Topography of the Northeastern US: *a brief review*

Does your region have rolling hills? Mountainous areas? Flat land where you never have to bike up a hill? Topography is the change in elevation over an area. The topography of the Northeast is intimately tied to weathering and erosional forces, and the type and structure of the underlying bedrock.

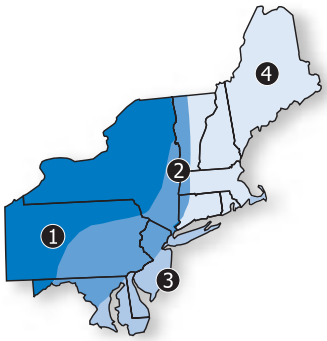
Weathering includes both mechanical and chemical processes that break down a rock. Wind and water in all forms, including streams, the ocean, and ice, are all media by which physical weathering and ***erosion*** occur. Streams are constantly trying to erode their way down through bedrock to sea level, creating valleys in the process. With sufficient time, streams can cut deeply and develop wide flat floodplains on the valley floor.

Weathering *is the break down of rocks;* **erosion** *is the transport of weathered materials.*

The pounding action of ocean waves on the coastline contributes to the erosion of coastal rocks and sediments. Ice plays a major role in the weathering and erosion of the Northeast landscape because of the frequent episodes of ***freezing*** and ***thawing*** in temperate latitudes. On a small scale, as water trapped in fractures within the rock freezes and thaws, the fractures widen further and further. This alone can induce significant break down of large rock bodies. On a larger scale, ice in the form of glaciers in mountain valleys and continental ice sheets can reshape the surface of a continent.

see Glaciers, p.60 for more on **freeze-thaw** *fracturing.*

Working in conjunction with mechanical weathering, chemical weathering also helps to break down rocks. Some minerals of igneous and metamorphic rocks that are formed at high temperatures and pressures, far below the surface of the Earth, become unstable when they are exposed at the surface where the temperature and pressure are considerably lower, especially in contact with water. Unstable minerals are altered to more stable minerals, which in the process results in the breakup of rock. Weak acids, such as carbonic acid found in rainwater, promote the disintegration of certain types of rocks. Limestone and marble may be rapidly broken down chemically as carbonic acid reacts with the carbonate mineral composition of these rocks, forming cavities and caverns in the rock. Other sedimentary rocks held together by carbonate cement are also particularly sensitive.



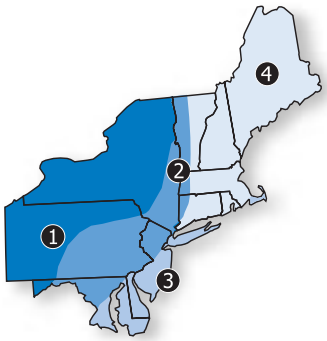
Rock type at the surface has an important influence on the topography

Topography

of a region. Certain rocks are able to resist weathering and erosion more easily than others; resistant rocks that overlie weaker layers act as caps and form ridges. The inland ocean basins of the Ordovician Taconic and the Devonian Acadian mountain-building events collected and preserved sediments that became sedimentary rocks. Sedimentary rocks weather and erode differently than crystalline, generally harder igneous and metamorphic rocks that are more common in the Exotic Terrane and Appalachian/Piedmont region. Silica-rich igneous rocks have a crystalline nature and mineral composition that resists weathering far better than the cemented grains of a sedimentary rock. The metamorphic equivalents of sedimentary and igneous rocks are often more resistant due to ***recrystallization***. However, there are exceptions, such as schist, which is much weaker than its pre-metamorphism limestone or sandstone state. The unconsolidated sediments of the Coastal Plain region, which are not even yet considered rocks, are the least resistant to erosion. The Coastal Plain sediments have little cement, compaction, or interlocking crystals to stand up to the effects of wind, oxygen, and water.

Recrystallization *refers to the change in mineral crystals that make up rocks. When rocks are metamorphosed, recrystallization often occurs as the pressure allows crystals to grow larger into a tighter, interlocking arrangement.*

The underlying structure of the rock layers also plays an important role in the topography at the surface. Sedimentary rocks are originally deposited in flat-lying layers on top of each other. Movement of the plates creates stress and tension within the crust, especially at plate boundaries, which often deform the flat layers by folding, faulting, intruding or overturning. These terms are collectively used to describe rock structure and can be used to interpret what forces have affected rocks in the past. The folding of horizontal rock beds followed by erosion and uplift expose layers of rock to the surface. Faulting likewise exposes layers at the surface to erosion, due to movement and tilting of blocks of crust along the fault plane. Tilted rocks expose underlying layers. Resistant layers stick out and remain as ridges, while surrounding layers of less resistant rock erode away.



The glacial ice sheet of the most recent ice age covered part of the region, leaving its mark on the topography of the Northeast. Glaciers carved away at the land's surface as they advanced generally southward, creating many classic glacial U-shaped valleys and characteristic glacial depositional features such as drumlins and moraines. Mountains were sculpted, leaving high peaks and bowl-like cirques. As the ice sheet melted, other characteristic glacial features were left

behind to mark its former presence, including glacial lakes and eskers.

Just as we were able to make sense of the type of rocks in an area by knowing the geologic history of the region, we are able to make sense of the topography of the Northeast based on the rocks and structures resulting from past geologic events.

see Glaciers, p.60, for more on the scouring and deposits of glaciers.

