BOSTON BUILDING STONE

WALKING TOUR 2010

HISTORIC USES OF STONE IN BOSTON

The first recorded use of building stone was in 1650, when the house of Deacon John Phillips was built from local granite boulders. The house stood until 1864. The oldest stone building still extant is King's Chapel (stop 5), built in 1749-54 of hand-split blocks from Quincy granite boulders.

Streets were formerly paved with cobblestones and cut granite paving blocks, still visible in the historic districts and, in places, at the bottoms of potholes. Starting in 1792 gneissic granite was shipped from Connecticut for curbing and paving, and beginning in the early 19th century most curbing was made of granite, initially from Chelmsford, MA. Unlike many areas outside of the northeast, stone is still used routinely for street curbing. Prior to the Great Depression granite curbing and paving blocks were supplied from New England quarries, most commonly from quarries located near the coast. Currently active sources of granite curbing for the Boston market are quarries in the Chelmsford granite (quarries located in Westford, Mass.), the Concord Granite in Concord, New Hampshire, and a grey granite near Otis, Massachusetts. Stone was also used for sidewalks. We will walk on various types of granite as well as "bluestone," a fine-grained arkose from the Catskill Mountains, during our trip today.

STONE IN OLDER BUILDINGS

Prior to the use of steel framing for building, massive stone blocks of local building stones were used for load-bearing walls of buildings. The proximity of Boston to several sources of granite has made this a granite-rich city, at least in the commercial districts. The most common granites on older building in Boston are Quincy Granite, Milford Granite, Rockport Granite, Stony Creek Granite, and various granites from the coast of Maine (Deer Isle Granite is probably the most abundant). The dark blue-grey Quincy granite, a peralkaline riebeckite granite (referring to a sodium-rich blue amphibole) quarried south of Boston, was very popular for buildings and monuments (including the Bunker Hill Monument, begun in 1825). The pink gneissic Milford Granite, quarried southwest of Boston, blended well with the brick structures of the City. Grey, and greenish grey Rockport Granite, a hornblende granite quarried on Cape Ann north of Boston, has a fairly distinctive texture. Stony Creek Granite is a pink gneissic granite from near Branford, Connecticut. The Maine coastal granites are commonly pink and tan in color, and porphyritic or relatively coarse grained.

As in New York, brownstone flourished as a fashionable facing for townhouses during the peak construction in Back Bay in the 1870's and 1880's. Most of the brownstone is arkosic (felspar-rich) sandstone from quarries in the Mesozoic Connecticut Valley redbeds. Most of the brownstone buildings exhibit deterioration of the facing, particularly in blocks laid perpendicular to bedding.

The use of building stone as purely decorative cladding only began when steel framing became the structural support of buildings. The market for building materials also changed when rail transportation became more available, and materials such as Indiana Limestone could compete in the Boston market. As in cities all over the country, there are numerous institutional and commercial buildings clad with Indiana Limestone in Boston and Cambridge (MIT's main buildings, for example). Prior to the late 1960's and early 70's, granite and marble cladding was generally at least 2 inches thick, limestone cladding was generally about 8 inches thick, and most of the stone used on buildings in Boston came from North American sources.

MODERN STONE CLADDING

Developments in stonecutting technology during the last 20 years or so have produced a revolution in the use of building stone in cities throughout the world, and Boston is no exception. Modern stone cladding is thin (to 1 inch or even less) and hung from buildings by complex anchorage systems.

Major stonecutting centers today, particularly those in Italy, buy rough stock (quarry blocks) from quarries throughout the world, do the cutting and finishing, and then ship the finished stone panels all over the world. The Italian fabricators have dominated the world market for several years. Since there are now hundreds of different building stones marketed under nondescript trade names, it is commonly difficult to determine where in the world the stone on a local building was originally quarried.

