GEOLOGIC PROVINCES OF VIRGINIA

INTRODUCTION

The present surface features of the state, the distribution of minerals, rocks, and soils, and the great and varied physical changes which they have undergone, have been caused by the ceaseless action of geologic agents and processes. Among these are rock disintegration and decay; wind action; work of streams, ground water, the ocean, lakes and swamps; the deformation of rocks by folding and faulting, mountain-making movements; earthquakes, and the movements of molten rocks. The succession of geologic phenomena has been orderly and continuous. When measured in the terms of human existence, the rate of geological change has been very, very slow.

As the result of detailed studies, made mainly during the past 100 years, of exposures of rocks of many different kinds and ages in various parts of the world, geologists have developed a "geologic time table" in which rock formations of different ages and the major events of the earth's history are recorded in chronological order. In this "time table," all known geologic time is generally divided into five major "eras" with subdivisions of each in terms of "periods." The major divisions from oldest to youngest are the Archeozoic, Proterozoic, Paleozoic, Mesozoic, and Cenozoic eras. The earliest discernible geologic records were made in the Archeozoic era. These major divisions and the characteristic forms of life developed during each, together with the various "period" subdivisions, are shown in Table I. The reader will find here the relative positions of the various geologic time intervals and geological formations referred to in this article. As used herein "Cretaceous formations" refers to beds of rock formed or deposited during the Cretaceous division of the Mesozoic era.

Table I.
GEOLOGIC TIME TABLE

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<th>Major Divisions or eras</th>
<th>Subdivisions or periods</th>
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<td>Cenozoic</td>
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<td>Higher plants, early insects, reptiles and birds (dinosaurs, etc.)</td>
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<td>Paleozoic</td>
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<td>Pennsylvanian</td>
<td>Ferns and allied plants, many invertebrates, and lower vertebrates (fishes and amphibians).</td>
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<td>Mississippian</td>
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<td>Proterozoic*</td>
<td>Several</td>
<td>Low forms of plants and invertebrates</td>
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<tr>
<td>Archeozoic*</td>
<td>Several</td>
<td>Primitive forms of plants and invertebrates.</td>
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*The Archeozoic and Proterozoic eras are frequently considered together as pre-Cambrian, since the first period of Paleozoic time is designated Cambrian.
GEOLOGIC PROVINCES

Virginia lies in the Atlantic Coastal Plain and the Appalachian Highlands. It extends from the sea westward, a maximum distance of 440 miles along the southern boundary. The greatest width is about 200 miles. The area of the state is 42,627 square miles, of which some 2,365 square miles are covered by tidal waters. The approximate mean altitude of the state is 950 feet. The state's geographic center is in Appomattox County, 11 miles southeast of Amherst.

The topography and geology of Virginia, as revealed by the surface features and the exposed rocks, are varied and complex. Virginia is divisible into five distinct geologic and geographic provinces, which are from east to west: (1) The Coastal Plain, a terraced plain bordering the Atlantic Ocean; (2) the Piedmont province, a gently rolling plateau extending from the Coastal Plain westward to the first continuous mountain ridge; (3) the Blue Ridge, an almost continuous, dissected, mountain ridge and plateau; (4) the Appalachian Valley and Ridge province, better known locally, in part, as the Valley of Virginia, consisting of a series of linear valleys and ridges; and (5) the eastern escarpment of the Appalachian Plateaus, or the Cumberland Front, which crosses a small part of southwestern Virginia. The width of each province varies somewhat from east to west, but the geologic limits are fairly well defined. With the exception of the Appalachian Plateaus, each province extends northeast across the state. (See Fig 1.)

Figure 1—Map showing physiographic divisions of Virginia and parts of adjacent states (from Virginia Geographical Survey Bulletin 34, Figure 2, 1933)
Because of the marked differences in the character and origin of the rocks and surface features in the five natural divisions of the state and their bearing upon its economic development, the characteristics of each geologic province are briefly described.