Topography of the Inland Basin
Region 1

The Inland Basin has three main topographic divisions: the ***Allegheny*** Plateau, the Adirondacks and the Lowlands *(Figure 5.1)*. The existence of the basin itself is due to the downward buckling of the crust at the onset of the Taconic and Acadian mountain-building events. What makes the Inland Basin distinct from the other regions of the Northeast are the structure and nature of the sedimentary rocks that fill the basin. Unlike the Appalachian/Piedmont region or the complexly deformed Exotic Terrane region, the surface rocks of the Inland Basin have been gently tilted and folded, and were far enough removed from the mountain-building events to have escaped being metamorphosed. The exception to this pattern is the ***Adirondack region***, where uplift independent of the Paleozoic mountain-building events raised bedrock metamorphosed during the late Precambrian to the surface as erosion removed the overlying Inland Basin sedimentary layers.

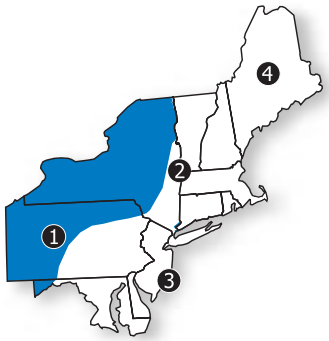
*'**Allegheny**' refers to the plateau or front; 'Alleghanian' refers to the mountain-building event.*

Figure 5.1: Generalized topographic divisions of the Inland Basin.

*see Rocks, p.32 for more on the rocks of the **Adirondack region**.*

Allegheny Plateau

The Allegheny Plateau dominates much of the Inland Basin region, extending from the southern tier of New York through Pennsylvania and Maryland to Alabama *(Figure 5.1)*. The layers of rock within the plateau have been only gently folded and tilted slightly to the south during the final mountain-building event during the Permian. A drive through the Allegheny Plateau region reveals a landscape contrary to the common concept of a plateau as an



elevated flat-topped region. The Allegheny Plateau was probably flat, but since its uplift 400 million years ago it has been deeply dissected by streams, making the area quite hilly and in some places even mountainous in appearance. The Plateau is bounded on the eastern side by the Allegheny Front, a scarp separating it from the Appalachian Mountains.

The Shawangunks, or 'Gunks' as they are locally known, are famed for being the best rock climbing spot in the Eastern United States.

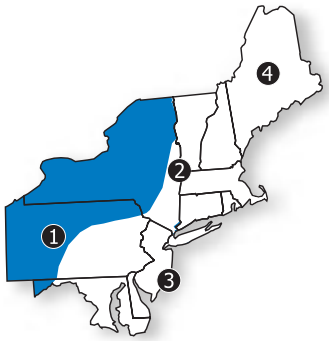
The scarp includes the white cliffs of the ***Shawangunk*** Ridge that extend southwest from the Hudson River into New Jersey and Pennsylvania, where it is known as Kittatinny Mountain. The Catskill ***Mountains*** form the eastern boundary of the Allegheny Front in New York. They are often called one-sided mountains because there is a steep scarp on the eastern side, but the west side has a gentle slope that grades more gradually into the surrounding provinces. The layers of rocks forming the Catskills are the Devonian sedimentary beds of the Catskill Delta, created during the Acadian mountain-building event as sediment eroded from the Acadian highlands. The mountains are thus unusual, as the rocks are flat lying and the relief over the area comes from deep erosion of the flat-lying layers. The elevation in the Catskills is much higher than other parts of the Allegheny Plateau because of the thicker sequences of sediments deposited on the eastern side of the Catskill Delta (closer to the Acadian highlands) and erosional differences by glaciers during the last ice age.

The Catskills are not considered by some to be technically **'mountains'** *because of the underlying layers of rock lack deformation.*

The highest point in the Catskills is over 914 m above sea level.

The Paleozoic sedimentary rock layers of the basin, tilted just a few degrees to the south, form many of the east-west ridges that stretch across New York. These gentle ridges are called cuestas, formed from the more resistant layers of tilted rocks, while the softer surrounding rocks have eroded away *(Figure 5.2)*. The tilting most likely occurred during the Permian ***Alleghanian*** mountain-building event, the final crunch on the east coast of North America.

see Geologic History, p. 14, for more on the **Alleghanian** *event.*



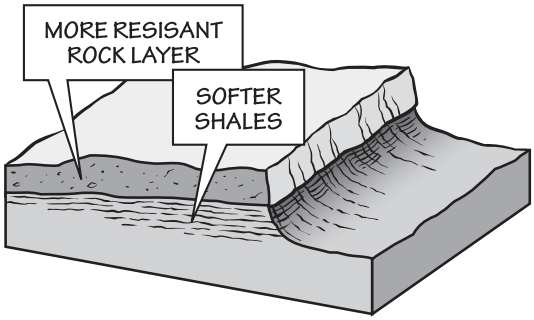


Figure 5.2: A cuesta ridge is formed from a resistant layer of gently tilted rock. Figure by J. Houghton.

The different looks of different mountains

A mountain may be formed from any rock type and a variety of underlying structures. The type of mountain that we see today all depends on the amount of erosion, the resistance of the rock, the structure of the rock layers and the events occurring in geologic history that formed the mountains. There is a wide variety of mountains throughout the Northeast that formed in diverse geologic situations relating to the geologic history of the region (Figure 5.3).