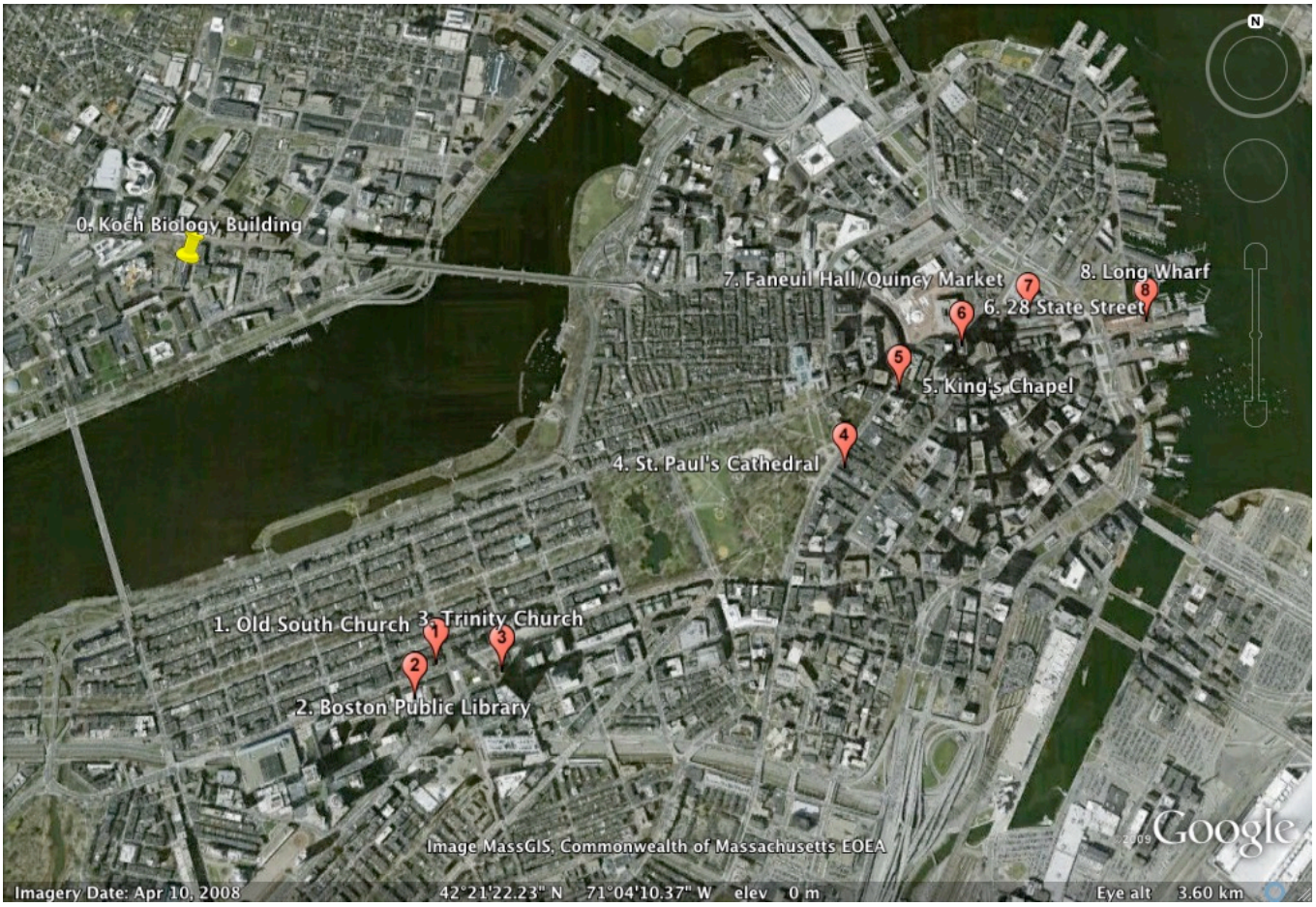

Figure 1. The stops for the field trip, starting at MIT and ending at Long Wharf.

BOSTON BUILDING STONE TRIP LOG

STOP 0. KOCH BIOLOGY BUILDING (BUILDING 68).

The paving is red perthitic granite with pegmatitic regions. Finer-grained igneous rocks are used in the wall. The blocky wall covering is a coarsely crystalline fossiliferous limestone, along with lovely red sandstone or mudstone with casts of oscillation ripples. The tall petrified tree trunk (a sequoia?) was replaced with silica, and shows which way it lay by embedded pebbles. Bright green rock used as seating is quartzite containing a chromium-rich variety of muscovite called fuchsite.

Proceed north on Ames St. to Main St. Turn R on Main, and walk one block to the Kendall/MIT T station. Take the inbound entrance, and board a train. At Park Street, transfer to a westbound Green Line train. Get off at the Copley Station. Once at ground level, cross Dartmouth St. and proceed half a block west to Stop 1.

STOP 1. OLD SOUTH CHURCH.

This building is actually the "new" Old South Church, constructed in 1875. Cummings and Sears were the architects and the style is described as Italian Gothic. The "old" Old South Church Meeting House, built in 1729, still stands at the corner of Washington and Milk Streets in downtown Boston.

The building blocks of this church are Roxbury Conglomerate, Boston's famous puddingstone. The Roxbury Conglomerate is from the Boston Basin, now generally considered a late Precambrian Avalonian structure. The conglomerate used in this structure is well indurated and has weathered well.

Two contrasting sandstones are used extensively as trim on the Old South Church. The reddish sandstone is likely the Longmeadow sandstone from the Connecticut Valley. The red arkosic sandstone quarries at East Longmeadow, Massachusetts are located in the redbeds of the Mesozoic Connecticut Valley. The quarries, no longer active, produced the most durable of the so-called brownstones that were enormously popular building stones in the last quarter of the 19th Century. At the peak of demand over 50 quarries were active. The demand for replacement stock for historic preservation purposes is so high that blocks from old bridge abutments and stone from other structures are salvaged and re-sold. Four replacement pieces from such salvaged stone were recently installed on the Trinity Church tower (Stop 3).

We are not certain where the buff-colored sandstone was quarried.

Return to intersection of Dartmouth and Boylston. Cross Boylston. If construction on the eastbound green line entrance permits, walk half a block west on Boylston to Stop 2. If construction blocks the front of the building, walk one block south on Dartmouth and then half a block west on Blagden to the other side of the Library.

STOP 2. BOSTON PUBLIC LIBRARY.

The Boston Public Library consists of two wings occupying the block between Exeter Street and Dartmouth Street. The original building, facing Dartmouth Street in Copley Square, was designed in the Italian Renaissance style by Charles Follen McKim of McKim, Mead and White, and opened in 1895. The new wing was designed as an understated modern addition by Philip Johnson to complement the old wing; it opened in 1971.

The granite on both the old and new portions of the library is the Milford Granite, a pink, foliated Precambrian biotite granite quarried at Milford, Massachusetts. In the old wing, the granite is used in load-bearing walls with rusticated rock-pitch surfaces. In the new wing, the granite has a thermal finish and is at least 2 inches thick. Massive monolithic slabs are used to form a distinctive wall around the new wing at street level.

The color and texture of the granite are quite distinctive. Milford Pink was used for many buildings in Boston prior to WWII. In later years, the stone was not very popular, and most of the quarries operated intermittently. We understand that one quarry was re-opened to produce granite for the new wing of the library, and it is the last major building project produced from the Milford Granite.

Here we will also discuss the 2010 proposal to close 10 of Boston's public library branches.

Cross Dartmouth Street and the plaza at Copley Square to Trinity Church.

STOP 3. TRINITY CHURCH.

Trinity Church was designed by Henry Hobson Richardson in the Romanesque style and opened in 1877. The portico and front tower peaks were added in 1898. The stone on the exterior of the church is light colored granite liberally trimmed with brownstone. According to information provided by Mr. Richard Merrill, the building supervisor, the granite is Dedham Granite and the trim is Longmeadow sandstone.