**Coastal Plain**

The Coastal Plain, or Tidewater province, is the easternmost geologic division of the state. It is divided into two distinct parts by the Atlantic shore-line: an eastern submerged portion and an emerged land portion. The submerged area extends from about 50 to as much as 75 miles eastward from the present shore-line to the edge of the continental shelf. The emerged Coastal Plain comprises about 11,000 square miles, or slightly more than one-fourth of the area of the state. It extends from the shore-line west to the Fall Zone. The Fall Zone is a narrow zone where streams plunge by falls and rapids from the resistant rocks of the Piedmont province to the weaker rocks of the Coastal Plain. Some 2,365 square miles of the Coastal Plain are covered by the waters of Chesapeake Bay and numerous tributary estuaries. Chesapeake Bay and four tidal rivers divide the eastern part of the land area into five peninsulas which are known as the Eastern Shore, the Northern Neck, Middle Peninsula, the Peninsula, and the Norfolk Peninsula.

The average width of the Coastal Plain is about 100 miles, and its length from the Potomac River at Alexandria to the North Carolina line is about 160 miles. The average elevation does not greatly exceed 100 feet, but altitudes of 300 feet or more occur along the western margin.

The Coastal Plain is a broad region of low relief, with a gradual eastward slope of about 3 feet to the mile. The coast line is indented with numerous bays and coves, and much of the coastal area is marshy, because in comparatively recent geologic time the entire area has been lowered with respect to sea level. Hence, tidal waters have invaded the major valleys, such as the James, converting them into estuaries with local swamps. The surface of the Coastal Plain consists of numerous terraces, or broad benches, which rise stair-like in steps above the sea. They were formed by the planation of streams and waves when the sea at times stood higher in the geologic past.

In the southeast part of the Coastal Plain is the great Dismal Swamp, whose surface is about 20 feet above sea level. The swamp area is heavily wooded, mainly with red cedar, and in places contains relatively dense growths of canebrakes. Locally cypress trees are found growing in the water. Lake Drummond, a picturesque, shallow circular lake, about 2½ miles in diameter, is in its center.

The Coastal Plain is underlain mainly by loose unconsolidated beds of gravel, sand, clay, and marl of Cretaceous, Tertiary and Quaternary ages. These beds of variable thickness rest upon a floor of Piedmont crystalline rocks, principally of pre-Cambrian age, and slope seaward with dips of 5 to 30 feet per mile. The basement crystalline rocks are 2,246 feet below the surface at Fort Monroe, and 2,318 feet deep at Mathews Court House, as determined by drilling for water and oil, respectively.

**Piedmont Province**

The Piedmont province extends from the Coastal Plain on the east to the Blue Ridge on the west. It comprises about one-third of the area of the state. Its width at the north is only about 40 miles, but the province broadens southward to a width of nearly 165 miles along the Virginia-North Carolina line.

The surface of the Piedmont province is an elevated rolling plain, or low plateau, with an eastward slope of 10 to 15 feet per mile. It descends from elevations of 800 to 1,500 feet along its western border at the foot of the Blue Ridge, to elevations of 200

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1See Table I.
to 400 feet along the Fall Zone. The maximum elevation along the Fall Zone is about 520 feet. On the west the change from the plateau to the Blue Ridge is rather well marked, although numerous hills and short ridges, in part outliers of the Blue Ridge, are found over the western Piedmont.

The province is drained southeastward into the Atlantic by the Potomac, Rappahannock, James, and Roanoke rivers. The sources of these streams, except the Rappahannock, are west of the Blue Ridge. In places streams flow in rocky gorges, which are of rare scenic beauty, and have swift currents as far as the Fall Zone, where they descend by falls and rapids onto the Coastal Plain.

Despite the mature dissection of the region, the flattish to gently rolling nature of this former vast plain-like region is a conspicuous feature. Many monadnocks, ridges, and hills rising 200 to 1,000 feet above the plateau surface, occur in the Piedmont province, being more abundant in the western part near the Blue Ridge. Catoctin Mountain in Loudoun County, Southwestern and Carters mountains in Albemarle County, White Oak Mountain in Pittsylvania County, and Willis Mountain in Buckingham County are examples.