Mountains	Location	Origin
The Catskills	New York	erosion of flat-lying rock layers
Kittatinny Mountain/ (Shawangunks)	PA, NJ, NY	hogback/cuesta formed from resistant conglomerate
Green Mountains	Vermont	resistant Precambrian gneiss
White Mountains	New Hampshire	igneous intrusions
Mt. Katahdin	Maine	exposed volcano magma chamber
Taconics	NY, VT, MA, CT	slices of resistant metamorphosed Cambrian rocks, stacked on top of each other and moved west
Bolton Range	Connecticut	resistant Ordovician volcanic rocks originating fromTaconic volcanic islands
Adirondacks	New York	Precambrian resistant rock, uplifted during the Tertiary

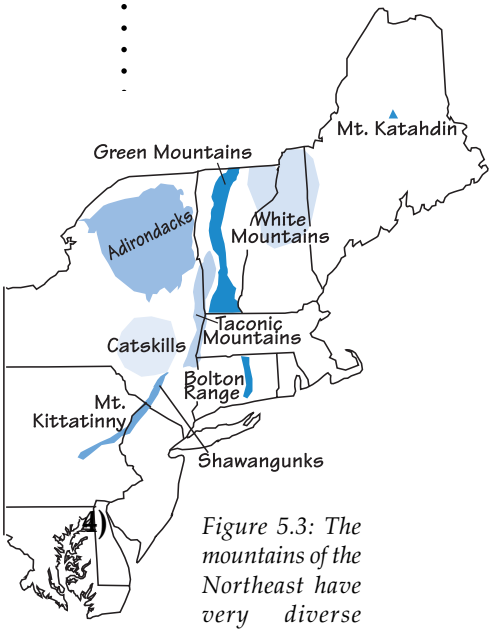


Figure 5.3: The mountains of the Northeast have very diverse origins.

Adirondacks

The Adirondacks loom high over the surrounding lowlands *(Figure 5.4)*. Uplifted during the late Mesozoic and Tertiary, much of this mass of crystalline metamorphic Precambrian rock is extremely ***resistant*** to erosion. The surrounding lowland rocks are considerably less resistant and are made of much younger sedimentary rocks. Both the relatively recent uplift of the area and the resistant metamorphic rocks contributed to the height of the Adirondacks. Additional scouring by glaciers during the ice age helped to carve the Adirondack peaks.

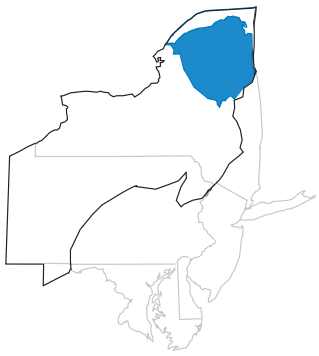


Figure 5.4: The Adirondack region of the Inland Basin.

Not all Precambrian metamorphic rock is extremely ***resistant*** *or uniformly resistant to erosion. Precambrian schists, for example, are not as resistant as harder sedimentary rock found in other parts of the Inland Basin.*

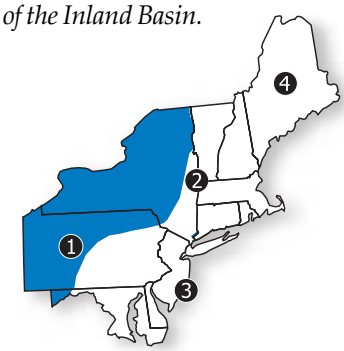


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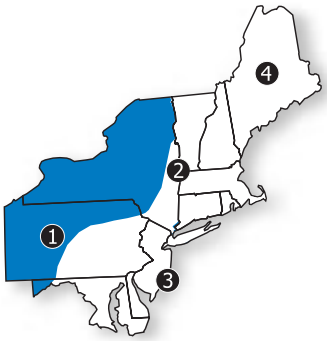
Figure 5.5: The Lowlands of the Inland Basin.

Lowlands

The Lowlands of the Inland Basin surround the Adirondack region on all sides, including the Erie, Ontario, St. Lawrence and Mohawk Valley lowlands *(Figure 5.5)*. Many of the topographic features of the Lowlands region were formed during the most recent Ice Age. The Lowlands preserve remnants of large glacial lakes scoured by glaciers and filled with glacial meltwater as the continental ice sheet advanced and retreated over the Northeast. The region of Lake Ontario was formerly occupied by a series of glacial lakes, including Glacial Lake Iroquois. The Tug Hill Plateau, which is actually a part of the Allegheny Plateau has been isolated through erosion by meltwater escaping through the present Mohawk Valley from former Lake Iroquois. As the glacial lakes shrunk, or altogether disappeared, characteristic glacial lake deposits were left behind: sand, silt and clay, and other evidence of ancient shorelines. Many striking glacial features are evident within the ***Lowlands***, including thousands of drumlins in the Ontario Lowlands.

see Glaciers, p.67, for glacial features of the **lowland** *areas.*



Topography of the Appalachian/Piedmont
Region 2

The dominance of northeast-southwest trending ridges and valleys throughout the Appalachian/Piedmont region is characteristic of the Northeast, reflecting the compression of the crust during the mountain-building events of the past. Nowhere is this distinctive topography seen better than in the Valley and Ridge region of Pennsylvania and Maryland *(Figure 5.6)*. The Great Valley runs lengthwise through the whole region, defining the eastern edge of the Valley and Ridge province. The ridges of the Blue Ridge, Reading Prong, Hudson Highlands, Berkshires and Green Mountains, made of resistant Precambrian gneiss, form the spine of the ***Appalachian Mountains***. The Taconic Mountains, made of stacked slices of Cambrian and Ordovician-age rock, stretch across the north-south border between New York and Vermont, Massachusetts and Connecticut. They were pushed westward to their present position during the Taconic mountain-building period.

