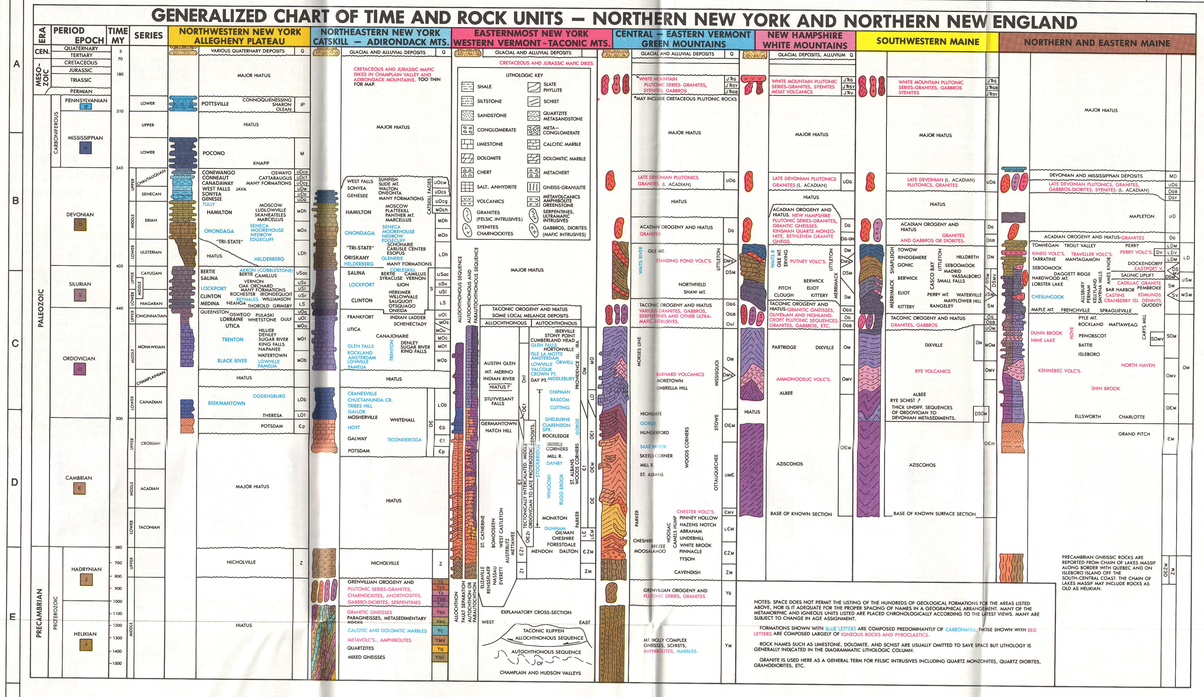
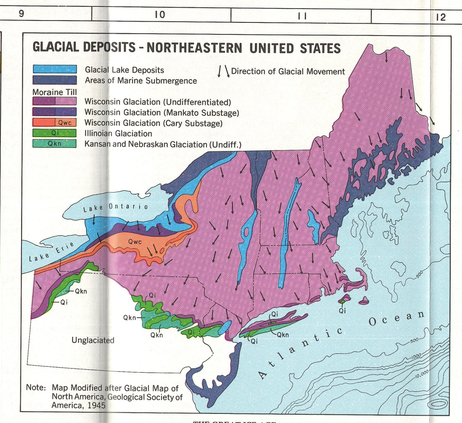
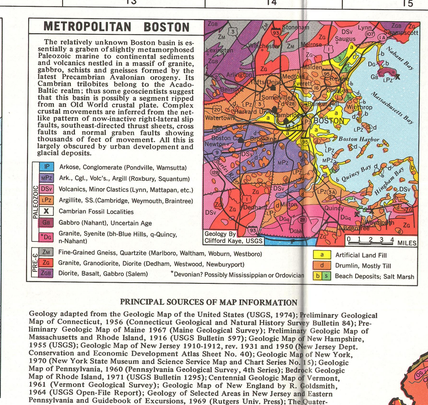




THE GREAT ICE AGE

During much of the Pleistocene Epoch the northeastern states resembled the great Antarctic ice sheet. At least four major advances of continental glaciers (Nebraskan, Kansan, Illinoian, Wisconsin) left extensive deposits that choked and changed the stream systems, scoured mountains, and dumped vast amounts of till, mixed clay, sand, and gravel over the landscape. Thus, much bedrock is concealed until it is revealed in quarries, highway cuts, and wells. In the last 20,000 years the glacial ice sheet has receded to Greenland and the neighboring Canadian Islands, but it may advance again after thousands of more years of the relatively warm interglacial phase we are enjoying.