The rocks of the Piedmont province, which are among the oldest in the state, are largely crystalline, such as granite, gneiss, and schist, with altered sediments, such as slate, quartzite, and marble occurring locally. The granites and similar igneous rocks crystallized directly from masses of molten rock that were injected or forced upward into the overlying rocks and have since been exposed on the surface by the erosion of former overlying rocks. Some of the gneisses and schists are altered igneous rocks, and some are beds of sand, clay, and limy muds which were altered by great pressure, thus losing all trace of their original structure. Most of the rocks in this province are very old (Cambrian and pre-Cambrian), but some early Paleozoic formations, such as the Arvonia slate of Ordovician age, are present.

Blue Ridge Province

The Blue Ridge province extends northeastward across the state, a distance of about 300 miles. It is essentially a narrow mountainous ridge northeast of Roanoke, but broadens into a high, broad, triangular plateau south of Roanoke. As the principal eastern range of the Appalachian Highlands, it is an outstanding topographic feature in the state. It is cut deeply by the Potomac at Harpers Ferry and the James at Balcony Falls. Roanoke River separates the narrower, northern part from the broader plateau to the south.

The Blue Ridge rises from about 1,200 feet at Harpers Ferry to 4,031 feet on Stony Man, in the Shenandoah National Park, and 4,001 feet on the Peaks of Otter. Near the southern boundary of Virginia, Whitetop Mountain at 5,540 feet, and Mount Rogers, at 5,719 feet, are the two highest points in the state.

The subdued mature topography and heavily forested slopes and summits of the Blue Ridge give it great charm. The summits of some of the peaks of the Blue Ridge to the north and parts of the broad plateau to the south are remnants of an old extensive erosion surface, a peneplain, formed mainly by the plantation of streams when the region was at a much lower level, probably not far above the sea. The southwestern rugged part was not eroded to a common level; hence high peaks, as Mount Rogers, rise above the general surface of the plateau.

The Blue Ridge is composed chiefly of granite, greenstone, and other crystalline rocks. The granite and related rocks were formed by the cooling and solidification of masses of molten materials (magmas) intruded into overlying rocks or from fluids that emanated from the magmas, whereas
greenstone and other similar igneous rocks solidified from bodies of lava that flowed out upon the crust of the earth in early geologic (pre-Cambrian) time. These rocks are exposed along the crests and eastern slope. On the steeper western slope ancient but younger (Cambrian) sandstones and shales overlie them. Some foothills in the Piedmont province and in the Valley are also composed of sandstones of early Paleozoic (Cambrian) age.

Appalachian Valley and Ridge Province

Between the Blue Ridge province on the east and the Appalachian Plateaus on the west, lies the Appalachian Valley and Ridge province, which in Virginia extends southwest for more than 360 miles from the Potomac to Tennessee, with a width of from 25 to 50 miles. The eastern part is the Valley of Virginia and the western part consists of the Valley Ridges. The Valley of Virginia is a beautiful tract of rolling country, which gradually rises to the south and west. It rises from 300 feet above sea level at Harpers Ferry, on the Potomac, to about 2,500 feet in places in southwest Virginia. On the east the rounded summits of the Blue Ridge rise to heights of 2,000 to 3,000 feet above the Valley floor.

The Valley of Virginia is divided into several distinct valley-like lowlands, by knobs and ridges which extend east from the easternmost Valley Ridges and west from the Blue Ridge. The width of the Valley proper is decreased by these ridges, as, for example, near Buchanan, where Purgatory Mountain constricts the Valley to a width of only two miles. Tinker Mountain, near Cloverdale just north of Roanoke, likewise confines the Valley within narrow limits, as do several other outlying ridges to the southwest.