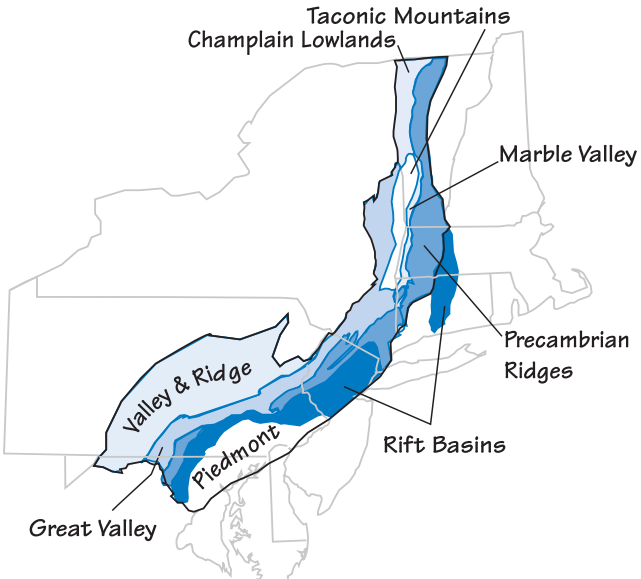
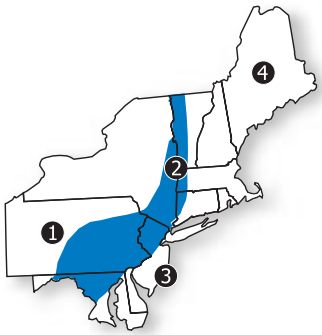


Figure 5.6: Generalized topographic regions in the Appalachian/Piedmont.

The Appalachian Mountains include many (but not all) ranges within the Appalachian/Piedmont region. The term 'Appalachian Mountains' denotes the chain of mountains that stretch from north to south parallel to the east coast that were compressed during the last two mountain-building events. The Appalachian Mountains proper include the mountains of New England, and the Precambrian ridges (with the exception of the Green Mountains of Vermont, considered an extension of the Appalachian Mountains.)

Figure 5.7: Valley and Ridge region of the Inland Basin.



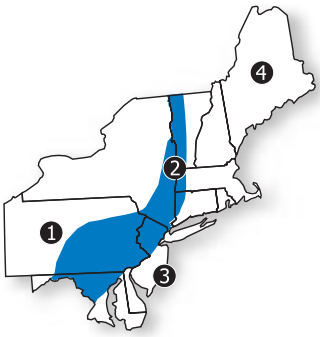
Valley and Ridge

The Valley and Ridge region is bounded by the Great Valley to the east and the Allegheny Plateau of the Inland Basin to the west *(Figure 5.7)*. Tight, narrow folds in the layers of rock from the final Alleghanian mountain-building event, created the long thin ridges and valleys throughout the province, with relief between 300 and 1000 meters or more *(Figure 5.8)*. These folds are much tighter than the broad bends of the adjacent Allegheny Plateau of the Inland Basin region. Sandstone and quartzite make up the ridges of the Valley and Ridge region; more easily eroded shale, limestone and dolostone floor the valleys. The valleys are

One of the great debates concerning the Valley and Ridge region is the reason for the even heights of ridge tops in the area over long distances. Are the ridges all capped by equally resistant beds? Or was the region eroded flat and subsequently uplifted, to be eroded to its present topography by dissecting streams?

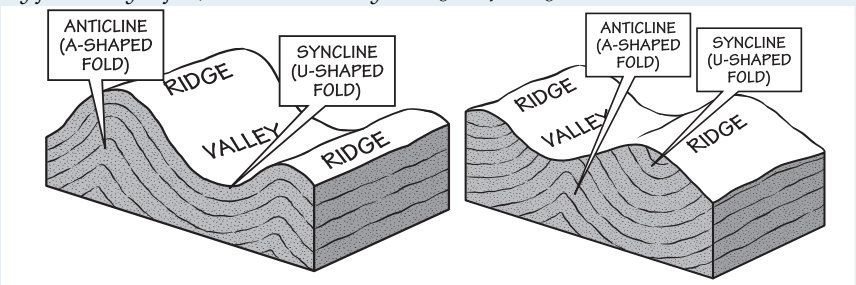
commonly formed from rock layers that have been folded upward and eroded in the center; ridges in the region often form from rock layers that have been folded downward, with resistant centers. This is known as ***topographic inversion***, because one would expect ridges to form from upfolds and valleys to form from downfolds.

Figure 5.8: Topographic map of the Valley and Ridge region of the Appalachian/Piedmont.
Topographic map provided by Topozone.com: http://www.topozone.com.



Topographic inversions

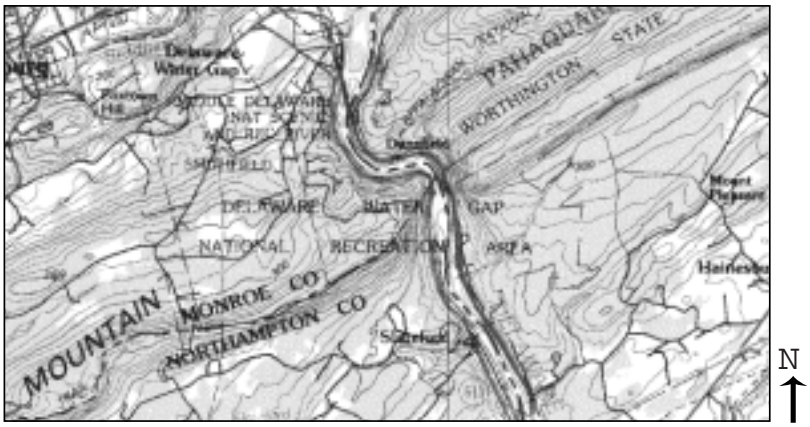
Common sense would have us believe that more often than not, synclines (U-shape folds) form valleys and anticlines (A-shape folds) form ridges. However, we often see 'topographic inversions', especially in the Appalachian/Piedmont region. Topographic lows (valleys) form from the structural high (top of an anticline), where the term 'structure' refers to the form of the rock layers. At the top of the anticline, a layer may erode away because of cracks at the top of the fold caused by bending of the rock. Fracturing at the top of the fold allows increased water penetration, and topographic highs are subjected to more severe weather. Thus, the less resistant layers below the eroded top quickly erode away to form a valley. The limbs of the resistant layer, however, are generally still intact. This leaves two ridges of resistant rock on either side of a valley floored by softer, less resistant layers. Figures by J. Houghton.



