5x; 9.35 mm field; ppl


Situated on less-than-stable artificial fill at Mall west end


Nearby, Braddock’s rock marker (location of former “Potomac Bluestone” quarry); geocaching.com


Close-up of (repaired) Yule mbl foundation cracks

Snippet derived from pubs.usgs.gov:

In colonial days, the first solid ground on the marshy north shore of the Potomac, now just north of the Lincoln Memorial, was an outcrop of Piedmont rocks that jutted into the river. This promontory served as the starting point for surveys establishing property lines for the early settlers. It was called Braddock's Rock, because the British General Edward Braddock and his red-coated soldiers, accompanied by Lt. Col. George Washington, are thought to have landed there in 1755 on their way to Fort Duquesne (now Pittsburgh). In time Braddock's Rock became a quarry, and it may have furnished stone for the foundations of both the White House and the Capitol.

Competition Proposals for a Monument to Abraham Lincoln, 1912

Henry Bacon’s Competition Proposal

John Russell Pope’s Competition Proposal (one of several)

National Archives (http://blogs.archives.gov/prologue/?p=13465)

Site#13: DC World War I Memorial

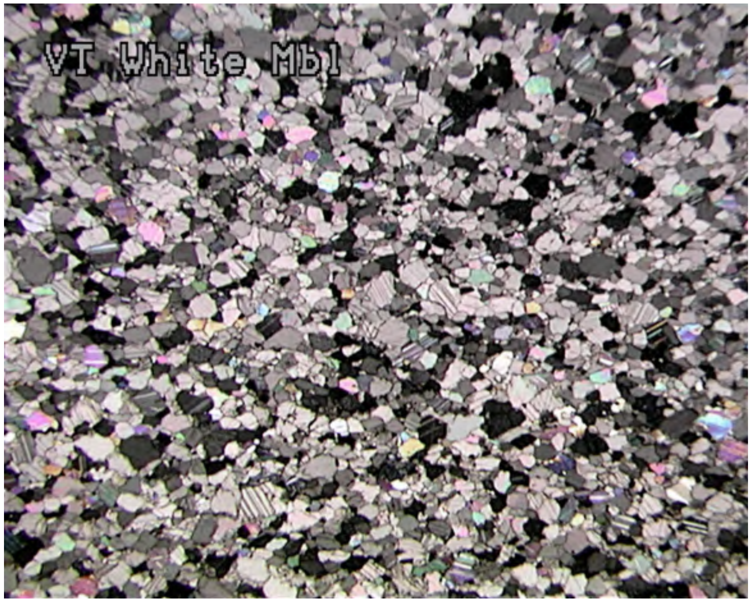
Construction date: 1931 Original architects: Fred Brocke, Nathan Wyeth, & Horace Peaslee

- dedicated by Herbert Hoover during Great Depression (much construction then)
- regionally metamorphosed marble, located between Adirondacks and Green Mountains (Danby, VT), part of western VT marble belt
- relatively little city-maintenance prior to 2010 restoration, extreme chemical weathering of calcitic marble; stalactites, staining, corrosion, oxidation of impurities
- active cracking and modern dripstone "healing" in lower portions of column cracks i
- VT white mbl also: Jefferson Mem., west Capitol balustrades, Supreme Court, DAR

A: Structure: Shelburne (Vermont) white marble, E. Ord. (485-470 mya)
B: Central floor: Tennessee light pink "marble" (Holston Fm., foss. limestone), Mid. Ord. (ca. 460 mya)

Bio-chemical weathering, now removed

Stalactites beneath ceiling cracks, now removed



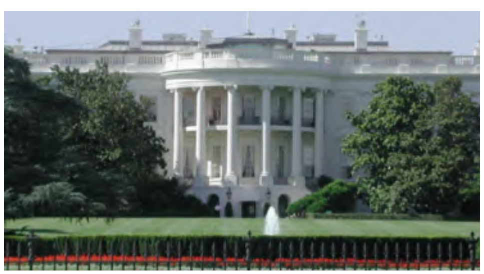
Shelburne (VT) mbl; 12.5x; 9.35 mm field; xn

Site#14: Jefferson Pier (and views N & S)

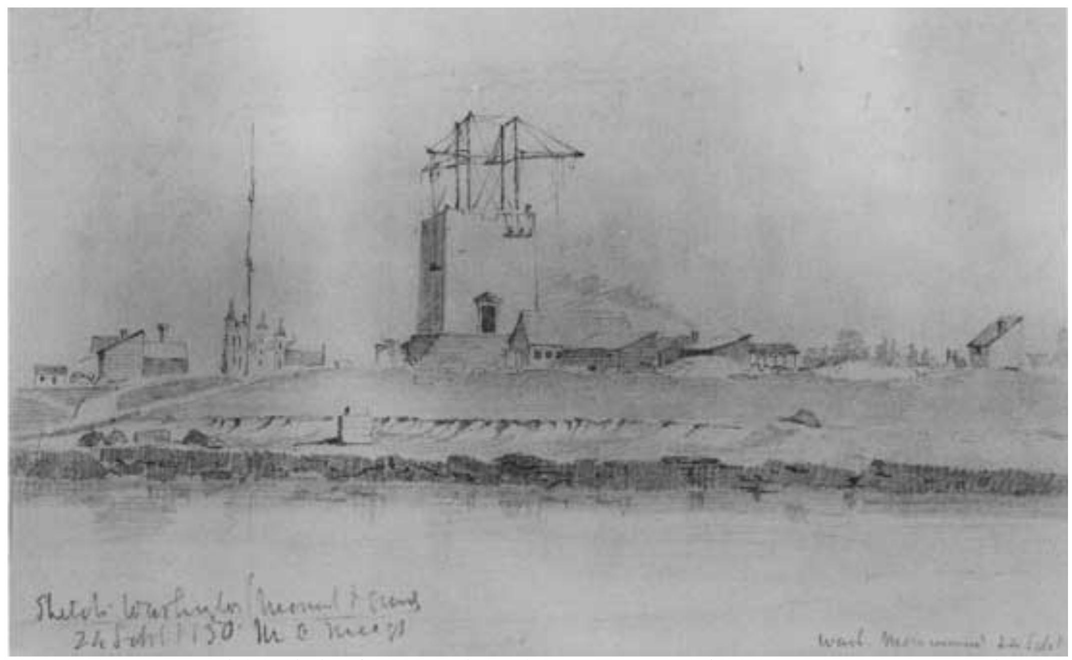
Construction date: 1804 (Colonel O.H. Ernst; stake, then sandstone marker; later granite, stolen and restored in 1889)

- original position on banks of Tiber Creek, marked in 1793 by wooden stake, then stone pier of Aquia Crk SS (see Meigs drawing, below), and later granite
- Indicates originally intended site for Washington Monument, as drawn by L'Enfant and chosen by Jefferson
- now made of strong and durable Petersburg Granite; defaced (and incorrect) inscription reads "being the center point of the…"