The largest of these lowlands in the Valley of Virginia is Shenandoah Valley, which extends from Harpers Ferry southwest beyond the Natural Bridge. It is about 150 miles long and from 10 to 20 miles wide. Massanutten Mountain is a majestic isolated ridge which divides the northern part of Shenandoah Valley into two parts. Rising suddenly east of Harrisonburg to an elevation of 3,000 feet, it extends northward for 50 miles to the vicinity of Strasburg where it ends abruptly. A large part of Shenandoah Valley and the numerous valleys and ridges to the west are drained by Shenandoah River which flows northeast into the Potomac. The southeastern part of Augusta County and most of Rockbridge County are drained by James River and its tributaries.

The other prominent individual valleys of the Valley of Virginia are: (1) Fincastle Valley, principally in Botetourt County, (2) Salem or Roanoke Valley, largely in Roanoke County, (3) Dublin Valley, embracing portions of Montgomery, Pulaski, and Wythe counties, (4) Abingdon Valley, in Smyth and Washington counties, and (5) Powell Valley in Wise and Lee counties.

The several divisions of the Valley of Virginia are essentially a series of limestone valleys which owe their present form to solution of the limestones and erosion of the weaker shales, all of Paleozoic age, which underlie them. These limestones and shales occur in broad extensive northeast-southwest belts. In sharp contrast is the west slope of the Blue Ridge, consisting mainly of resistant sandstones and quartzites of Cambrian age. The prominent Valley Ridges to the west also contain highly resistant sandstones, mainly Silurian age.

Most of the northwestern part of the Appalachian Valley region in Virginia is occupied by the Valley Ridges section. It comprises a series of roughly parallel, narrow, elongate, steeply folded mountain ridges with numerous delightful and picturesque intermontane valleys, very similar to Shenandoah Valley but smaller. The valleys are mostly in shale but some are in limestone. They were formed by the solution of limestone and the erosion of shale,
as explained above. The width of this Valley Ridges belt increases northward, from 25 to 45 miles. In the northern half of the region three distinct chains of rather prominent ridges occur. The most prominent of these parallel ridges are Shenandoah, North, Little North, and Great North mountains in the northern part, Alleghany and Sweet Springs mountains in the central-western portion, and Peters, Walker, Clinch, and Copper Ridge mountains in southwestern Virginia. These ridges are in places deeply cut by picturesque water gaps. The Virginia-West Virginia State line follows an irregular course along the crests of several of the ridges of this belt.

The James and its tributaries, principally Cowpasture and Jackson rivers, drain the mountainous or Valley Ridges section in the central-western part of the province. The southwestern half of the Valley region is drained by Roanoke River, flowing south-eastward, New River, coursing northward into West Virginia, and the several branches of Clinch, Holston, and Powell rivers which flow southwestward into the Valley of eastern Tennessee.

Appalachian Plateaus

The counties along the extreme south-western border of Virginia, from Buchanan County southwest, and the northwestern parts of Tazewell, Russell, and Scott counties, lie in the eastern part of the Appalachian Plateaus. The area is a high upland underlain by gently folded to almost horizontal sedimentary rocks, chiefly sandstone, shale, and coal of upper Paleozoic (Pennsylvanian) age, and embraces an area of about 1,500 square miles. The coal is the most interesting and valuable rock in this area. This part of the state, because of its average elevation of about 2,000 feet or more and its humid climate, has been dissected by a maze of streams into a mosaic of steep hills and ridges and deep ravines and valleys. Flat lands, even of small extent, are rare. Altitudes range from 1,000 feet and less in places along the Kentucky boundary to 3,700 feet and more above sea-level along the northeastern and central parts of the area. The area is drained mainly by tributaries to the Ohio River.

The flat-topped ridges in Scott and Wise counties indicate the surface of the old plateau, whereas the more deeply eroded areas to the northeast do not preserve the plateau surface. Cumberland, Stone, and Powell mountains and Sandy Ridge represent remnants of the former plateau surface. The scenery of this part of Virginia is impressive, particularly the “Brakes of the Sandy,” a deep rugged gorge in northern Dickenson County through which the Big Sandy River flows.