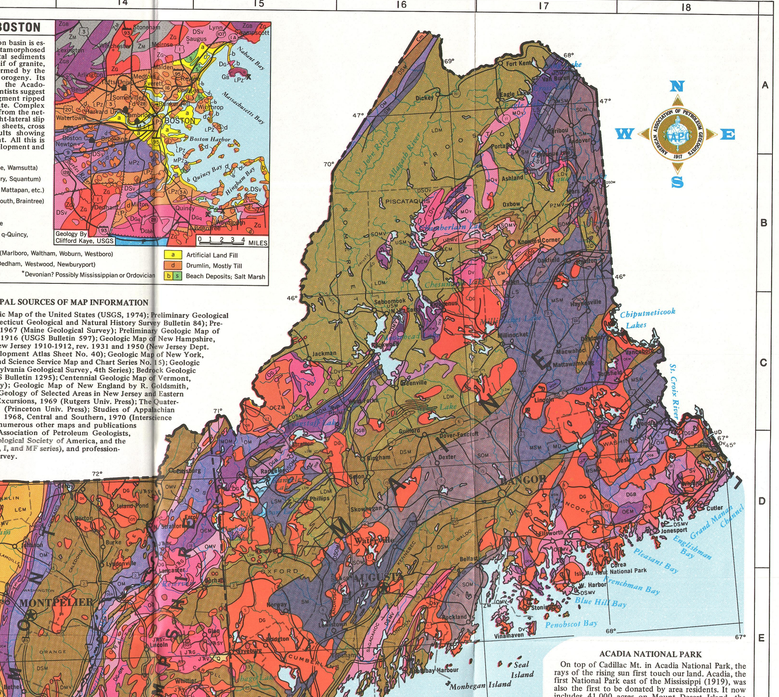


The relatively unknown Boston basin is essentially a graben of slightly metamorphosed Paleozoic marine to continental sediments and volcanics nestled in a massif of granite, gneiss, schists and gneisses formed by the latest Precambrian Avalonian orogeny. Its Cambrian trilobites belong to the Acadian faunal realm; thus some geoscientists suggest that the area is possibly a segment ripped from an Old World crustal plate. Complex crustal movements are inferred from the network pattern of now-inactive right-lateral slip faults, southeast-directed thrust sheets, cross faults and normal graben faults showing largely obscured by urban development and glacial deposits.

Pz — Arkose, Conglomerate (Pondville, Wamsutta)
Ꝑ — Ark., Cgl., Volc's., Argill (Roxbury, Squantum)
Ꝑ — Volcanics, Minor Clastics (Lynn, Mattapan, etc.)
Ꝑ — Argillite, SS (Cambridge, Weymouth, Braintree)
Ꝑ — Cambrian Fossil Localities
Ꝑ — Gabbro (Nahant), Uncertain Age
Ꝑ — Granite, Syenite (bh-Blue Hills, q-Quincy, n-Nahant)
Ꝑ — Fine-Grained Gneiss, Quartzite (Marlboro, Waltham, Woburn, Westboro)
Ꝑ — Granite, Granodiorite, Diorite (Dedham, Westwood, Newburyport)
Ꝑ — Diorite, Basalt, Gabbro (Salem)
*Devonian? Possibly Mississippian or Ordovician
a — Artificial Land Fill
d — Drumlin, Mostly Till
b — Beach Deposits; Salt Marsh