A: Pier: "Richmond" granite (= Petersburg Granite), L. Miss. (Alleghenian intrusive, ca. 330 mya)
B: White House (view to north): Aquia Creek Sandstone (painted), Potomac Group, E. Cret. (ca. 100-145 mya)
C: Jefferson Memorial (view to south), Shelburne (Vermont) white marble, E. Ord. (485-470 mya)

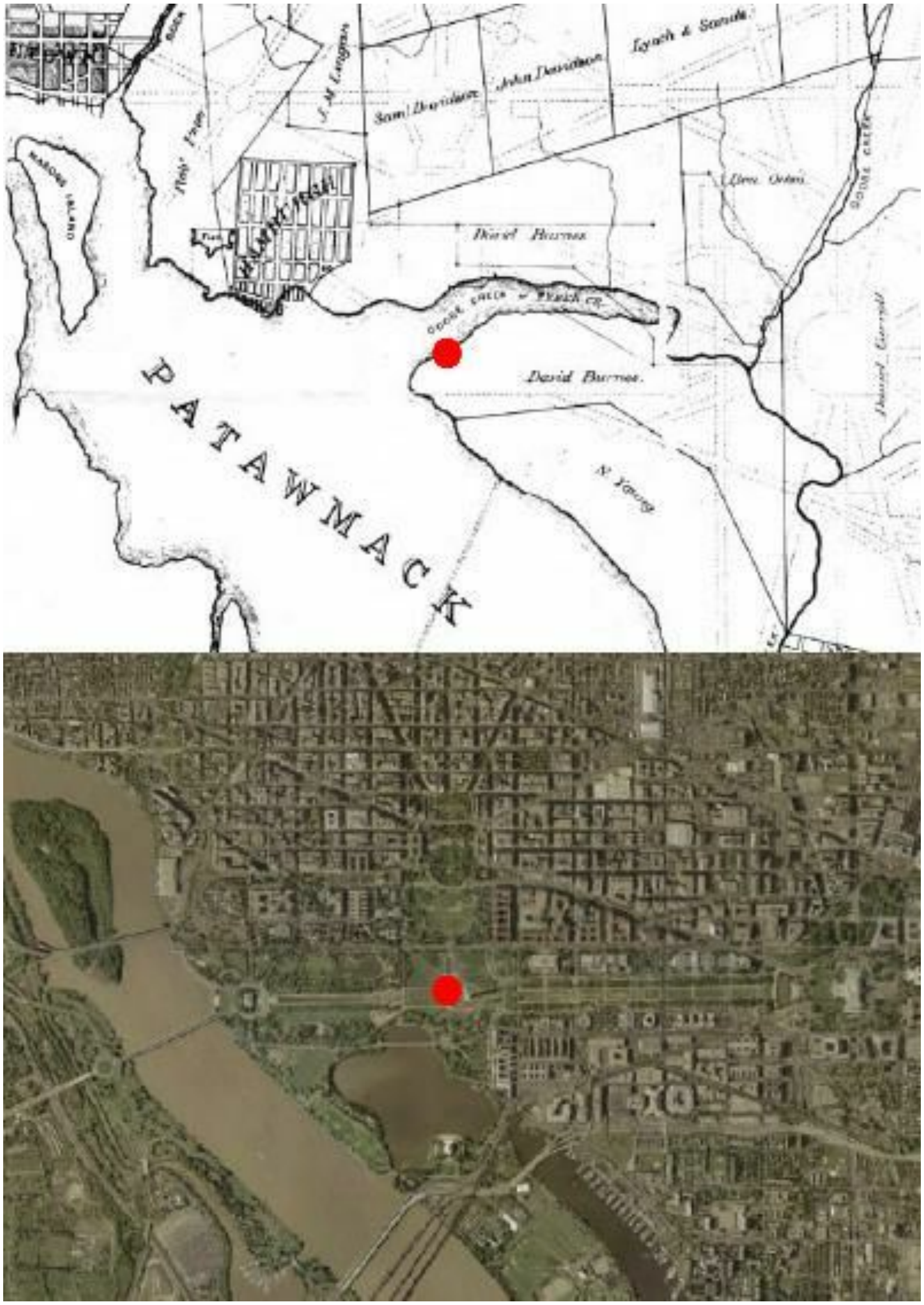


Nearby White House on natural50-ft Talbot Terrace (ca. 211,000 ybp)



Wash. Mon. with original stone pier; drawn 9/24/1850 by Montgomery Meigs
http://www.nps.g ov/parkhistory/online_books/ncr/designing-capital/sec5.html

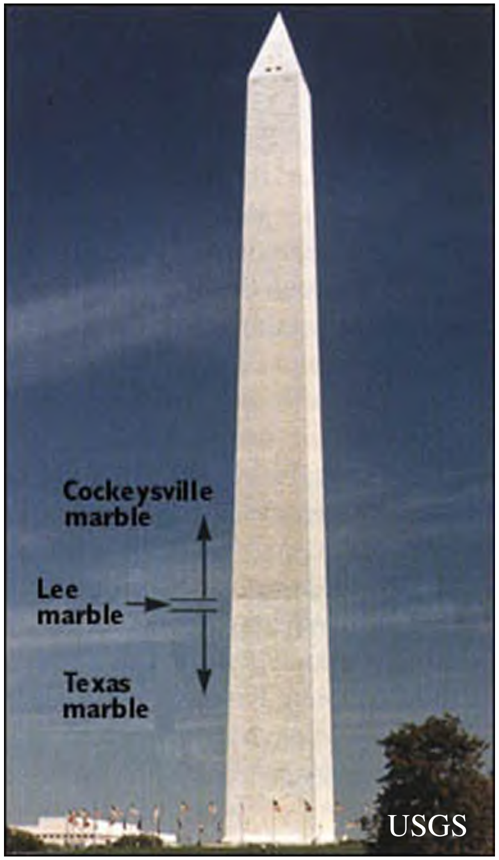
The Position of the Jefferson Pier: Then (1804) and Now



Comparison of Washington, D.C. from 1800 historic map and modern satellite image, showing location of Jefferson Pier. (Wikipedia: DC-old-and-new-Jefferson-Pier.jpg). Recall previous image of geologic map of Washington West Quad.

