

A short geologic history of the northeast United States

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 anticlinal 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" or Iapetus after the father of Atlantis), 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 re-advanced 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 for 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 invasion 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

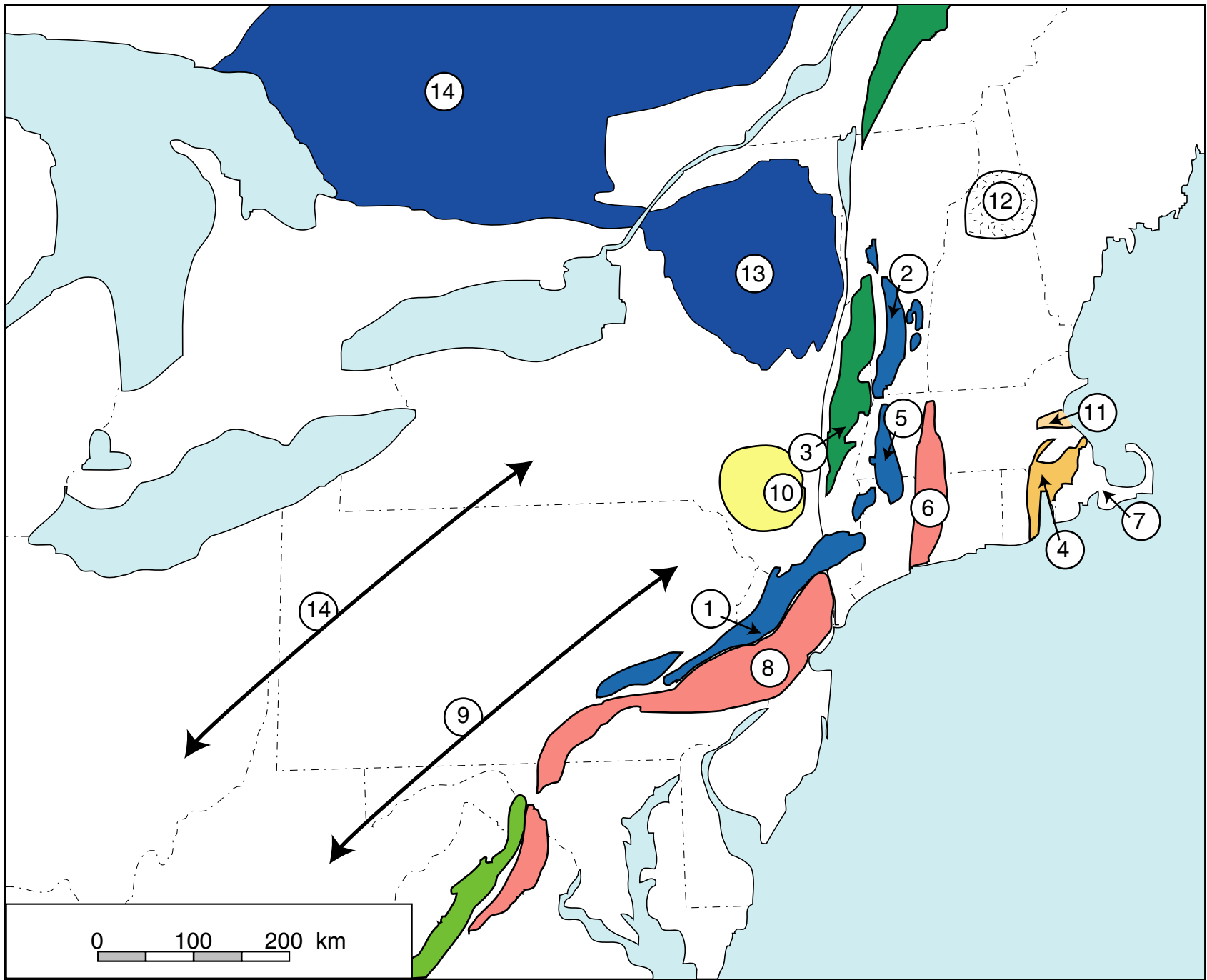
known to range in age through Late Triassic and Early Jurassic. At the same time or, more probably, a little later in the Jurassic, the present Atlantic Ocean began to open, and seawater again lapped against the eastern margin of the North American continent. Here the present continental shelf, slope, 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 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.

Important ages

1150-1050 Ma	Age of the Grenville orogeny, which produced the fabric and granulite facies metamorphism of the Adirondack Mountains.
550 Ma	Upper Cambrian - Deposition of the Potsdam sandstone
500-460 Ma	Early-to-Middle Ordovician Taconic Orogeny
465 Ma	Oldest cooling ages on amphiboles associated with the Taconian Orogeny
440-450 Ma	Radiometric ages of the Oliverian gneisses in western New Hampshire, thought to be intrusive rocks of the island arc that collided during the Taconian Orogeny.
400-380 Ma	(Lower Devonian) Acadian Orogeny
320-280 Ma	(Pennsylvanian-Early Permian) Alleghenian Orogeny
220-180 Ma	(Late Triassic to Middle Jurassic) Initiation of rifting of Atlantic
11 ka	End of last glaciation



Key to map

Blue – Precambrian

Green – Taconic allochthon

Pink – Mesozoic rift basins

Tan – Boston Basin (Proterozoic)

Orange – Narragansett Basin (Carboniferous)

1. Hudson Highlands
2. Green Mountains
3. Taconic Allochthon
4. Narragansett Basin
5. Berkshire Mountains
6. Hartford Basin
7. Cape Cod
8. Newark Basin
9. Allegheny Front
10. Catskill Mountains
11. Boston Basin
12. White Mountains
13. Adirondack Mountains
14. Grenville province