Southworth (1992) states that the granite was quarried in Dedham, Quincy, Westerly RI, and the Maine coast. Perhaps the Quincy and Maine coast granites, generally coarser grained than the stone visible at street level, were used for the granite piers discussed above. Dedham granite, pale pink with green epidote specks, is known geologically as the late Precambrian Dedham granodiorite. Dale (1923) list quarries in the Dedham at Wrentham, Stoughton, and Cohasset, but they are described as medium to coarse grained grey granites. The quarry at Wrentham opened in 1884, after Trinity Church was opened.

We think the fine grained pinkish grey granite on the exterior of the church might be Westerly Granite from Rhode Island. Westerly Granite is fine grained biotite granite noted for its uniformity. The USGS geochemical standard G-1 is Westerly Granite.

Trinity Church is a landmark structure that is carefully maintained. Reportedly, some of the brownstone on the front portico was re-cut during restoration work in 1915. The exterior of the building was cleaned in 1974 with a dilute acid wash, and the freshly revealed contrasting color of the granite and brownstone drew much comment. The most recent historic preservation activities have been on the tower where patching mortar has been used and a "stone strengthener" or consolidant has been injected into selected pieces.

Since the church is constructed on fill in the former Back Bay, the building is supported by 4,500 wooden piles, of which over 2,000 are in an area of 90 feet by 90 feet to support the foundation of the front tower. Four granite pyramids, each measuring 35 feet square at the base, 17 feet high, and 7 feet square at the top sit on the piles for the tower. The wood piles must be kept saturated, and the water table under the church is constantly monitored. We will pause here to discuss the filling of Back Bay, the channelization of the Charles River estuary, and other major changes to the Boston landscape.

Walk east on Boylston St. past the Public Garden. Turn left at Tremont, keeping the Common on your left, and continue to St. Paul's Cathedral, 138 Tremont, on the right.

STOP 4. ST. PAUL'S CATHEDRAL.

Designed by Alexander Parris and opened in 1820. The style is described as Greek Revival, an Ionic Greek temple. If you step back from the building, you can see blank stones in the pediment, intended for bas-relief carvings that were never executed.

The walls are light Quincy Granite, much more uniform than those of Kings Chapel because they were quarried from fresh bedrock.

The 32-foot high columns are Acquia (also Aquia) Creek Sandstone, a Cretaceous sandstone from Stafford County, Virginia. This is the same stone used for the White House and the columns of the Capitol building, but its use here in Boston is something of a surprise. Watch out for same-colored plaster covering on some of the columns. According to a brochure published by the Church, a stone from Valley Forge in Pennsylvania was also included as a demonstration of patriotic fervor, but we do not know which one it is (perhaps a lintel?). Interesting features of the sandstone in the columns are the pronounced crossbedding, the bluish tint of the quartz clasts, and rusty nodules. The Acquia Creek Sandstone is notorious for its poor weathering properties, and extensive repairs are visible on the columns here.

Continue east on Tremont St.

128 Tremont Street.

Carnelian (trade name) granite polished storefronts. This granite is quarried in Milbank, South Dakota in the Minnesota River valley. The high-strontium granite is also known as Dakota Mahogany, and is 2 Gya rock containing quartz, potassium feldspar, plagioclase, and biotite. The plagioclase and quartz sometimes display myrmekitic texture. Note the "clear" uniform texture on the Dunkin Donuts storefront and the "wavy" gneissic texture on the Finagle-A-Bagel on the corner of Winter and Tremont Streets.

Park Street Subway Station.

Deer Isle Granite on both the original building across the street and on the recently renovated kiosks on the same side of the street. This granite displays rapakivi texture, in which phenocrysts contain cores of potassium feldspar ringed with orthoclase. Note that this is the opposite from the normal crystallization sequence put forward by Bowen's reaction series, in which Feldspar crystallization grades from sodium to potassium rich with increased fractional crystallization. Phenocrysts in igneous rocks often record complicated histories in which different processes can disrupt normal fractional crystallization. In the case of rapakivi texture, it is hypothesized that such granites underwent severe decompression events between the crystallization of the cores and rims of the phenocrysts.

120 Tremont Street.

Indiana Limestone facing.

Old Granary Burying Ground. Across the street.

Resting place of Paul Revere, Samuel Adams, John Hancock, Robert Treat Paine, and Benjamin Franklin's parents. The Egyptian-style Quincy Granite gate was designed by Solomon Willard, architect for the Bunker Hill Monument.

94 Tremont Street.

Rockport Granite sidewalk slabs.

90 Tremont Street.

Deer Isle granite. Note rapakivi texture.

88 Tremont Street.

Indiana Limestone in the doorway.

73 Tremont Street. Across the street.

Milford Granite load-bearing walls. Note the structural cracks at the corners of the building.

Omni Parker House Hotel.

Polished Rockport Granite facing. Not sure of the identity of the newer inset polished green granite on School Street façade. Note the fancy marble columns next to the entrance.

STOP 5. KING'S CHAPEL.

King's Chapel was designed in 1749 by Peter Harrison. The AIA guide (Southworth, 1992) calls the style of this building American Georgian. The exterior walls of Kings Chapel are blocks of Quincy Granite trimmed from boulders, not from bedrock. Kings Chapel is reportedly the oldest cut granite building in the US. Brayley (1913) contains a description of the splitting of the boulders for this building: First, the boulders were heated by building a fire on top, and second, a heavy iron ball was dropped on the boulder. The famous Quincy Granite quarries were started several decades later. The granite blocks exhibit varying colors due to the varying degrees of weathering of the original boulders.

16 Tremont Street.

Stony Creek Granite facing.