Site#15: Washington Monument

Construction date: 1848-1885 Original architect: Robert Mills; simplified in 1878 by T. Casey USACE

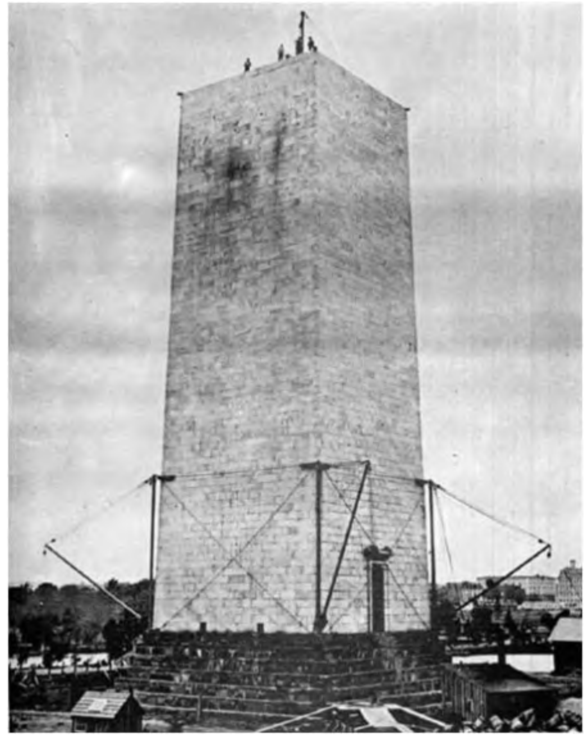


- within 100 yds of intersection of east-west line (from Capitol) and north-south line (from White House); weight of monument: 90,854 tons; number of blocks: 36,491; foundation = quarried "Potomac bluestone" blocks (subsequently improved in 1876)
- tallest free-standing masonry structure in world (555 ft. 5 1/8 inches), built of three marbles (Texas, Lee, Cockeysville); interruption during **1858-1878 at 156 ft-mark**, due to insufficient funds and Civil War (discovered tilting northward, and fixed)
- built in 2 phases: private (Wash. Nat. Mon. Soc., Polk adm, 1848-1854) and public (USACE led by Lt. Col. Thomas L. Casey, Grant adm, 1876-1884). Casey simplified design in 1878, straightened tilt, widened sub-foundation, and reduced wall thickness (13 ft to 9 ft) above 156 ft.; has 193 memorial stones inside; 1934, 1999, 2011 restor.
- base of Texas marble unfortunate: coarser, degrades more rapidly, purer (non-dolomitic); weakness at edges and joints (cleaned, repaired, +/ or replaced 1999-2000)
- 100 oz cast Aluminum pyramid at tip for lightning rod; cost $225 (= **$5,720** in 2014 US$), but worth $4.44 now (using Oct. 2015 price of $0.71 per lb for Aluminum)
- 19^{th} C. building cost = $1.2 million; post-2011 E-quake repairs = $15 billion
- Cockeysville MD marble also: Capitol wing columns, Battle of North Point Mon. (Baltimore, MD)

A: Cast Aluminum (pyramid) tip: worn 3/8 inch over 130 years (1885-2015)
B: Upper 390 feet: Cockeysville, MD marble (fine/dolomitic), Neoprot.-E. Ord.
C: Middle (4) courses: Lee, MA marble (Sheffield Mbl, Stockbridge Fm), Camb.- E. Ord. (ca. 541-470 mya); problems with timely delivery and quality control of Lee Mbl
D: Lower 152 feet: Texas, MD marble (coarse/pure calcitic), Neoprot.-E. Ord.
E: Foundation: "Wissahickon" metamorphics (Sykesville Fm.; Potomac "Bluestone"), Neoprot.- E. Ord.? (ca. 650-470 mya?) and cement; extends 37 ft below ground

Capstone w/Casey http://www.loc.gov

Mills' winning design of 1852, by Chs Fenderich; colonade intended to house statues of GW and others. http://www.loc.gov/item/2002723506/

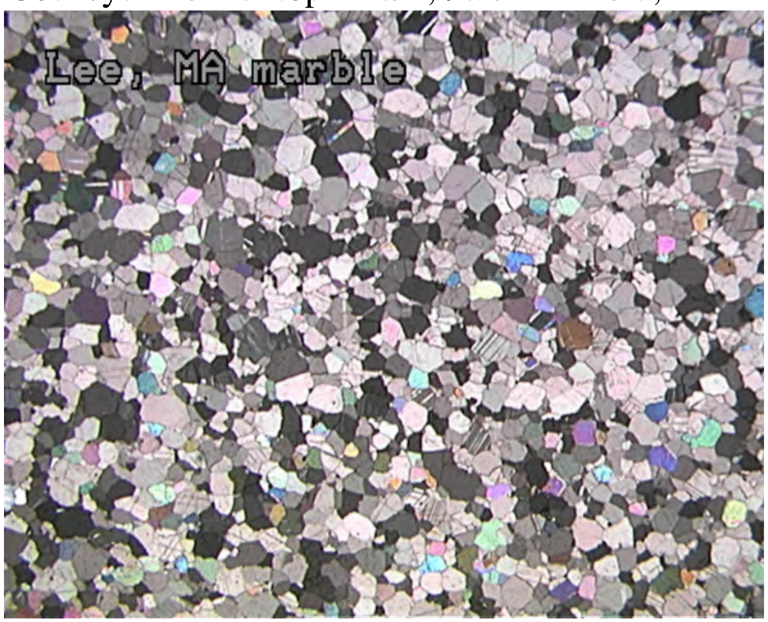


Unfinished Texas section before Casey renewal of construction, 1876; Library of Congress

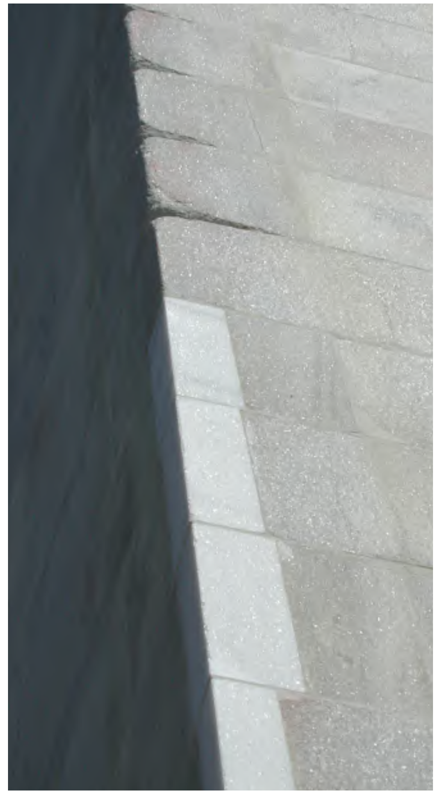
Proposed design for completion of monument by H.R. Searle, ca.1877 (http://www.loc.gov/pictures/item/2005695795/)

Shaft nears completion, ca. 1880-1884 (http://www.loc.gov/pictures/resource/hhh.dc0261.photos.027187p/)