GEOLOGIC HISTORY

Coastal Plain

The geologic history of the Coastal Plain has been relatively simple compared with that of the other divisions of the state. This province has repeatedly been elevated and depressed with respect to sea level and many of the sedimentary beds contain fossil evidences of some of the physical and organic changes which have occurred in this region. The sediments differ considerably in character and origin. Some were formed in brackish or fresh water, whereas some were deposited in marine waters. Some were deposited in water of shallow depth, others in deeper water. The sediments were derived in part from a higher land mass to the west, carried seaward by eastward coursing streams.

During the greater part of the Paleozoic era—the time of “ancient life”—the crystalline rocks of the Piedmont province and those which form the floor or basement of the Coastal Plain apparently formed a land surface which probably extended far to the east of the present shore line, perhaps to the edge of the continental shelf. This land surface may have been elevated and depressed several times.
During Mesozoic time this old land mass was eroded and depressed. In the early part of that era (Triassic period) lowlands or basins were formed locally in the Piedmont region, in which were deposited layers of sand, gravel, and mud. Coal was also formed in some of the Triassic basins. One of these coal-bearing basins, termed the Richmond basin, lies along the eastern margin of the Piedmont region.

Early in Cretaceous time the land along the western side of the Coastal Plain apparently was depressed. It is thought by some that the Piedmont province to the west was also uplifted. Sediments, derived mainly from the higher lands to the west, were deposited in the depressed area, brought and dumped there by eastward coursing streams. Late in Cretaceous time, possibly as a result of seaward tilting of the land, ocean waters invaded the region and marine sediments were deposited over the Coastal Plain.

During Tertiary time the Coastal Plain was alternately above and beneath the sea at repeated intervals, and beds of clay, sand, and shell marl were deposited. These sediments extended as far west as the Fall Zone, and, perhaps, even into the Piedmont province. The beds of shell marl at Yorktown are famous for the abundance and variety of fossil shells in them.

During Quaternary (Pleistocene and Recent) time several minor emergences and submergences of the Coastal Plain occurred. They are marked by a series of deposited and wave-cut terraces of sand and gravel. The terraces represent fan or bench-like deposits of sediments, in part of continental and in part of marine origin, which extend in a general northerly direction across the Coastal Plain. The highest and oldest terraces occur in the western part of the region and the lower and younger successively eastward. Princess Anne County is on the lowest of these terraces, which forms or borders the coast line from North Carolina to the mouth of the Potomac River and also extends along the east and west sides of the Eastern Shore peninsula.

A geologically recent rise of the sea flooded a large expanse of coastal land. Prior to this submergence Chesapeake Bay was a great river valley through which flowed the Susquehanna, with the James, Potomac and other streams as tributaries. The Susquehanna River probably flowed between Cape Charles and Cape Henry to empty into the Atlantic many miles east of the present shore line. The recent rise of the sea drowned the lower valleys of the old Susquehanna and its major tributaries, thus forming Chesapeake Bay, Hampton Roads, and the drowned valleys of the James and the York.

**Piedmont Province**

The geologic history of the Piedmont province has been varied and complex. Where the plateau now lies were once lofty hills and mountains, but erosion has reduced all the former great irregularities of surface. In past geologic time, this area has been folded, elevated, depressed, and tilted. It now stands higher above the sea than it did geologically a short time ago. Hence the rivers of the Piedmont province are swift-flowing and unnavigable, and actively deepening their channels.

During the earliest recorded time, in the Archeozoic and Proterozoic (pre-Cambrian) eras, an extensive trough, trending in a northeasterly direction, occupied parts of the Piedmont and Blue Ridge provinces. Sedimentary rocks of variable composition were deposited in the geosynclinal trough. Intermittently during deposition there were periods of volcanic activity as is indicated by numerous lava flows. Masses of molten materials were also intruded far below the surface, where they cooled and crystallized to form igneous rocks of various types. Before the beginning of the Paleozoic era (Cambrian time), most of the pre-Cambrian rocks were highly deformed and altered.