Normal erosion of a fold. *Topographic inversion.*

Water gaps

Generally, streams move along the path of least resistance, carving valleys into the softest, least resistant rock units following weak layers along structure. The majority of streams and rivers have cut valleys between pre-existing ridges. There are exceptions, however, in which streams are constrained to cut through resistant ridges. One of the most spectacular examples is the Delaware Water Gap. Water gaps are an unusual topographic feature found in the Appalachian/Piedmont, where the elongate ridges are made of resistant rock and are otherwise generally continuous. The rivers bisect the ridges in places where the structure of the rock is weak (at faults, folds or changes in rock type), often cutting across at an angle perpendicular to the ridge. Although the formation of water gaps is not well understood, it is thought that runoff on opposite sides of a ridge cuts ravines that drain to their respective sides. As the ravines develop, becoming larger streams, the headwaters on either side erode further up the ridge. Eventually a notch is formed when the two headwaters meet and become one stream, flowing through the ridge.



Topographic map of the Delaware Water Gap, Pennsylvania. Topographic map provided by Topozone.com: http://www.topozone.com.

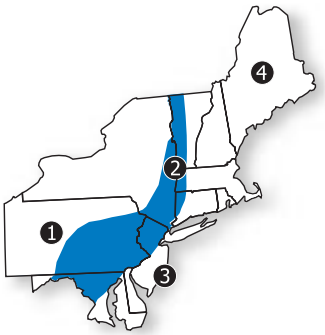
The Great Valley

The Great Valley is adjacent to the Valley and Ridge region extending from New York as far south as Georgia *(Figure 5.9)*. Floored by Cambrian and Ordovician limestone and dolostone, the wide valley forms a topographic low because of the less-resistant nature of the rock. The local names of the Great Valley vary throughout the Northeast. In Maryland the Great Valley is the Hagerstown Valley; in Pennsylvania it is the Cumberland, Lebanon and Lehigh Valley respectively from south to north. The Great Valley cuts across northern New Jersey and up into New York as the Hudson Lowlands. Finally, in Vermont, the Valley is known as the Champlain Lowlands. The Hudson and Champlain Lowlands exist because of the weak Cambrian and

Figure 5.9: The Great Valley of the Appalachian/Piedmont.

Interstate 81

Just like the rivers which seek to erode through the least resistant layers of rock, early road-builders chose the path of least resistance. Interstate 81 is a classic example of a roadway built in a valley floored by less resistant rocks, following a prominent geologic feature of the east coast: the Great Valley. Rather than build multiple interstates across the rugged and resistant Appalachian Mountains, we have one long highway that runs the length of the Great Valley.



Topography

Ordovician rocks that line the Valley, which were easily eroded by glaciers during the most recent ice age.

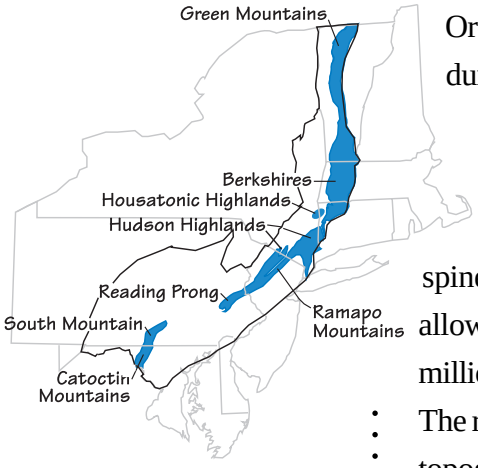


Figure 5.10: Precambrian ridges of the Appalachian/Piedmont.

Mt. Mansfield, the tallest of the Green Mountains*, is 1339 meters above sea level.*

Precambrian Ridges

Extending up and down the Appalachian/Piedmont region is a rigid spine of Precambrian rock *(Figure 5.10)*. The crystalline, metamorphic rock has allowed the spine to resist erosion to some extent over the last several hundred million years, while the overlying younger sedimentary rocks have eroded away. The resistant nature of the Precambrian rock is responsible for the mountainous topography of the ***Green Mountains***, the Berkshires, Hudson and Housatonic Highlands, Reading Prong, Ramapo Mountains, South Mountain and the Catoctin Mountains.

At the southern end of the Precambrian Ridges region, Pennsylvania's South Mountain marks the northern extent of the Blue Ridge physiographic province. The Blue Ridge refers to the Precambrian rock making up the spine of the southern Appalachian Mountains from Pennsylvania to Georgia. The rocks of the Blue Ridge are bent into a large upward fold. The upward fold has many smaller folds superimposed upon it. The wrinkles cause the rolling topography of much of the mountainous Precambrian Ridge region. In Maryland, the Catoctin Mountains are part of the Blue Ridge region as well.