Cockeysville mbl top: 12.5x; 9.35 mm field; xn

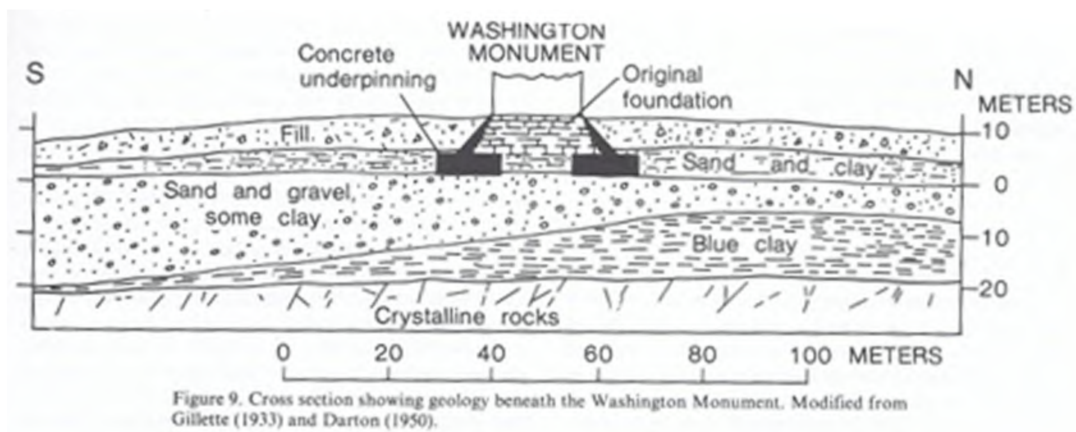


Lee, MA marble midl.:12.5x; 9.35 mm field; xn



Corner deterioration and
1999-2000 replacement
of Texas, MD marble

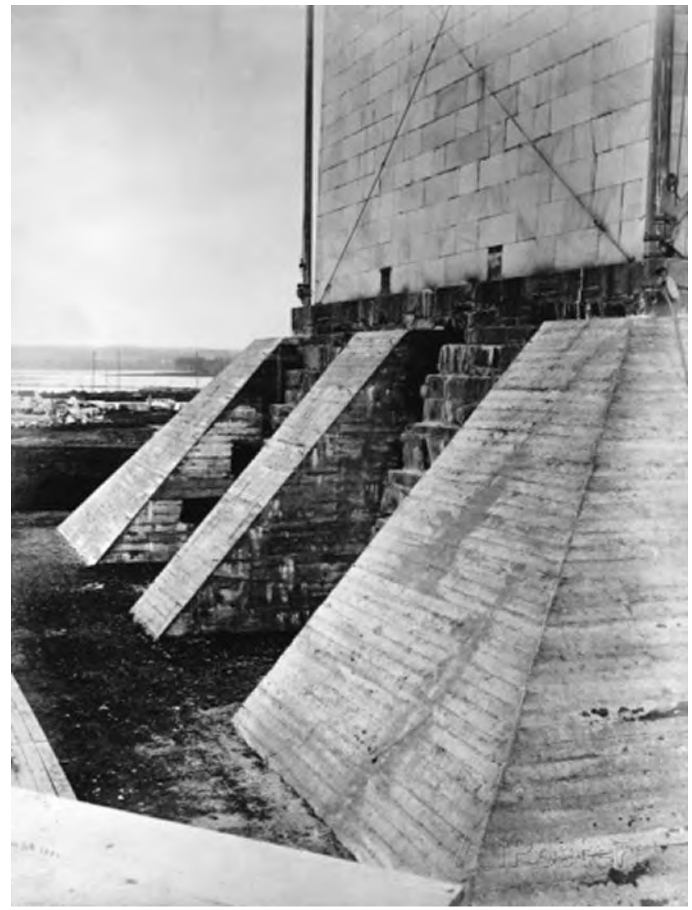
1999-2000 mortar patching; mica,
pyrite oxidation



Geol. & Hydrol. of Washington, DC, Moore & Jackson, Eds. (1989)

From: "A History of the Washington Monument, 1844-1968", by George J. Olszewski, April 1971, Washington, D.C. (npshistory.com)

Original "Potomac Bluestone" block foundation



Details on Portland cement buttresses

Widened, reinforced with cement buttresses in 1876

Site#16: National Museum of Natural History

Construction date: 1911 (E/W wings in 1961/64) Original architects: Hornblower & Marshall

• third building of Smithsonian, after Castle and A&I; made of extremely strong/durable granite to house increasing quantity of national treasures; building cost = $4 million

• three different exterior granites, lighter-colored and younger rx towards top, with rough & smooth facing styles; note especially *Corinthian* columns carved of Bethel, VT *granite*

• Unakite terraces at Mall entrance (= VA state rock): greenish-pink, hydrothermally altered granite with pink K-spar, green epidote (from altered plagioclase), and quartz

• great geological information on display inside: see end of Geol/Gems/Mins Hall for display on building stones, weathering, White House "facelift", etc.

A: Rotunda interior columns: "Breccia Stazzima" marble, Tuscany, Italy (L.Tri. - E. Jur. dep, Eocene alteration)
B: Rotunda floors: Tennessee light pink "marble" (Holston Fm., foss. limestone), Mid. Ord. (ca. 460 mya)
C: Interior courts: "Woodstock" granite (Quartz Monzonite), Granite, MD, Ord. (ca. 444 mya)
D: Interior G/G/Min Hall display: info on building stones, weathering processes!
E: Attic floor: Mt. Airy white granite, Mount Airy, NC, L. Dev. – E. Miss. (ca. 360 mya)
F: Two main floors & exterior columns: Bethel (VT) white granite, M. Miss. (ca. 335 mya)
G: Ground floor, Mall terrace: Milford, MA pink granite, Neoproterozoic, (ca. 600 mya)
H: Mall terrace: Unakite, Blue Ridge Province (these from NJ), Neoproterozoic (ca. 1 bya)
I: Dome: green Poultney, VT slate (Camb. dep, E. Ord. Taconic alteration)

Bethel, VT over Milford, MA granite

Display at end of G/G/Min Hall

Breccia Stazzima mbl, with TN "mbl" base

Site#17: National Gallery of Art (West)

Construction date: 1936-1941

Original architect: John Russell Pope (also Nat. Archives & Jeff. Mem.)

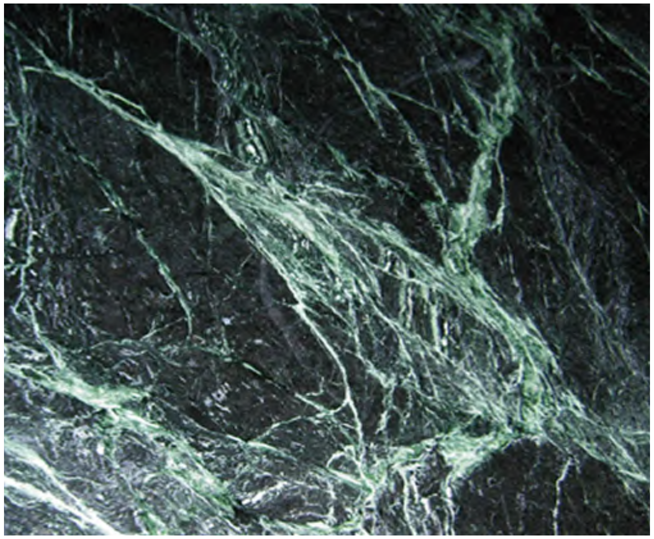
- excellent demonstration of coarse, bioclastic nature of TN “marble”, plus interior Rudistid and orthocone nautiloid fossils, and mbl breccia columns
- see well-developed cross-bedding in exterior stones, which are highly etched by 75 yrs of exposure to acid rain; rain-shadow on inner side of exterior columns
- coiled molluscs in highly polished "Radio black marble” of bathroom walls
- Tennessee light pink "marble" also: Amer. Hist. , Lincoln statue, NMNH floors, Sculpture Garden, NASM , US Capitol East Vis. Ctr., etc.