It was during the late pre-Cambrian that
the Appalachian trough or geosyncline was formed across the western part of the state. The Blue Ridge province and the western part of the Piedmont province were probably included in the extensive area of land involved in this downwarping. During the Paleozoic era there was extensive and widespread deposition of sedimentary beds throughout the Appalachian trough. It is probable that Paleozoic sediments were laid down over considerable areas in the Piedmont province, although most of them were later removed by erosion. Early Paleozoic (Cambrian) rocks occur in a belt extending northeasterly through Charlottesville and Warrenton. During the Ordovician period, seas extended over portions of the Piedmont province, as is indicated by the occurrence of belts of slate containing marine fossils, in Buckingham, Fluvanna, Stafford, and Prince William counties.

In the Permian period, toward the close of the Paleozoic era, the present Piedmont, Blue Ridge, and Appalachian Valley and Ridges provinces were involved in the massive crustal movements (Appalachian Revolution) which gave rise to the old Appalachian Mountains. The earth’s crust was fractured and large blocks of it were elevated and shoved far to the northwest. There was also intrusion of igneous material, such as the granite that now crops out in the Petersburg-Richmond area, in the Piedmont province.

In the early part of the Mesozoic era (Triassic period), the Piedmont region probably was a relatively high land undergoing rapid erosion. Further folding and faulting along certain belts produced elongate inland basins in the middle and eastern portions of the Piedmont region across Virginia. Into these basins streams carried fragmental material, derived from the eroded highland areas, which formed beds of conglomerate, sandstone, and shale. Swamps or marshes with abundant vegetation existed at times in some of these Triassic basins and coal deposits accumulated.

The Richmond Basin is probably the best known of these areas. Molten material was intruded into the Triassic and older Piedmont rocks.

At or near the close of Triassic time there was again crustal movement in the Piedmont region and the recently deposited materials were tilted and warped. There were probably several stages of uplift during the Mesozoic era which increased the power of the streams and thus caused them to continue active erosion of the Piedmont rocks.

During the latter part of the Mesozoic era and the early part of the Cenozoic era, much of the Piedmont region apparently had been worn down to a low rolling plain—a peneplain—of great extent. There were probably several intervals of uplift during Tertiary and Quaternary time, which further rejuvenated the streams and increased erosion. Thus the Piedmont peneplain has been considerably dissected by long-continued erosion and the present rolling topography has been very gradually developed.

Blue Ridge Province

The Blue Ridge and the Valley Ridges in Virginia are mountains originally formed by folding and faulting, followed by erosion and vertical uplift of the eroded folded mass. They were not formed by a sudden single movement but slowly during a series of successive uplifts. During pre-Cambrian time a great trough was formed along the site of the present Blue Ridge and Appalachian Valley and Ridge province. This is called the Appalachian trough or geosyncline. It was occupied in the Paleozoic era by many shallow seas in which were deposited a great thickness of sediment approximately 25,000 feet or more in the Valley. In late Paleozoic time these more or less horizontal beds of sediment were intensely folded and overthrust by great lateral pressure acting chiefly from the southeast, producing a series of long, narrow folds (anticlines
and synclines) of southwest trend. The intensity of the folding, crushing and faulting of these beds is emphasized by the compression of a broad belt of horizontal rocks into a closely folded mountain mass estimated to be one-half or less of the original width.

**Appalachian Valley and Ridge Province**

During the early history of this region, in the Paleozoic era, enormous thicknesses of sediments, later consolidated into limestones, shales, and sandstones, were deposited in nearly horizontal beds in great interior seas which at successive geologic periods occupied the Appalachian region. Toward the end of the Paleozoic era, during the slow formation of the ancient (not the present) Appalachian Mountains by strong lateral pressure and pronounced vertical uplift, this huge mass of sedimentary rocks was highly deformed by intense folding and profound faulting. Countless zones of weakness, such as joints and belts of crushed and faulted rock, were developed, perhaps more abundantly in the limestones.

In the latter part of the Paleozoic era, local swamps, some of considerable extent, existed in the Appalachian Valley. Coal was formed in several of these swamp areas as the result of the accumulation and decomposition of the peculiar plant growth.