10 Tremont Street.

The doorway trim is Carrara Marble, a building and sculpting stone from Northern Italy that has been used since Ancient Roman times. Note the deformed stylolites (look for short-wavelength wiggles in a line that is defined by clay or other insoluble material).

6 Tremont Street.

The Bank of America building at the corner of Tremont and Court Streets is faced with polished Stony Creek Granite.

Government Center/Scollay Square.

The Sears Crescent Building near the subway station is a remnant of Scollay Square, the predecessor of Government Center, another major urban renewal project. Brownstone sills and lintels on the Sears Crescent have been extensively patched with a mortar that simulates the appearance of the brownstone pretty well. At the Court Street end of the Sears Crescent is a small grey granite (not sure of the source) building known as the Sears Block, which dates from 1848.

Granite gutters on the Government Center station building are cut from Rockport Granite.

Around the corner to the northwest, the walls of 100 Cambridge St are faced with Morton Gneiss, a 3.6 Ga rock quarried in Minnesota. This is the oldest commonly used building stone on Earth.

Turn right on Court St., which becomes State St., and proceed to Stop 6.

STOP 6. 28 STATE STREET.

This former bank headquarters building was designed by Edward Durrell Stone and erected in 1969. The granite on the exterior is Carnelian Granite from Milbank, South Dakota. The stone is 2 inches thick, has a thermal finish, and on the main tower is attached to a precast concrete backup. At the lower levels, the granite was hand-set. Look closely at the granite on the tower, and you will see that every piece of granite has been re-anchored to the backup by bolts applied from the exterior. This major repair work was done around the year 2000. Note also that several corner cracks have been repaired on the tower, and that some repaired cracks start at the edge of the stone and stop in the middle of the panel. We suspect, but do not know because we have not examined the granite at close distance, that some of the "cracks" repaired in this operation are natural mineralized features in the granite that do not impair its strength.

Looking across State St., we can see the Old State House, a famous Boston landmark. And looking to the left of 28 State St., we can see the ungainly hulk of City Hall looming in the background. This gives us an opportunity to discuss two popular urban building materials that we have thus far neglected – brick and reinforced concrete – while weaving in some Boston history.

Proceed half a block east on State St. and turn left on Congress St. Walk half a block to Faneuil Hall on the right. Walk around Faneuil Hall to the space between Faneuil Hall and Quincy Market.

STOP 7. FANEUIL HALL/QUINCY MARKET.

The main Quincy Market building was designed by Alexander Parris, the same architect for St. Paul's Cathedral in 1824. Benjamin Thompson and Associates were the architects for the hugely successful renovations in 1976. According to Brayley (1913), the foundation of the Quincy Market building is Quincy Granite. Chelmsford Granite probably makes up most of the balance of the building, although Brayley also states that Hallowell Granite from Maine was used in part. The columns, single shafts of granite 20 feet 9 inches long, were quarried in the town of Chelmsford and were brought to Boston by canal.

The granite slab pavers between Quincy Market and Faneuil Hall are Chelmsford Granite. The 50-inch diameter round granite stools near the flower market are calyx cores from the Chelmsford Granite quarries. The cores were drilled for installation of quarry wire saws.

New buildings in the Marketplace are: One Faneuil Hall Square (housing Abercrombie & Fitch), Graham Gund Architects, 1988, faced with Stony Creek Granite; and, at the far end of the complex, Marketplace Center, WZMH Group architects, 1983, faced with Deer Isle Granite.

Walk underneath Marketplace Center and cross the greenway. Stay to the right of the Marriott Hotel and walk to the end of Long Wharf.

STOP 8. LONG WHARF.

There are some interesting textures in the massive slabs at the water's edge. We will pause here, weather permitting, and discuss the filling of the Harbor, the Charles River Dam, and the modification of the Boston waterfront.

Walk west along the northern edge of the wharf, Cross Columbus Park, and walk NW on Richmond St. to enter the North End. Note the granite sidewalk slabs with mafic xenoliths. Turn left on Hanover St. Walk down Hanover and cross the greenway to the Haymarket T Station. Take

any westbound Green Line train. At Park Street, transfer to the Red Line toward Alewife. Get off at Kendall/MIT.