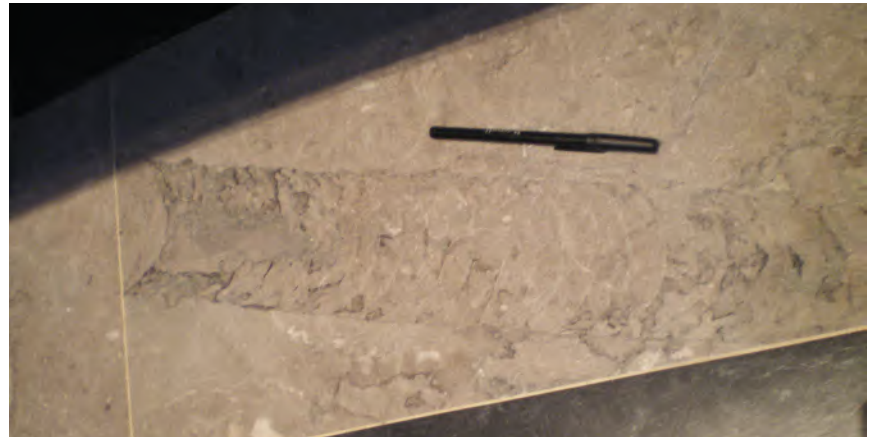
A: Exterior: Tennessee dk-lt pink "marble" (foss. limestone), Mid. Ord. (460 mya)
B: Exterior lower terrace: Milford, MA pink granite, Precambrian (Neoprot., ca. 600 mya)
C: Green floors: Vermont verde antique “marble” (serpentinite, as in Rockville, MD), Ord.?
D: Rotunda columns: Carrara brecciated marble, Carrara, Italy (L.Tri. - E. Jur. dep, Oligo. alt)
E: Gallery walls: Alabama limestone (micritic; gastropods, crinoids), L. Miss. (335-325 mya)
F: Restrooms: NY "Radio black”, or VT “Champlain black marble”, (foss. ls), M. Ord.

TN “marble” with well-etched x-bedding

VT verde antique “marble” (serpeninite)

Brecciated Carrara, Italy marble columns





Large, straight nautiloid in muddy Cret.? limestone floors

VT verde antique "marble" floors (serpeninite)

On our way to Stop # 18… pass National Gallery of Art East Building – designed by I.M. Pei, completed in 1978, undergoing exterior renovation in 2012 for failing anchor supports for TN "marble" panels.

Site#18: Peace Monument

Construction date: 1877 Designers: Adm. David Porter (by sculptor F. Simmons; fountain by Edward Clark)

- 44-foot-tall statue, originally intended for Naval Academy in Annapolis, is made of world famous white Carrara marble of Italy
- upper figures represent Grief weeping upon shoulder of History (tablet reads "they died that their country might live"; lower female figure represents Victory, with Mars and Neptune as infants at her feet; Peace is located on east side, facing Capitol
- note serious dissolution, broken/replaced limbs, alteration crusts, and resultant loss of surface details (especially in faces) due to ca. 140 yrs of exposure to acid rain
- fountain of Maine blue granite with abundant, darker (mafic) xenoliths

A: Statue: Carrara white marble, Tuscany region, Italy (L. Trias.- E. Jur. dep, Oligo. alt)
B: Fountain: Maine blue granite, Midl. - L. Dev. (ca. 393-359 mya)

Grief, History

Victory, Mars, Neptune

Xenolith in Maine blue granite

Site#19: Capitol Building (West elevation)

Construction date: 1793-1865

Original architects: Thornton, Latrobe, Bulfinch, Mills, & others

• Jenkin's Hill site (90-ft Wicomico Terrace, ca. 300,000 ybp) chosen by L'Enfant

• President Washington laid southeast cornerstone of main building 9/18/1793, orig. north wing in 1800, orig. south wing in 1807- all burned by British in 1814

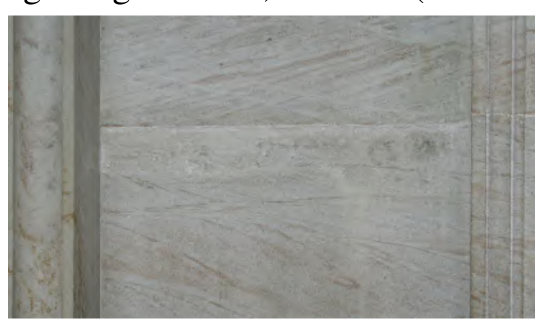
• interior of main building made of finest quality Aquia sandstone, excellent condition when protected from elements (unlike Capitol Gate Posts & House)

• has undergone many stages of construction and restoration (see https://youtu.be/Os1djKfl7ZU for excellent visual timeline); cleaning & repair 1983-87, with parts of corroded VT mbl balustrade replaced

• beautiful interior Leesburg Congl. columns nearly impossible to work/polish

A: Outer stone wall: mixed stones (Aquia?, Indiana LS, pink granite, Potomac "Bluestone")
B: West upper steps: Mt. Airy white granite, Mount Airy, NC, L. Dev. – E. Miss. (ca. 360 mya)
C: Senate/HR wings: Lee, MA marble (Sheffield Mbl), Camb.- E. Ord. (ca. 541-470 mya)
D: Senate/HR wing-columns: Cockeysville, MD marble (dolomitic), Neoprot.-E. Ord.
E: West balustrades: Shelburne (Vermont) white marble, E. Ord. (485-470 mya)
F: W. Center: painted Aquia Creek Sandstone, Potomac Group, E. Cret. (ca. 100-145 mya)
G: Rotunda floor: Seneca Creek Sandstone (polished), L. Trias. (Norian, ca. 209 mya)
H: Columns (Old Senate/Statuary Hall): Leesburg Conglomerate, L. Trias. (ca. 209 mya)