PRINCIPAL SOURCES OF MAP INFORMATION

Geology adapted from the Geologic Map of the United States (USGS, 1974); Preliminary Geological Map of Connecticut, 1956 (Connecticut Geological and Natural History Survey Bulletin 84); Preliminary Geologic Map of Maine 1967 (Maine Geological Survey); Preliminary Geologic Map of Massachusetts and Rhode Island, 1916 (USGS Bulletin 597); Geologic Map of New Hampshire, 1955 (USGS); Geologic Map of New Jersey 1910-1912, rev. 1931 and 1950 (New Jersey Dept. Conservation and Economic Development Atlas Sheet No. 40); Geologic Map of New York, 1970 (New York State Museum and Science Service Map and Chart Series No. 15); Geologic Map of Pennsylvania, 1960 (Pennsylvania Geological Survey, 4th Series); Bedrock Geologic Map of Rhode Island, 1971 (USGS Bulletin 1295); Centennial Geologic Map of Vermont, 1961 (Vermont Geological Survey); Geologic Map of New England by R. Goldsmith, 1964 (USGS Open-File Report); Geology of Selected Areas in New Jersey and Eastern Pennsylvania and Guidebook of Excursions, 1969 (Rutgers Univ. Press); The Quaternary of the United States, 1965 (Princeton Univ. Press); Studies of Appalachian Geology—Northern and Maritime, 1968, Central and Southern, 1970 (Interscience Publishers, John Wiley & Sons); numerous other maps and publications of the state surveys, American Association of Petroleum Geologists, American Journal of Science, Geological Society of America, and the bulletins, circulars, maps (GQ, HA, I, and MF series), and professional papers of the U.S. Geological Survey.



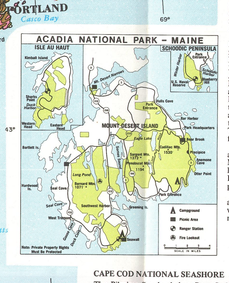
ACADIA NATIONAL PARK

On top of Cadillac Mt. in Acadia National Park, the rays of the rising sun first touch our land. Acadia, the first National Park east of the Mississippi (1919), was also the first to be donated by area residents. It now includes 41,000 acres on Mount Desert Island, the Schoodic peninsula, and Isle au Haut, which is the remains of a rugged mountain range reshaped by the mile-thick glacier that covered much of North America 20,000 years ago.

State Rte. 3 leads to Park Headquarters near Bar Harbor, where guidebooks, maps, and even a tape-recorded tour are available. Rte. 3 continues to the Nature Center at Sieur de Monts Springs (open May 30 - Oct. 30) and the nearby Abbe Museum of Stone Age Antiquities. Following the Park Loop (Ocean Drive) brings you to Champlain Mt. Overlook, offering a spectacular view of seacliffs and island-studded bays. From the cliff base of Champlain Mt., the climb to the top along Precipice Trail takes half a day. Farther along the Loop a trail leads to Anemone Cave, where thousands of sea anemones can be seen at low tide. At Thunder Hole, at high tide, waves rush into an ocean-formed chasm.

Inland, Jordan Pond lies in a great glacier-carved amphitheater cradled by the Pemobscot and Pemetic Mts. On one towering peak the melting glacier left a huge boulder balanced at the brink of a precipice. Finally, you reach the summit of Cadillac Mt. and a panoramic view of the area.

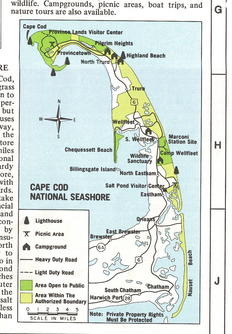
Sargent Drive skirts the east shore of Somes Sound, a true fiord. The heavily forested island abounds in wildlife. Campgrounds, picnic areas, boat trips, and nature tours are also available.



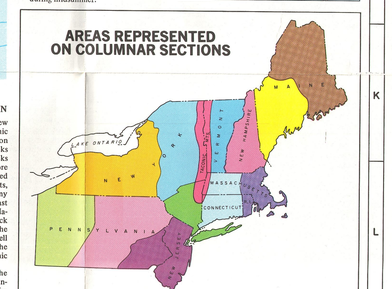
CAPE COD NATIONAL SEASHORE

The Pilgrims first landed at Cape Cod, where they found forests and good grass cover. Although the Pilgrims went on to Plymouth, later settlers not only permitted the land to be overgrazed, but also cut down the trees to build houses and ships; thus the topsoil blew away, leaving shifting dunes which covered the remaining vegetation. In order to restore and preserve the landscape along 35 miles of the outer cape, Cape Cod National Seashore was established in 1961. Hardy plants now stabilize the shifting shore, and in spring the dunes are bright with flowers and alive with shore birds.

