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.

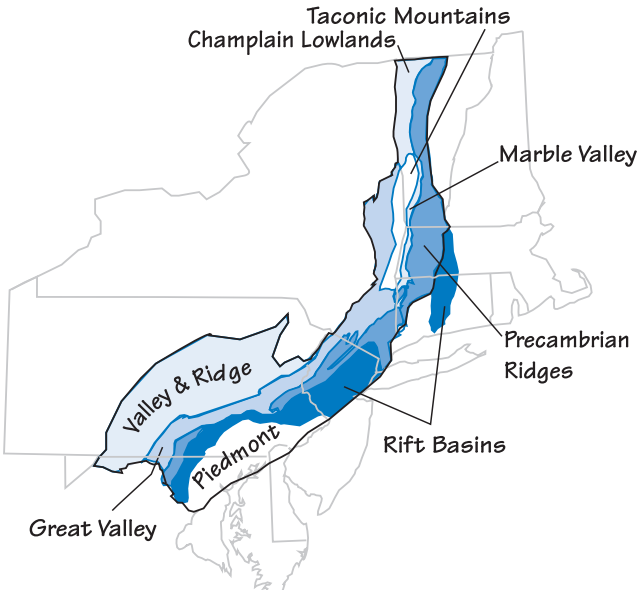
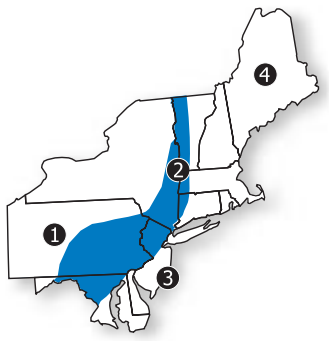


Figure 5.6: Generalized topographic regions in the Appalachian/Piedmont.

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

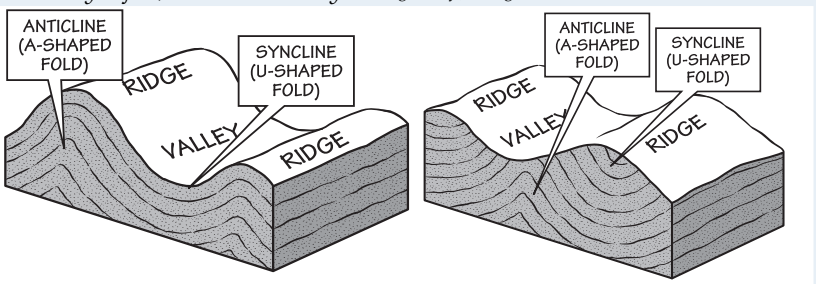
One of the great debates concerning the Valley and Ridge region is the reason for the even heights of ridge tops in the area over long distances. Are the ridges all capped by equally resistant beds? Or was the region eroded flat and subsequently uplifted, to be eroded to its present topography by dissecting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

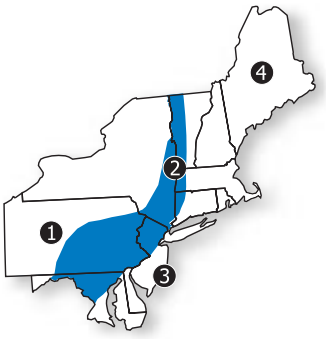
Figure 5.8: Topographic map of the Valley and Ridge region of the Appalachian/Piedmont.
Topographic map provided by Topozone.com: http://www.topozone.com.

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.

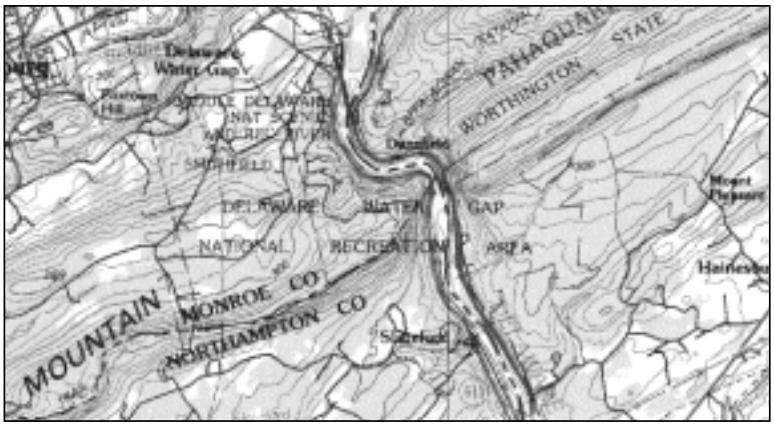


Normal erosion of a fold. *Topographic inversion.*



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.

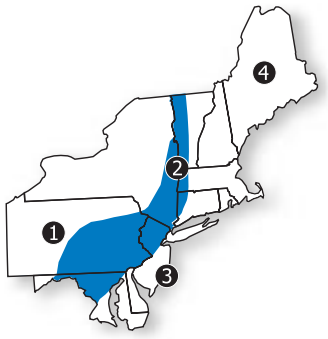
The Great Valley

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

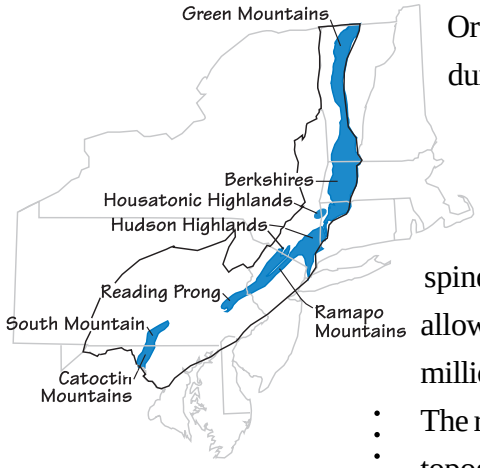


Figure 5.10: Precambrian ridges of the Appalachian/Piedmont.

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

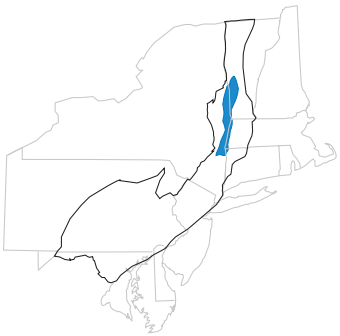
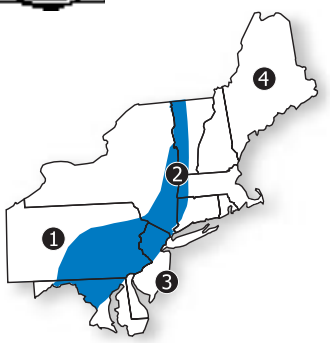


Figure 5.11: The Taconic Mountains of the Appalachian/Piedmont.

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



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

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.

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.

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.*

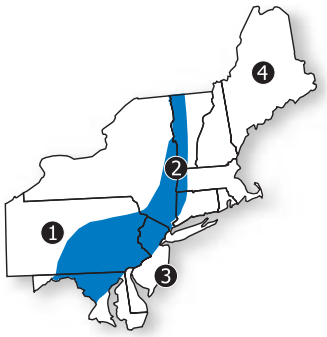
Rift Basins

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.