Vermont marble balustrades



Interior Aquia SS shows cross-bedding

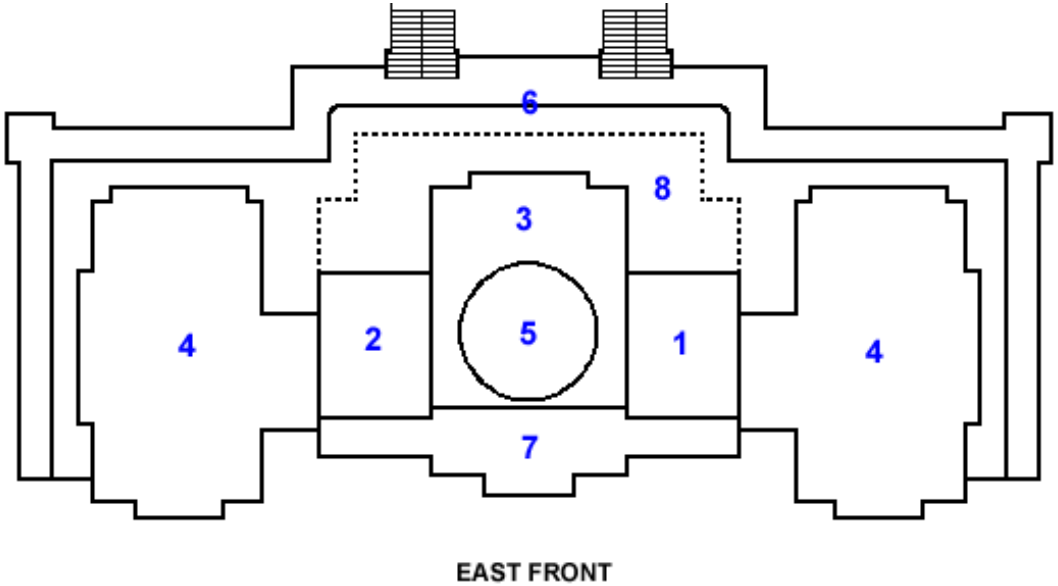
Statuary Hall: Leesburg Congl. & Aquia SS wall

Capitol Building History

West elevation of Thornton's winning original (and late!) design entry of 1793, ultimately selected by President Washington

View of west front July 2001 (showing 3-part wall)

Stages of Capitol Building Construction



Numbers on drawing show the order in which different sections of the Capitol were built. The dates below are for each section's first construction period and do not include rebuilding or repair.

1. Original north (Senate) wing, 1793-1800
2. Original south (House) wing, 1793-1807
3. Center section and Rotunda, 1818-1824
4. Present House and Senate wings and connecting corridors, 1851-1867
5. Cast-iron dome, 1855-1866
6. Terraces, 1884-1892
7. East front extension, 1958-1962
8. Courtyard infill rooms, 1991-1993

Architect of the Capitol

Washington City Canal looking west from Capitol (Library of Congress)

1860 photograph of Washington City Canal, in front of west side of Capitol Hill; note unfinished dome (Library of Congress)

Alexander Jackson Davis (1803-92) painting of early east front of Capitol; (Library of Congress)

1922 Ulysses S. Grant Memorial by Henry M. Shrady; bronze over Georgia White "Cherokee" Marble; under restoration 2015-2016

Site #20 National Museum of the American Indian

Construction Date : 1999-2004

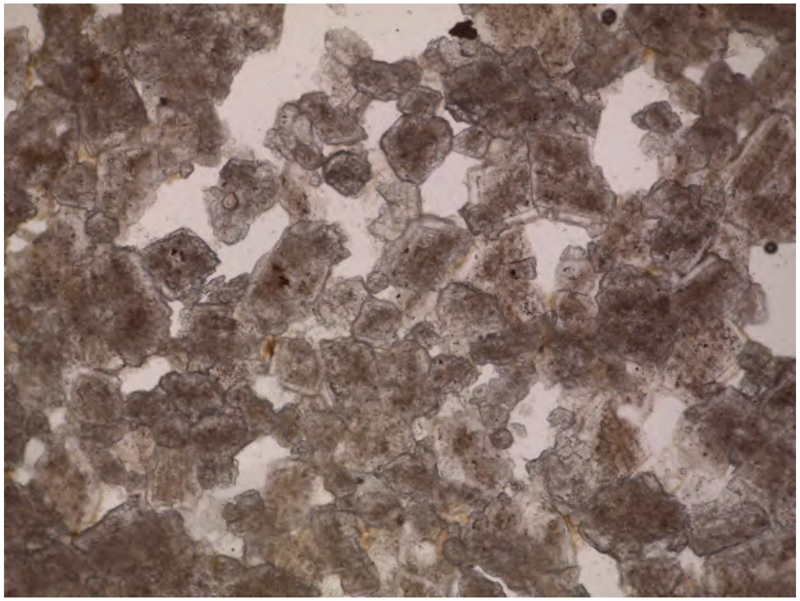
Original Designers/Architects: Douglas Cardinal and Johnpaul Jones

- south-central MN; restricted platform, shallow, peritidal carbonate facies within Sauk epicontinental sea; evaporative influences, yet live bottom
- complex diagenetic history: syndepositional dolomite, shallow burial diagenesis (incl. karstic dissolution and replacement dolomitization), and later hydrothermal dolomitization & calcite precipitation (Smith & Simo, 1997)
- design suggests wind and water erosion of stratified rock; dolomite content creates higher resistance to weathering; iron oxide gives warm yellow color
- Kasota also: Constitution Center, DC; MN State Capitol (interior)

A. Exterior: Kasota dolomitic limestone (Oneota Fm), Prairie du Chien Group, E. Ord, (ca. 485-470 mya)

B. Exterior fountain: Unkn. diabase

Abundant horizontal & vertical burrows



100x; 1.1 mm field; ppl

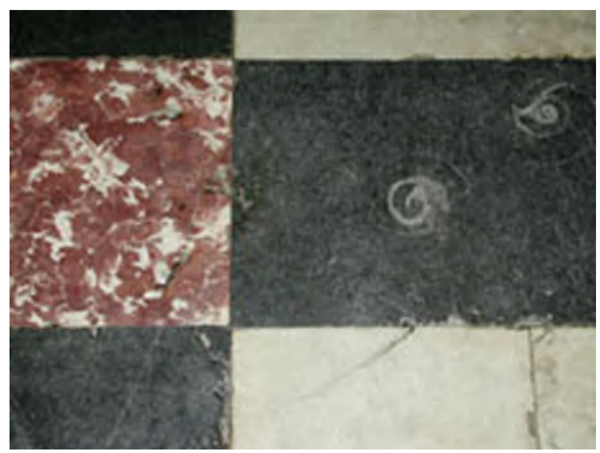
Site#21: Arts and Industries Building (interior)

Construction date: 1881. Original architects: Adolf Cluss and Paul Schultz

- originally the “US National Museum”; also known as “Baird’s Castle”, was second SI building on Mall (at lowest cost per square foot of any federal building in DC; according to SI, total cost = $250,000)
- exterior of brick, based on a design by Gen. Montgomery C. Meigs for a centennial government exhibit; sculpture above door is “Columbia Protecting Science and Industry” (note Owl of Wisdom located at the feet of Science)
- first event was to host Inaugural Ball of 20th Pres. James Garfield (Mar. 4, 1881); housed materials from the Centennial Exposition of 1876, held in Philadelphia
- interior floor tiles of New York "Radio black” (or “Champlain Black marble”) contain Ordovician fossils, such as Maclurites and Orthoceras
- *may* reopen in 2016 following complete restoration (estimated at $72 million)

A: Floor tiles: New York "Radio black”, or “Champlain black marble”, VT (foss. limestone), M. Ord. (470-458 mya)

Unknown fossil mollusc



Maclurites (Ordovician-age gastropod)

“Columbia Protecting Science and Industry”; commons.wikimedia.org, 2011 Jamie L. Adams

1994 removal for restoration (Smithsonian Inst.)