END

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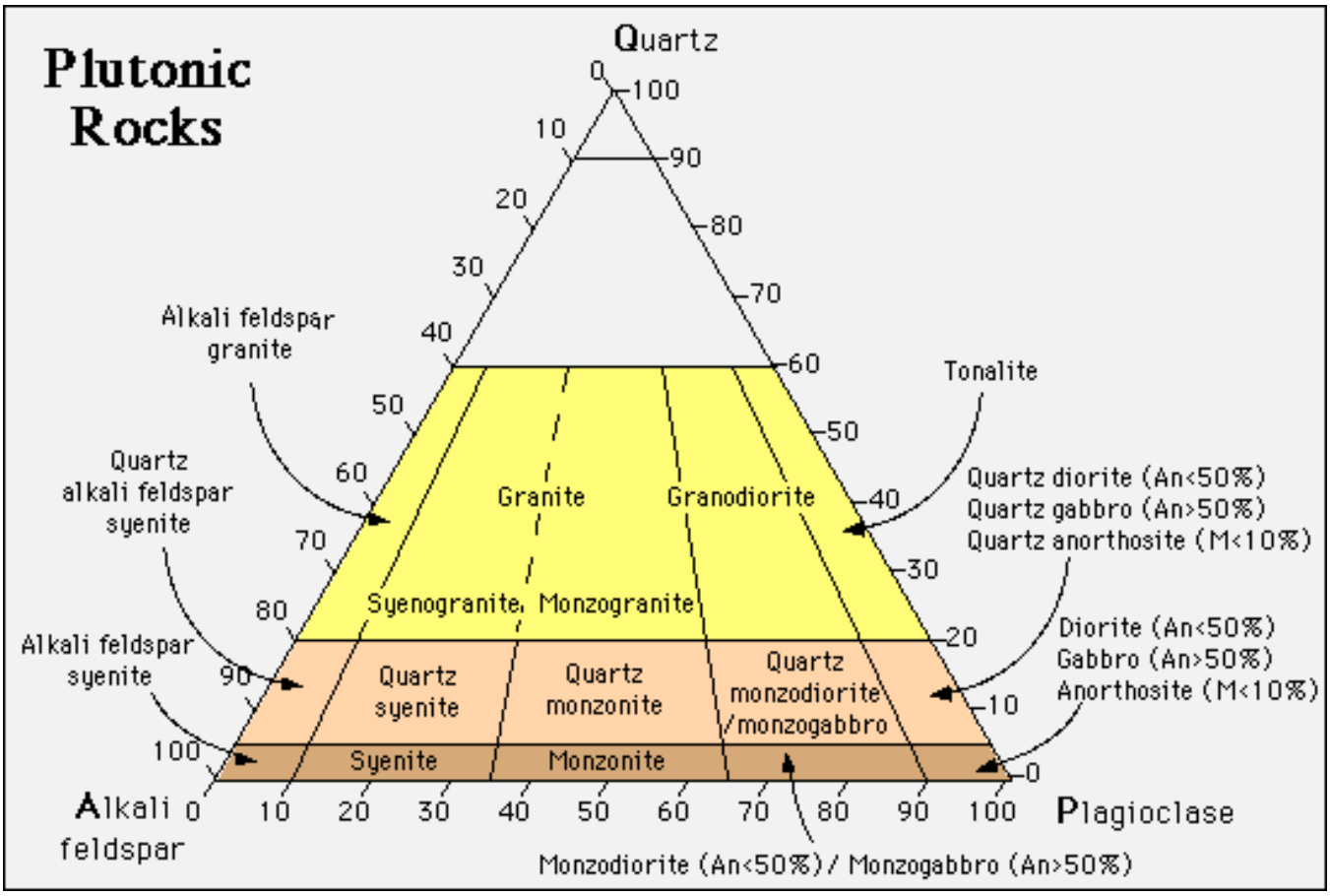
GLOSSARY

Alkaline or Alkalic	An igneous rock containing more Na + K than its group, or more than are required to form feldspar with the available silica.
Arfvedsonite	A green to black high-sodium amphibole: $Na_3(Fe, Mg)_4FeSi_8O_{22}(OH)_2$.
Arkose	Feldspar-rich sandstone.
Art Deco	A popular movement that peaked in 1929, affecting architecture, interior, and industrial design. An amalgamation of Constructionism, Cubism, Modernism, Bauhaus, Art Nouveau, and Futurism, the style is marked by crystalline shapes and sweeping curves in architecture, and by refined elegance (*e.g.* Erté) or muscular industrialism (*e.g.* Santiago Delgado) in the visual arts.
Bluestone	Bluish or grayish flagstone, particularly from the Devonian sandstones from eastern New York and Pennsylvania.
Brownstone	A brown or reddish sandstone with grains coated with iron oxide, more specifically, a building stone from the Connecticut River Valley.
Diorite	Intrusive igneous rocks containing hornblende, plagioclase, and pyroxene, the intrusive equivalent of andesite.
Georgian Architecture	Styles current between about 1720 and 1840, named after the four British monarchs named George. Marked by symmetry, regularity, and simplicity, and called Federalism in America.
Granodiorite	Intrusive igneous rocks intermediate between diorite and monzonite, the intrusive equivalent of rhyodacite, containing two feldspars (more plagioclase than potassium feldspar), quartz, biotite, hornblende.
Honed finish	The rock is polished as for a polished surface, but the process is ended before buffing. The surface is smooth but not shiny.
Indurate	To harden a rock or soil horizon by pressure, heat, or cementation (particularly heat).
Monzonite	Intrusive igneous rock intermediate between syenite and diorite, with equal amounts of potassium feldspar and plagioclase, little quartz, and the mafic mineral is usually augite. Extrusive analog is latite.
Myrmekite	An intergrowth of plagioclase and quartz, where the grains are commonly vermicular ("wormy").
Palladian Architecture	A European style derived from the designs of the Italian architect Andrea Palladio (1508–1580), marked by arched windows with entablatures and pilasters, loggias and porticos. Followed by Thomas Jefferson.
Peralkaline	An igneous rock containing less total molat aluminum than sodium plus potassium. Also a high Al/Si ratio.
Perthite	Potassium feldspar from which plagioclase has exsolved, typically as lamellae or blebs.
Polished finish	The rock surface is polished and then buffed with increasingly fine grit to a mirror-like finish.
Postmodernism	Controversial term, but usually meaning past the use of narratives and absolutes in references in the arts, that is, against the Modernist aim of finding common and fundamental truths in our reality.
Rapakivi	Plagioclase crystallized around orthoclase. From Finnish for "rotten" or "crumbly," referring to the different thermal expansivities of the phases that results in rapid cracking and weathering. Alkali feldspar's coefficient of thermal expansion is 1.7×10^{-5},

	but in the directions of its crystallograhic axes expansion is in the ratio 1:4.94:23.8, meaning that any thermal change creates a significant asymmetric stress in the rock.
Riebeckite	A dark bluish amphibole: $Na_2(Fe, Mg)_3Fe_2Si_8O_{22}(OH)_2$, sometimes used as asbestos.
Stylolite	A thin seam or surface in a carbonate rock with irregular and mutually-interlocking faces thought to mark a surface of melting due to pressure solution. The surface is marked with clay or other insoluable residue.
Syenite	Intrusive igneous rock containing potassium feldspar greatly in excess of plagioclase, in addition to a mafic mineral (usually hornblende) and with no or only traces of quartz.
Thermal finish	The rock surface is heated with a flame while simultaneously washed with water, resulting in cracked surface grains wit sufficient roughness for good traction, but an unfractured rock.
Travertine	A hard, finely-crystalline rock of calcite or aragonite deposited from solution of ground or surface water, particularly in caves or hot springs. Commonly tan or white and often finely layered.
Xenolith	A stone included in an igneous rock to which it is not related.