To reach the National Seashore, take Route 6, which follows a ridge of glacial till– a coarse mix of sand, pebbles, and boulders. The land on either side contains hollows, or "kettles," formed by ice blocks melting slowly under insulating sand. Much of the seacoast north of Chatham has been eroded away to form high bluffs which end near Truro in a high escarpment. All the land beyond was carried by the sea from the beaches of Wellfleet and Truro to form the outer cape. On the inner or bay shore of the Cape are many grass-covered salt marshes. Visitors will find the Cape less crowded in late spring and early fall than during midsummer.



AREAS REPRESENTED ON COLUMNAR SECTIONS



THE NORTHEAST—A BILLION YEARS OF HISTORY

By John Rodgers

The geologic history of the northeastern United States begins with the Precambrian Grenville rocks. They are visible in the Adirondack Mountains of northern New York State and in the anticlinorial uplifts of the Green Mountains of Vermont, the Hudson and Jersey Highlands, and the Reading Prong in eastern Pennsylvania, and are present beneath the Paleozoic rocks throughout the area farther west. These rocks record a long Precambrian history which probably included repeated epochs of sedimentation, deformation, metamorphism, and intrusion. The major Grenville orogenic period, ending about 950 million years ago, concluded the Precambrian. The eastern limit of the Grenville rocks is not known; it may have lain well to the east of what is now North America.

The next major event seems to have been a splitting of the continent that contained the Grenville belt, producing first rift zones and then an ocean basin (called "proto-Atlantic" by some), with North America on its northwest side. In and beside this ocean were deposited late Precambrian and early Paleozoic sediments and volcanic material. These deposits probably formed a continental shelf, slope, and rise (the slope was probably in the present area of western New England and perhaps southeastern Pennsylvania); one or more volcanic island arcs may have been present farther to the east. Seawater gradually encroached over the continent to the west in the form of large epeiric seas, covering most or all of the region by Late Cambrian time.

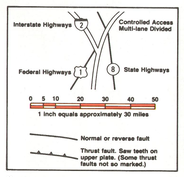
In Middle Ordovician time the ocean began to close again and deformation occurred (Taconic orogeny), expressed as folding, thrust faulting, uplift and gravity sliding, metamorphism, and granodiorite intrusion. The areas affected were northern Maine, western New England and adjacent New York, northern New Jersey, and southeastern Pennsylvania. Mountains were produced, and a great delta (Queenston delta) was built to the west, reaching beyond Niagara Falls. Farther southeast in New England, however, deposition was probably never interrupted, except in part of coastal Maine. As the mountains wore down, the sea readvanced over them, reestablishing the continental shelf and slope, though probably somewhat farther east than before.

In Middle Devonian time all of New England and the edge of New York were intensely deformed (Acadian orogeny). There was much metamorphism and granite intrusion, and the sea was expelled. Again mountains were produced, and a great delta (Catskill delta) was built to the west beyond the limits of the deformed area. The sea did return into western Pennsylvania for a short time during the Mississippian Period, but deformation was renewed, this time in a belt in southernmost New England and southwestward. Deltaic deposits spread over much of the region, though they are now preserved only in Pennsylvania and in Rhode Island and adjacent Massachusetts. Great swamps developed on these deltas (and there were brief marine invasions in the west); the resulting coal is widespread in Pennsylvania. Deformation culminated about the end of the Pennsylvanian Period or in the Permian (Allegheny orogeny), producing the "typical Appalachian" folds of central and western Pennsylvania and also folding, metamorphism, and granite intrusion in Rhode Island and the vicinity.

The next recorded epoch was one of warping and faulting accompanied by nonmarine (red fluvial and dark lacustrine) sedimentation and some volcanism in a rift valley or in separate basins from central Massachusetts to and beyond south-central Pennsylvania. Though these deposits have long been called "Triassic," they are now known to range in age through Late Triassic and Early Jurassic. At the same time or, more probably, a little later in the Jurassic, the present Atlantic Ocean began to open, and seawater again lapped against the eastern margin of the North American continent. Here the present continental shelf, slope, and rise developed (though without volcanic arcs); the oldest dated rocks at the bottom of the pile of shelf sediments are Jurassic, but the oldest visible at the present land surface are mid-Cretaceous. Southern New Jersey is underlain by mainly marine, undeformed, gently seaward-dipping Cretaceous and Cenozoic shelf deposits. Most of the rest of the region was being eroded in later Mesozoic and Cenozoic time; yet the Appalachian belt still stands moderately high and must have been differentially uplifted. Whether the belt was ever worn down completely and then rejuvenated (and, if so, how often) and whether the uplift was broadly continuous or spasmodic are matters of debate.