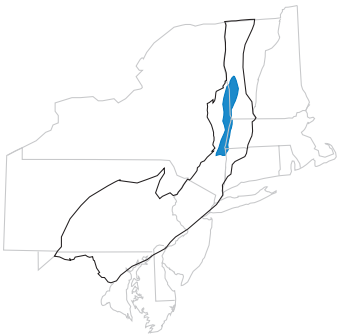
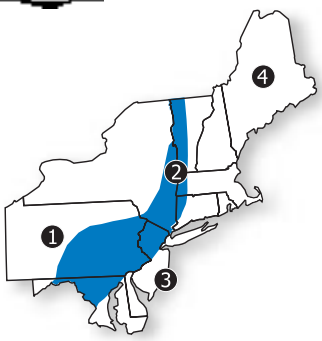


Figure 5.11: The Taconic Mountains of the Appalachian/Piedmont.

Taconic Mountains

The ***Taconic*** mountain-building event during the Ordovician created the modern Taconic Mountains of the Appalachian/Piedmont region, located between New York, Vermont, Massachusetts and Connecticut *(Figure 5.11)*. The Taconic volcanic islands, formed over the subduction zone of the North America and Baltica plates, were on a collision course with North America. As the volcanic islands drew nearer to the continent, they pushed ahead of them like a bulldozer the Cambrian and Ordovician sedimentary rocks of the seafloor. The crust continued to compress until the volcanic islands were sutured to the side of North America. The compression stacked slices of the seafloor on top of one another, like a collapsed telescope, and pushed the slices a good distance to the west. The Cambrian sedimentary rock resisted erosion, protecting the less-resistant underlying layers of rock. Today's Taconic Mountains are a section of the stacked slices that have been isolated by erosion.

see Geologic History, p. 7 for more on **Taconic events.**



Piedmont

The Piedmont region abuts the Triassic Rift Basins of Pennsylvania and extends south through Maryland to the Coastal Plain boundary *(Figure 5.12)*.

The topography of the Piedmont is primarily rolling hills, composed mostly of metamorphic rock that is uniform in its resistance to erosion. Therefore no ridges stand out in particular from differential weathering. There are a few notable exceptions, however, due to the presence of highly resistant rocks such as the quartzite of Sugarloaf Mountain. Near Baltimore, there are a series of '***domes***' that have Precambrian gneiss in the middle, surrounded by rings of quartzite and marble. The Piedmont rocks have been squeezed so tightly and are so complexly deformed, that the folds have been overturned and folded, and later eroded to expose the resistant Precambrian gneiss that stand out in relief as domes.

Figure 5.12: The Piedmont region of the Appalachian/Piedmont.

These **domes** *are not technically domes, but rather, overturned folds.*

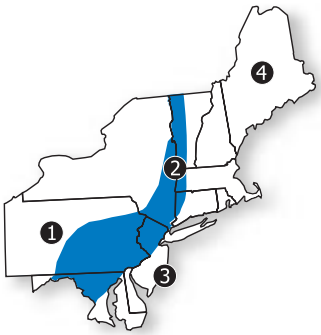
Rift Basins

Two connected ***rift basins***, the Gettysburg and Newark Basins, form lowlands in the Appalachian/Piedmont region *(Figure 5.13)*. The basins begin at the southeastern tip of New York and continue through New Jersey, Pennsylvania, and Maryland. The basins exist because of the rifting of Pangea during the Triassic and Jurassic. As the continents tore apart, cracks in the crust acted as fault planes on which blocks of crust slipped downward to form basins. The basins were filled with layers of less-resistant sedimentary rock as well layers of cooling lava on the surface, which formed basalt. Occasionally, the magma did not make it to the surface. Instead, it squeezed its way between the rock layers and cooled to form diabase. Over time, the basins were tilted and eroded, exposing the alternating layers of sedimentary and igneous rock. The layers of basalt and diabase are far more resistant to erosion than the sedimentary rock, so they stick out in relief as ridges while the surrounding sedimentary rock is eroded away.

The Palisades, along the west side of the Hudson River in New York and New Jersey, are resistant exposures of diabase. The Wachtung Mountains of New Jersey are tilted remnants of three basaltic lava flows. The basin remains a topographic low today, bounded on the west by the up-faulted Precambrian Ramapo Mountains.

Figure 5.13: The Triassic Rift Basins of the Appalachian/Piedmont.

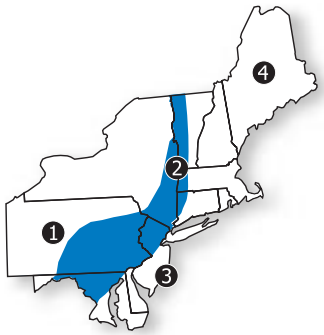
see Geologic History, p. 16 for more on the **rift basins.**



The Marble Valley

A narrow valley bounded by steep walls runs from southern Vermont through western Massachusetts and Connecticut *(Figure 5.14)*. The valley is floored with Cambrian and Ordovician limestone that has been metamorphosed to marble. Due to the less-resistant nature of marble, a valley was scoured out by weathering and erosion, separating the Green Mountains from the Taconic Mountains.

Figure 5.14: The Marble Valley of the Appalachian/Piedmont.



Topography of the Coastal Plain
Region 3

Generally, the land surface of the Coastal Plain rises only about 30 meters above sea level and dips less than one degree. The primary reason for the flat nature of the Coastal Plain is the unconsolidated sediments that are the 'bedrock' of the region. The sediments in the Coastal Plain have not been significantly compacted or cemented and have certainly not become rock. There is little resistance to erosion because of the nature of the sediments, and therefore ridges do not form in the Coastal Plain. There is some moderate difference in relief between the western Coastal Plain and the eastern Coastal Plain due to the ages of the deposits. Cretaceous and Tertiary deposits dominating the western Coastal Plain show more relief than the younger Quaternary deposits that are close to the shoreline and constantly pounded by wave action and flooding.