ROCKS

Acquia Creel Sandstone (also Aquia): Cretaceous sandstone from a river island in Stafford, Virginia. Crossbedding common. Used at the Cathedral Church of St. Paul, for the White House, and for the columns of the Capitol Building.

Balmoral Red Granite: From Taivassalo, southern Finland, a 33% quartz rock used in International Place.

Bethel White Granite: 335-Myr quartz monzonite from Bethel, Vermont, used at 18 Tremont and to build Union Station in Washington, DC.

Biritiba Granite: From Brazil, fabricated in Italy, used at 75 State.

Cape Ann (Rockport, Gloucester) Granite: Gray hornblende-biotite or hornblende-annite granite, first quarried in 1824. Varies from light gray through greenish to almost black. This granite is used at the Boston Post Office, Boston Water-Works, St. Vincent de Paul church, and subway entrances, according to the Loughlin thesis, and the largest quariries in the mid-1800s were near Vinal Haven, Maine. Other quarries at Rockport, Pigeon Cove, Bay View, Lanesville

Carmen Red Granite: A rapakivi granite from Virolahti, southeast Finland, also containing red, round perthites.

Carnelian Granite ("Dakota Mahogany"): A 2 Ga granite from Millbank, South Dakota, containing quartz, potassium feldspar, plagioclase, and biotite. Common myrmekitic texture, and high in strontium. Used at 128 Tremont.

Carrara Marble: Particularly homogeneous white marble from northern Italy, used for sculpting by Michelangelo.

Charcoal Grey Granite (also Charcoal Black): Xenolith-bearing rock from Cold Spring, Minnesota.

Chelmsford (Westford) Granite: Grey granite from Chelmsford, MA, used in Jordan Marsh, the old Boston Courthouse (1810), the New South Church and Congregational House at the corner of Beacon and Somerset (1814). Probably the first quarried granite in the state.

Concord Granite: From Concord, New Hampshire, a 354-Myr two-mica granite with 5 to 10 ppm U. Used in City Hall (1862-65).

Dedham Granite: Late preCambrian granodiorite from Dedham, MA.

Deer Isle (Stonington) Granite: Porphyritic pale pink or gray granite with rapakivi texture. Used in kiosks at Park Street Station.

Gamma Pink Granite: From Sardinia, fabricated in Italy, used at 75 State.

Hallowell Granite: Gray, from Maine, used at Faneuil Hall, the Soldier's Monument on the Boston Common (1880),a dn the Masonic building at the corner of Boyleston and Tremont.

Imperial Mahogany Granite: From Sweden, fabricated in Italy, used at 75 State.

Indiana limestone (also called Bedford and Salem): 320-360 Myr, quarried in central Indiana and used to build the Pentagon, the Empire State Building, and MIT, among other places. Visible cross-bedding, small shells, and oolites.

Lancaster Slate: Quarried as early as 1750 and used extensively for gravestones by the time of the Revolution.

Longmeadow sandstone: A red arkose from the Mesozoic Connecticut River Valley in Massachusetts. Very popular for brownstone buildings in the mid-1900s; characteristic of Huntongton Avenue. See also Portland brownstone. The feldspar, quartz, and mica grains of this rock are cemented by $CaCO_3$ and Fe_2O_3.

Maritaca Green Granite: Source unknown, fabricated in Italy, used at 75 State.

Milford Pink Granite: Pink folitated preCambrian biotite granite from Milford MA, used to build the Boston Public Library.

Napoleon Red Granite: From Sweden, fabricated in Italy, used at 75 State.

Portland brownstone: This first brownstone was quarried in Portland, Connecticut beginning in 1665, before the Massachusetts quarries became active. Much of the Back Bay may be built of this stone, and prior to about 1850 it was the dominant brownstone used.

Quincy Granite: A gray peralkaline riebeckite-bearing stone from used in the gate to the Old Granary Burying Ground, Faneuil Hall, the Bunker Hill obelisk, and the Titanic Memorial statue in Washington, DC. First quarried in 1825, perhaps the third granite quarried in the state.

Red Vånga Granite: From Vånga, Sweden, fabricated in Italy, used at 60 State.

Rockport Granite: A hornblende-bearing granite from Cape Ann, Massachusetts, used for gutters on the Government Center Station and on the sidewalk at 94 Tremont St.

Rosa Gamma Granite: A pink-grey granite from Sardinia.

Roxbury Conglomerate: The "puddingstone" of the ~595 Myr Avalon terrane, accreted to the eastern margin of North America during the closing of the proto-Atlantic. Used in buildings starting in the 1860s and 70s, including the Cathedral of the Holy Cross

Rutland Marble: From Vermont, used in the Parker House.

Sequoia Granite (also Sequoya): Folidated granite from Millbank, South Dakota.

Spanish Pink Granite: A pale-pink, fine-grained rock from Spain, used at 265 and 260 Franklin St.

Stony Creek Granite: Pink preCambrian gneissic granite from Connecticut. Used in Marriott Copley exterior trim.

Stony Creek Granite: Quarried in Branford, Connecticut, used at 6 Tremont.

Swensen Green Granite: Quarried at Cape Neddick, Maine, an alkaline syenite with accessoriy arfvedsonite, aegerine-augite, and biotite. Used in the Prudential retaining wall and in the Library of Congress.