Another Jurassic-Cretaceous event, roughly contemporaneous with the definitive opening of the Atlantic Ocean, was the production of a large group of volcanic calderas, centered in the present area of the White Mountains of New Hampshire but with outliers in adjacent states. The associated igneous rocks, both intrusive and extrusive, are markedly alkalic.

The last major geologic event in the region was the Pleistocene continental glaciation. Terminal moraines record two major Wisconsin advances and at least two older ones (probably Illinoian and Kansan); only central and southern New Jersey and the bulk of Pennsylvania were spared. The falling and rising of sea level that accompanied the advance and retreat of the glaciers alternately exposed the continental shelf and flooded the coastal areas, especially New Jersey. The last ice retreat is well recorded by glacial till which spread unevenly over the glaciated area, disrupting the drainage and producing the many lakes of New England and New York. Near the retreating ice, also, much stratified drift was deposited in rivers, lakes, and the sea. For a time the sea covered much of coastal Maine and penetrated up the St. Lawrence Valley to Lake Champlain and northern New York State, until glacial rebound drove it out again.



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Additional remarks by A.P.B.

The billion-year-old history of the Northeast as outlined above is manifested by some of the most complex geology in the United States. It still provides interesting revelations for those who scrutinize its great variety of rocks. Some of these rock varieties provide the minerals and raw material essential to the development of a great technological civilization, the rudiments of which were largely established during the great historic events 200 years ago. Some of these facets will be portrayed on the various exhibits on both sides of this map.

Use of Color and Symbol Codes

The main map on this page shows generalized ages and outcrop patterns of the surface rocks of the northeastern states. This has been done by using various colors and symbols to identify rocks of different ages and classes.

The time-rock chart shows the probable age of the rock group with a particular color—generally those used by the U.S. Geological Survey—and a particular letter symbol. For example, certain blue areas with a capital "M" are Mississippian rocks formed 305 to 330 million years ago. A smaller capital letter preceding the larger capital letter further divides the rock systems: "U" to indicate the upper (younger) subdivision, "M" to indicate the middle part, and "L" to indicate the lower (older) part. A special case is the Tertiary Period whose particular epochs are denoted by small letters following "T"—"Tx" for Paleocene, "Te" for Eocene, and "Tm" for Miocene. Those map units that include both Pliocene and Miocene rocks are shown by the combining symbol "Tpm." Throughout Pennsylvania and New York where nearly flat-lying Paleozoic beds are at the surface, a refinement is introduced for smaller subdivisions of great areal extent, such as "uDcy" for the Upper Devonian Canadaway Group of sedimentary formations. These devices are also used for other rock systems such as the Pennsylvanian rocks of Pennsylvania and the Upper Cretaceous deposits of New Jersey.

Other letter symbols are added for special classes of rocks—"M" for metamorphic or altered rocks, i.e., "Vm" for volcanic or extrusive rocks, "G" for intrusive granitic rocks, "BG" for gabbroic or dioritic rocks, "UI" for ultramafic intrusives, etc.

Also in the columns of time and rock units, rock types are shown with graphic representation. The patterns are explained in a legend within the upper time-rock chart. Limestone is shown by a brick-work pattern, sandstone by dots, shale by dashes, conglomerate by circles, schist by sloping wavy lines, etc. It was not possible to show all rock formations and lithic variations of the northeastern states in the limited confines of our charts. For more comprehensive data one should consult the many available publications for sale at the state and federal survey publication offices.

LAKE ONTARIO
LAKE ERIE
Niagara Falls
BUFFALO
Rochester
Syracuse
Utica
Albany
Binghamton
Elmira
Scranton
Wilkes-Barre
Williamsport
Harrisburg
PITTSBURGH
Erie
Altoona
Johnstown
Uniontown
Washington
Wheeling
Charleston
Huntington
Ashland
Lexington
Frankfort
Louisville
Cincinnati
Dayton
Columbus
Toledo
Cleveland
Akron
Canton
Youngstown
Pittsburgh
Erie
Buffalo
Rochester
Syracuse
Albany
Binghamton
Scranton
Harrisburg
Williamsport
Pittsburgh