Long Island, Cape Cod and the smaller islands off the New England Coast, though formed from glacial deposits, have the same flat nature as the topography of the rest of the Coastal Plain. The glacial deposits are unconsolidated sediments that erode as easily as the sediments of the Coastal Plain further south.

The wedge of sediments that forms the bulk of the Coastal Plain eroded from the topographically higher Appalachian/Piedmont region to the west. The hard bedrock of the Appalachian/Piedmont region lies beneath the Coastal Plain, but is deeply buried by the wedge of sediments. The boundary between the exposed Appalachian/Piedmont rocks and the wedge of Coastal Plain sediments is called the ***Fall Zone***. At numerous places along this boundary line are cascades and small waterfalls, such as the Great Falls of the Potomac. Rivers have eroded very slowly through the Appalachian/Piedmont bedrock and then very quickly through the soft Coastal Plain sediments to create a sharp drop in stream elevation at the Fall Zone *(Figure 5.15)*.

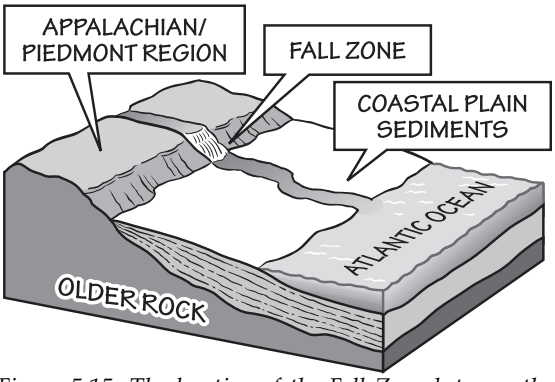
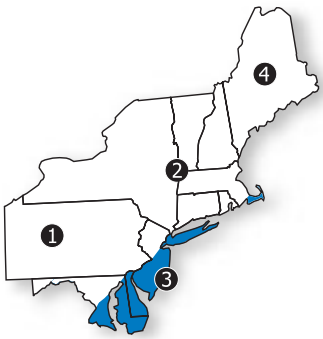


Figure 5.15: The location of the Fall Zone between the Appalachian/Piedmont and Coastal Plain regions. Figure by J. Houghton.

Cities along the Fall Zone

Follow the boundary between the Coastal Plain and the Appalachian Piedmont regions and count the number of cities that you find there: Washington, D.C., Baltimore, Wilmington, Philadelphia and Trenton. When settlers first came to America, they found that they were unable to navigate their ships past the Fall Zone, where the relief of the land was considerably greater than the flat Coastal Plain. Thus, many of the large cities of the East Coast, sprung up along the Fall Zone where shipping was still viable and cheap water power for mills was available.



Topography of the Exotic Terrane
Region 4

New England Uplands

Much of the Exotic Terrane region is simply classified as the New England Uplands. The region is characterized by rolling hills and valleys, and mountainous terrain. The Uplands include the mountainous terrain of the mountains of Maine, the White Mountains, the Bolton Range and the Mohegan Range *(Figure 5.16)*. The mountains of the Exotic Terrane region were formed over the last billion years from a variety of rock types: Ordovician-age ***igneous intrusions*** related to the Taconic mountain-building event; Ordovician volcanic rocks from the Taconic volcanic islands; Devonian-age intrusions related to the Acadian mountain-building event; Jurassic-age intrusions; and metamorphosed Silurian and Devonian sedimentary rock that originated as seafloor sediments in the Iapetus Ocean.

see Rocks, p.50 for more on Ordovician **igneous intrusions.**

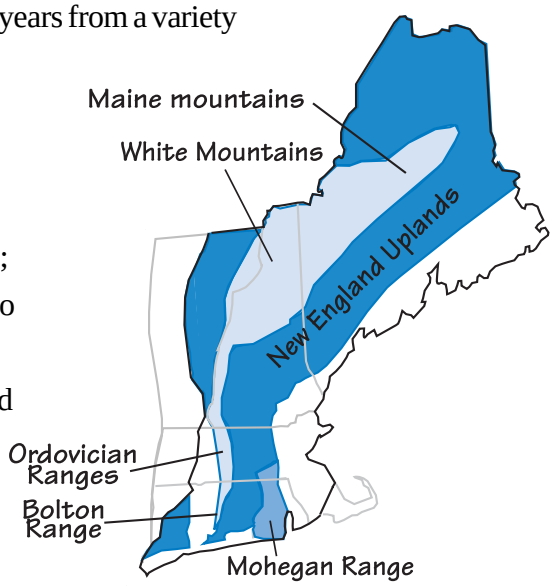
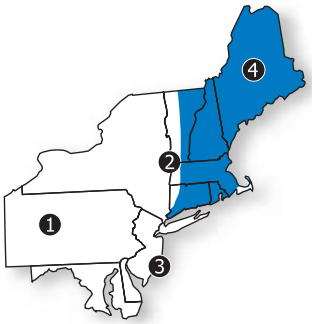


Figure 5.16: New England Uplands mountains found in the Exotic Terrane region.

The mountains of Maine stretch in a belt from the high peaks of the southwest to central Maine. The mountains are generally higher in the southwestern part of the state. Mt. Katahdin in central Maine is an exception; made of an unusually resistant granite from an Acadian mountain-building igneous intrusion, it is the highest peak in Maine at 1605 meters above sea level. During the Acadian mountain-building event, intense metamorphism of the rocks in southeastern Maine and the highly resistant volcanic rocks of the area created the Maine mountains. Further north in Maine, the rocks were subjected to less metamorphism. There are fewer ridges in this region because the rocks are less resistant to weathering and erosion.