Brendan McCabe, Smithsonian Inst., Wash. Post, 1/28/2014

Check out the time lapse video of the exterior renovation
http://www.earthcam.net/projects/smithsonian/?cam=mpa

The Arts and Industries Building Through Time


1878 sketch of architectural plan

1881(?) natural history exhibit

1960s “Rocket Row” display

http://www.smithsonianmag.com/smithsonianmag/the-arts-and-industries-building-innovation-through-the-years-174797/

Site#22: Smithsonian Institution “Castle”

Construction date: 1847-1857 Original architect: James Renwick, Jr.

• James Smithson bequeathed $515,169 in 1838; first building of Smithsonian Institution (established by Act of Congress Aug. 10, 1846); nearly consumed by fire in 1865

• built in Romantic, or Gothic Revival style; once housed all SI displays, offices, and laboratories; major and destructive fire Jan., 24, 1865

• built in “Brownstone” Era (1840-1880) from Fe-rich, Late Triassic Seneca Creek Sandstone; cheap and readily available about 25 miles north along Potomac in Montgomery County, MD (Seneca Creek cliffs; “Newark Supergroup” rocks)

• relatively cheap (1/2 the cost of Aquia SS) stone darkens and hardens on exposure to air, but must be oriented with original bedding horizontal (and away from foundation) to reduce rate of degradation

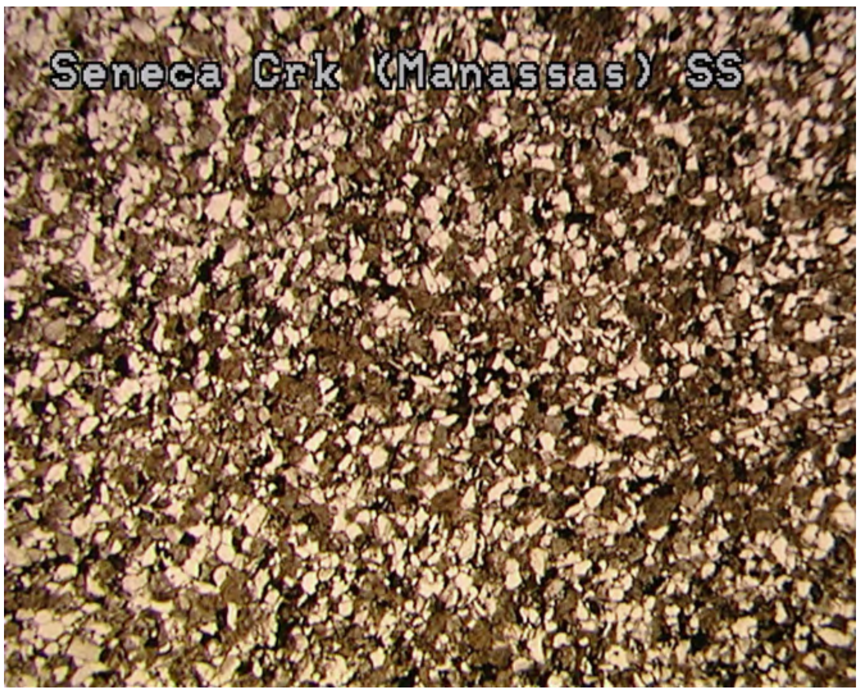
• Seneca Creek SS also: locks of Geo. Washington’s Potomac Canal (Great Falls), C&O Canal structures, “Brownstones”, inner Wash. Mon., US Capitol rotunda floor

A: Exterior facing: Seneca Creek Sandstone, Seneca, MD (cliffs on north bank of Potomac River, just west of Seneca Creek, Montgomery County, MD; equiv. of Manassas Sandstone), L. Trias. (Norian, ca. 209 mya)

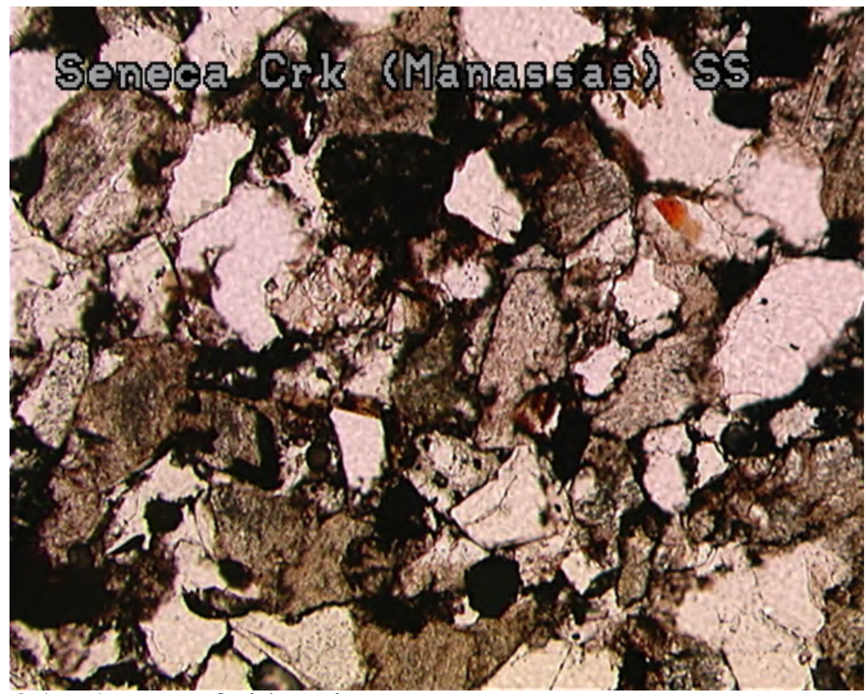
Surface spalling/sheeting

Library of Congress image, 1880’s Bison

April 1865 view behind Smithsonian Castle, looking east towards Capitol Building (Library of Congress)