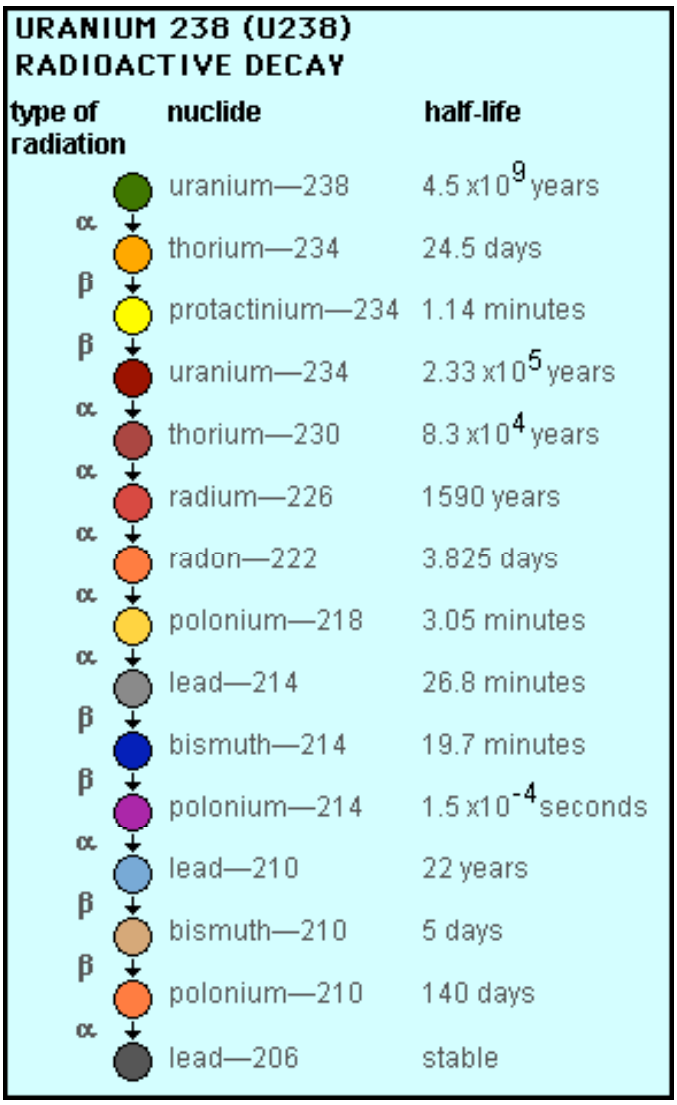
Texas Rose Granite: A coarse-grained rock with large micas from the Llano uplift in central Texas.

RADIATION PRIMER

Granite is an evolved igneous rock, that is, its composition is far from a primary melt of the peridotite mantle. Either because of fractional crystallization (during which elements that are incompatible with the minerals solidifying are progressively enriched in the remaining melt) or because of assimilation of incompatible-enriched materials, granites contain in unusual quantities elements that are not common in the bulk Earth. These enriched elements include uranium, thorium, and potassium, all of which have radioactive isotopes. Granites can as a result be among the more common radioactive rocks; granites commonly contain between 3 and 20 ppm of uranium.

In granite-rich areas like New England and Scandinavia, the uranium creates a particular danger by producing radon along its long decay path (see figure). The effect of radioactive decay on a person is determined by the type of decay and where in the body the person experiences it. Uranium decay from a building is well-shielded from organs by the skin, but radon is a gas and its decay therefore occurs in the vulnerable lungs. Compounding this problem, ^{222}Ra has a half-life of only 3.8 days, so its decay events are relatively frequent.

From Wikipedia: "The danger of radon exposure in dwellings was discovered in 1984 with the case of Stanley Watras, an employee at the Limerick nuclear power plant in Pennsylvania. Watras set off the radiation alarms on his way *into* work for two weeks straight while authorities searched for the source of the contamination. They were shocked to find that the source was astonishingly high levels of radon, around 100,000 Bq/m^3 (2,700 pCi/L), in his house's basement and it was not related to the nuclear plant. The risks associated with living in his house were estimated to be equivalent to smoking 135 packs of cigarettes every day. Following this event, which was highly publicized, national radon safety standards were set, and radon detection and ventilation became a standard homeowner concern."



The EPA action level for radon, by comparison, is only 150 Bq/m^3 (Bq = Becquerel = decays per second).

The following are expressed in Sieverts, which are J/kg (energy absorbed from radiodecay) multipled by a dimensionless factor that takes into consideration the organs being affected and the kind of decay occurring.

~3 mSv = natural ambient dose, about half of which is from radon

50 mSv = limit for radiation workers, per year

100 mSv = cancers result in 5:1000

10 Sv = death in days or weeks

NOTES ON RAPAKIVI FELDSPARS

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Irregular to ovoid alkali feldspar phenocrysts mantled by plagioclase “rapakivi” are a conspicuous texture of the coarse-grained edenite-biotite Oak Point and Stonington granites of the Deer Isle pluton. Rapakivi feldspars consist of salmon-colored alkali feldspars cores, with irregular embayed margins, overgrown by a creamy white plagioclase mantle of An26 or less. Quartz commonly occurs along the core-mantle interface. Plagioclase mantles comprised of discrete grains, a single continuous rim, or variations thereof, have been observed. The modal abundance of rapakivi feldspars (crystals per $0.46m^2$) decreases from 129 +/-8 at Flye Point in the NE portion of the pluton (Oak Point granite) to 15+/-3 at Crotch Island in the SW portion of the pluton (Stonington granite). Rapakivi feldspar numbers gradually decrease from NE to SW within the Oak Point and Stonington granites but exhibit a rapid decrease over a narrow region corresponding roughly to the gradational contact between these two granites. Amphibole-plagioclase geothermometry record a subsolidus temperature of ~516°C throughout the pluton consistent with mineralogical evidence for subsolidus alteration. Amphibole geobarometry, calculated at an assumed near-solidus temperature of 720°C record pressures <0-2.6 kb. Low to negative pressure values correspond to portions of amphiboles with abundant cleavage or fractures. Amphibole

crystals in the Oak Point granite yield an average pressure of 2.1 kb and in the Stonington granite yield an average pressure of 1.4 kb (excluding negative values).