The White Mountains of New Hampshire include the Presidential Range, the Franconia Mountains, and the hills of northern New Hampshire and northeastern Vermont. Igneous intrusions from the Taconic and Acadian mountain-building event, as well as volcanics from a possible hot spot during the Jurassic, form many of the peaks of the White Mountains. Some of the highest peaks of the range, however, are formed from Devonian schist, including ***Mt. Washington***, at nearly 1900 meters above sea level.

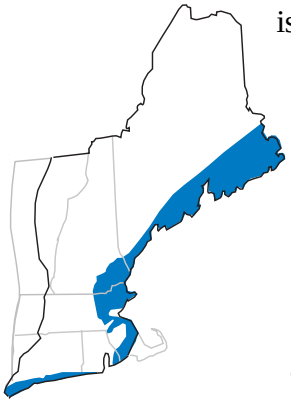
see Rocks, p.53, for more on the **hot spot..**

Mt. Washington *is the highest peak in the Northeast.*

Ordovician igneous intrusions and volcanic rocks from the Taconic mountain-building event form a narrow range of resistant mountains. The Ordovician ranges begin in Connecticut as the Bolton Range, and extend north to New Hampshire and Maine, where the Ordovician-age rocks intermingle with rocks of other ages to form the Maine and New Hampshire mountains.

The Mohegan Range, a series of north-northeast ridges in Connecticut and Rhode Island, was carved from one of the Exotic Terranes of the Exotic Terrane region. The microcontinent Avalonia, which was sutured to North America during the Devonian, had Precambrian bedrock exposed in certain places at the surface. This resistant, Precambrian rock became the Mohegan Range through weathering and erosion of surrounding less-resistant rocks.

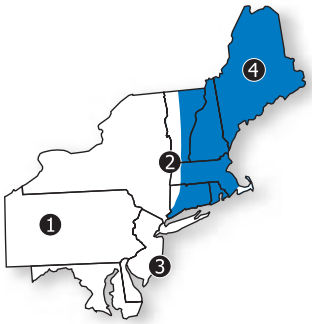
Unusual features of the Uplands topography include knobs of resistant rock that stick out high above the relief of the local landscape. These are known as monadnocks, the most famous example of which is Mt. Monadnock in New Hampshire. Throughout New Hampshire and northern Vermont, isolated mountains of resistant rock stick up above the local landscape, left standing after erosion of less-resistant surrounding rock.



Figrue 5.17: The New England Coastal Lowlands of the Exotic Terrane region.

New England Coastal Lowlands

The Coastal Lowlands of the New England Exotic Terrane region are a discontinuous swath of land along the coastline from Maine to Connecticut that has a lower elevation than the rest of the Exotic Terrane region *(Figure 5.17)*. The lower elevations of the Coastal Lowlands area are not due to softer, less-resistant rock types or the structure of the rocks. The glaciers of the last ice age depressed the



crust of the Northeast somewhat. When the continental ice sheet began to retreat back north and melt, the crust rebounded from the removal of the heavy weight of the glaciers. However, the crust could not rebound before the melting glaciers raised sea level high enough to flood much of the coastal portion of New England. Submergence and erosion by wave action are the cause of lower elevations in the Coastal Zone area of New England.

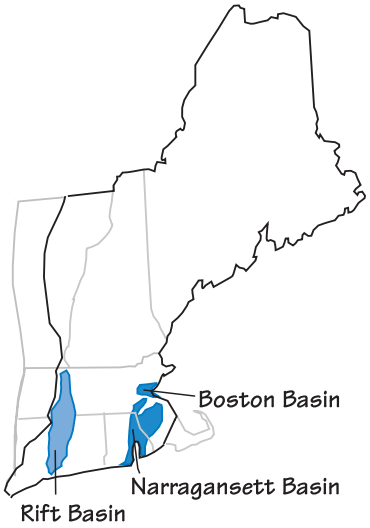
The New England coast is famous for its rocky shoreline. The ***rocky headlands*** are made of resistant granites, igneous intrusions that occurred through the Taconic, Acadian and Devonian mountain-building events. The resistant nature of these rocks, and the inadequate supply of sediment delivered to the coast by local rivers, prevent the formation of wide beaches and a flat coastal plain. Other sections of the New England coast have less-resistant rocks. Erosion of the bedrock creates a greater supply of sediment in local rivers to form wider beaches in these areas. Glacial sediment, dumped as the ice sheet retreated at the end of the most recent ice age also provides the sand, silt and clay making up the beaches in many parts of the Northeast.

The wide beaches of New Jersey, Delaware and Maryland do not have **rocky headlands** *like many New England coasts. New Jersey, Delaware and Maryland are all in the Coastal Plain region, underlain by a wedge of loose, unconsolidated sediments that are easily eroded flat by wind and wave-action, allowing wide beaches to develop.*

see Geologic History, p. 16, for more on **rift basins.**

New England Basins

The Connecticut Valley ***Rift Basin***, formed from the rifting of Pangea during the Triassic and Jurassic, creates a distinctive lowland area in the New England Exotic Terrane region that is very similar to the Newark and Gettysburg Basins of the Valley and Ridge.



Figrue 5.18: The New England Basins of the Exotic Terrane region.

As the basin tilted, layers of sedimentary and igneous rocks were exposed. The soft sedimentary rocks are easily eroded, forming the basin floor, while the igneous basalts and diabase stand out as ridges. The Pennsylvanian-age ***Narragansett Basin*** in Rhode Island, the Precambrian ***Boston Basin*** in Massachusetts and several other Pennsylvanian-age small basins in Massachusetts and Rhode Island also form lowland areas of the Exotic Terrane Region *(Figure 5.18)*.

see Rocks, p.49 and 52 for more on the **Naragansett** *and* **Boston basins,**