12.5x; 9.35 mm field; ppl



25x; 4.7 mm field; ppl

Site#23: Haupt Garden Arches

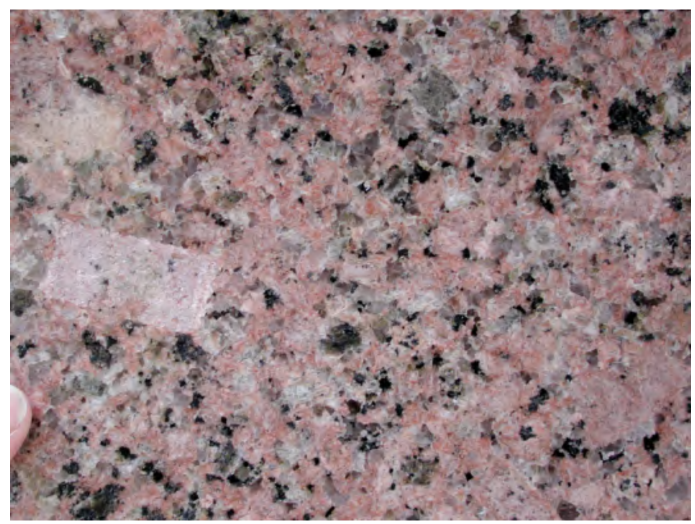
Construction date: 1987

Original architect: Jean Paul Carlhian

- solidified magma: pink feldspar, black mica and gray quartz
- study in very coarse pegmatitic igneous texture (intrusive, slow cool, water-rich) and various styles of surface dressing/polish
- same stone in reflecting pool, cut and polished differently
- known as the Moongate Garden. Inspired by the 15th century architecture of the Temple of Heaven in Beijing, China
- Symbolically: rock = body of Earth; water = spirit of Earth
- Texas "Sunset" also: Texas State History Museum, Austin, TX, Texas State Capital building, Austin, TX (1888)

A: Haupt Garden Arches & fountain walkway, Texas "Sunset Red" granite, Marble Falls, TX, Proterozoic

Contrasting dressing/polish



Large, zoned, K-feldspar phenocrysts

Useful References

Anderson, U.B. et al. Editors; Högdahl, K., Eklund, O., 2004, "The Transscandinavian Igneous Belt (TIB) in Sweden:a review of its character and evolution", Geological Survey of Finland, Special Paper 37.

Architect of the Capitol, "Chapter V The Work of Charles Bulfinch, Architect", U.S. Publishing Office http://www.gpo.gov/fdsys/pkg/GPO-CDOC-108hdoc240/pdf/GPO-CDOC-108hdoc240-2-8.pdf

Berg, S.,2008, "The Man With the Plan", Washington Post Magazine.

Bentley, C. and Rasmussen, K., 2018, "Travels in Geology: Touring the Capital Geology of Washington, D.C.": EARTH, December 2018, pg. 36-47.

Binczewski, G.J, 1995, "The Point of a Monument: A History of the Aluminum Cap of the Washington Monument", JOM Journal, a publication of The Minerals, Metals, and Materials Society. http:// www.tms.org/pubs/journals/jom/9511/binczewski-9511.html

Coli, M. and Garzonio, C.A., 2009, "ISRM Guide Book to the Carrara Marble Quarries", University of Florence Dept. Earth Science and Dept. of Restoration and Conservation of Architectural Heritage.

Dale, T.N., 1907, " The Granites of Maine", U.S. Geological Survey, Series A, Economic Geology, 93, Bulletin No. 313. http://pubs.usgs.gov/publication/b313

Dale, T.N.,1909, "Granites of Vermont", U.S. Geological Survey Bulletin 404

Garrigan, G.A. 1993, Revised Edition, " Eight Short Courses in Virginia Field Geology, Book Four; Structural and Decorative Stonework", Northern Virginia Community College.

Goldsmith, R., Robinson, P., Wones, D., Marvin, R., and Zartman, R., 1991, "The Bedrock Geology of Massachusetts", U.S. Geological Survey Professional Paper 1366-E-J.

Goode, J.M., 1974, "The Outdoor Sculpture of Washington, D.C.: A Comprehensive Historical Guide", Smithsonian Institute Press, Washington, D.C.

Grant, J.A., Himmelberg, G.R., Goldich, S.S., 1972, "Guidebook 5. Field Trip Guide Book for Precambrian Migmatitic Terrane of the Minnesota River Valley", Minnesota Geological Survey.

Maryland Geological Survey,1990, "Building Stones of Maryland".

McGee, E.S., 1990, " Deterioration of Building Stones in Washington, D.C.": A Field Trip Guide, U.S. Geological Survey, Open File Report 90-479.

McGee, E.S., 1997, " Acid Rain and Our Nation's Capital", U.S. Geological Survey.

Moore, J., Jackson. J, Editors, Rubin, J., Art Editor, 1989 "Geology, Hydrology and History of the Washington, D.C. Area". American Geological Institute.

Mohanty, M., Parthasarathi, C., and Mahadevappa, P. 2007 "PGE Concentraion in Nuggihalli Mafic- Ultramafic Complex, Karnataka", State Unit Kamataka and Goa, Bangalore, Geological Survey of India.

.

O'Connor, J.V., 1985, "District of Columbia", *Earth Science*, Fall:11-15.

Olszewski, G. J., 1971 "A History of the Washington Monument 1844-1968, U.S. Dept. of the Interior, National Park Service.

Osberg, P.H., Hussey, A.M. and Boone, G.M. 1985, Bedrock Geologic Map of Maine, Maine Geological Survey.

Perazzo, P. 2013, "The Kasota Quarries" (Dolomites and Dolomitic stones in southeastern Minnesota), The Manufacturer and Builder, Vol. 18, No. 6, Jun 1886, pp. 131-132.

Reed, J.C. and Obermeir, S.F., 1982, "The Geology Beneath Washington, D.C.- Foundations of a Nation's Capital", Leggett, R.F.,(Ed.) Geological Society of America Reviews in Engineering Geology, Vol. V, Geology Under Cities:1-23.

Robbins, E.I., and Welter, M.H., 2001" Building Stones and Geomorphology of Washington, D.C. – The Jim O'Connor Memorial Field Trip", U.S. Geological Survey.

Savage, K. 2009, "Monument Wars- Washington, D.C., the National Mall, and the Transformation of the Memorial Landscape". University of California, Smith, G.L. and Simo, J.A., 1997, " Carbonate Digenesis and Dolomitization of the Lower Ordovician Prairie Du Chien Group". Volume 16, Geoscience Wisconsin.

Thomas, W.A., Smith, W.E., Bicker, Jr., A.R., 1979, "Mississippian and Pennsylvanian Stratigraphy of Alabama and Carboniferous Outcrops of Mississippi", University of Alabama.

USGS Professional Paper 1110- A-L, "The Mississippian and Pennsylvanian (Carboniferous) systems in the United States".

Weeks, C., 1994, "AIA Guide to the Architecture of Washington, D.C.", 3rd Edition, Johns Hopkins Press.

Withington, C.F., 1975, "Building Stones of our Nation's Capital", U.S. Geological Survey.

Withington, C.F., Edited Olsen, D., 1998, "Building Stones of our Nation's Capital", U.S. Geological Survey.

Other Sources include:

American Treasures of the Library of Congress

http://www.loc.gov/exhibits/treasures/tri047.html

Designing The Nation's Capital: The 1901 Plan for Washington, D.C.

http://www.nps.gov/parkhistory/online_books/ncr/designing-capital/index.html

Explore President's Park

http://www.nps.gov/whho/planyourvisit/explore-president-s-park.htm

National Building Stone Database

Smithsonian Institute Historical Archives and the National Park Service