The asymmetric distribution of rapakivi feldspar crystals reflects variation in magma chamber dynamics of the Deer Isle pluton. Early formed rapakivi feldspar and amphibole crystals accumulated rapidly at the base of the magma chamber (i.e., the Oak Point granite). Rapakivi and amphibole are less common in the upper part of the chamber (i.e., the Stonington granite) and are dipersed among minerals that crystallized in situ. The abrupt decrease in rapakivi feldspars marks the transition between the stagnant cumulate pile and an overlying more dynamic portion of the magma chamber. Segregation of earlyformed material as well as its dispersal by convective currents are important processes that operated within this felsic magma chamber.

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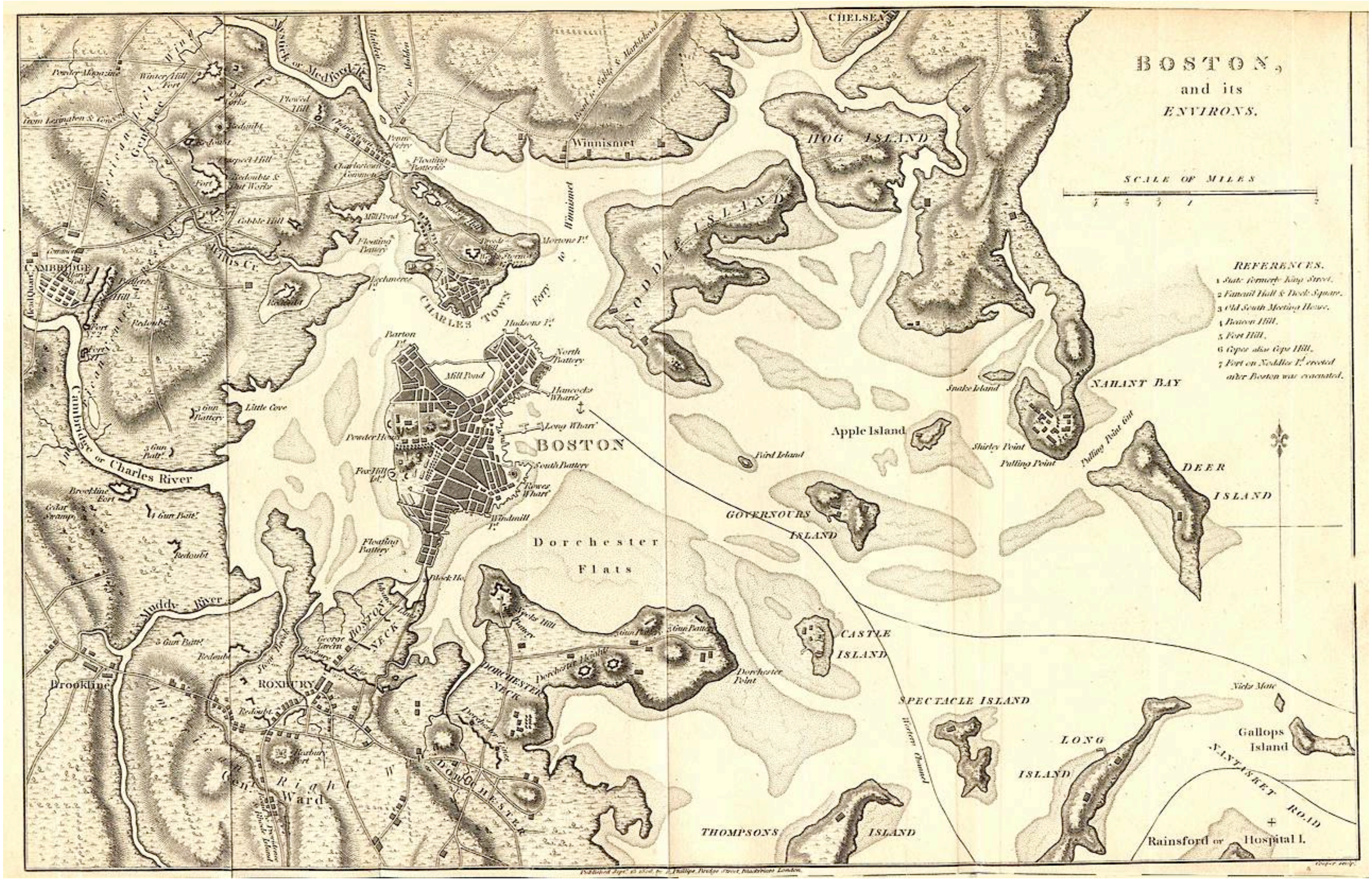
BOSTON,
and its
ENVIRONS.
SCALE OF MILES
REFERENCES.
1 State formerly King Street.
2 Faneuil Hall & Dock Square.
3 Old South Meeting House.
4 Beacon Hill.
5 Fort Hill.
6 Copse alias Cops Hill.
7 Fort on Noddles Id. erected after Boston was evacuated.
CHELSEA
Winnisimet
HOG ISLAND
NODDLES ISLAND
CHARLES TOWN
BOSTON
Dorchester Flats
Apple Island
Bird Island
GOVERNOURS ISLAND
CASTLE ISLAND
SPECTACLE ISLAND
LONG ISLAND
THOMPSONS ISLAND
DEER ISLAND
NAHANT BAY
Snake Island
Shirley Point
Pulling Point
Gallops Island
NANTASKET ROAD
Rainsford or Hospital I.
CAMBRIDGE
Cambridge or Charles River
Muddy River
Brookline
ROXBURY
BOSTON NECK
DORCHESTER NECK
DORCHESTER
Long Wharf
North Battery
South Battery
Mill Pond
Little Cove
Dorchester Point