During and following the late Paleozoic deformation of the Appalachian region, and the later vertical uplift at successive stages in the Mesozoic and Cenozoic eras, many thousand feet of the rocks were eroded and carried far away by the prolonged activity of rains, surface streams, ground water, and other geologic agents, such as frost, wind, freezing and thawing, and rock disintegration and decay. Hence beds of rock of variable composition and hardness were exposed in long, generally narrow, parallel northeast-southwest belts. Broad, flat-floor ed valleys were eroded in the areas underlain by the weaker rocks, such as limestone and shale, whereas the more resistant rocks, such as sandstone and quartzite, were left standing as prominent mountain ridges. As a result of several episodes of approximately vertical uplift and consequent intervals of widespread and deep erosion by rejuvenated streams and drainage systems, the present Blue Ridge, Valley of Virginia, and the Valley Ridges were created. These geologic processes required long periods of time, scores of millions of years.

**Appalachian Plateaus**

The extreme southwestern or main coal-bearing part of the state, which is a part of the Appalachian Plateaus, has had a geologic history similar to that of the Appalachian Valley and Ridge province. In the Paleozoic era (Carboniferous time), swamps or marshes of considerable extent existed in much of what is now the southwestern plateaus. Peculiar types of ferns and trees, very different from the present types, grew in these swamps. This vegetation, after being buried in the waters and accumulated sediments, was acted upon by heat and pressure and chemical agents, which converted it into coal. The profound change was caused in part by the extensive deformation of the rocks of the Appalachian region near the close of the Paleozoic era. Bacterial decay also was probably an important factor in the transformation of the plants into coal. Since Paleozoic time, the Appalachian Plateaus, like the Appalachian Valley and Ridge province, have been uplifted and eroded several times. The present dissected elevated plateau has been gradually developed as a result of the most recent uplift.

**Old Erosion Levels**

Certain characteristic topographic features prevail throughout the Appalachian Valley as evidence of the deformation and vast erosion which the rocks of the region have undergone.

Four distinct stages or cycles of erosion are recorded by recognizable topographic
levels. The flattish ridge crests and hilltops at each level are remnants of formerly extensive valley floors, each produced by streams eroding the region toward a common plane, not far above sea-level. Regional plains of this type are called peneplains. The peneplains of the Appalachian Valley in Virginia have been described by Stose and by Wright. The highest and oldest level is apparently marked by the uppermost flattish summits of the Blue Ridge and the highest ridges among the Valley Ridges.

These numerous summit areas are but meager remnants of the vast undulatory plain which formerly covered the entire region and from which the present valleys and ridges have since been carved. Due to the great age of this former land surface and the amount of uplift and consequent erosion it has undergone, remnants of this old land surface are not uniformly preserved throughout the Appalachian region. The highest level has been called by Stose the Summit peneplain. The remnants of this old surface, or uplifted peneplain, are now from 3,500 to 4,000 feet above sea-level.

The lowest widespread level is represented by the gently rolling, stream-dissected, solution-pitted floors of Shenandoah Valley and similar valleys west of the Blue Ridge. This youngest peneplain has been named the Valley-floor, or Harrisburg peneplain. Other local names are used in other divisions of the Valley of Virginia. It varies in altitude from about 600 feet along the Potomac to 2,200 feet at the southern end of Shenandoah Valley, and 2,600 feet at places in Dublin and Abingdon valleys. It was formed probably during Tertiary time.

Between these two distinct erosion levels, or peneplains, occur the Upland peneplain, represented by the even-crested summits of several of the mountain ridges in the Valley Ridges section as well as by the broad rounded tops of the Blue Ridge at an altitude of about 3,000 feet—such as the Big Meadows "flat" near the center of the Shenandoah National Park, and the Intermediate peneplain preserved in the even tops of the foothills and the spur ridges of the Blue Ridge and Valley Ridges at an altitude of about 2,200 to 2,300 feet. (See Fig. 2.)

Prominent hills and elongate ridges, termed monadnocks, rising 100 to 500 feet above the floor of the Valley, remain also as partially reduced remnants of former surfaces. Such monadnocks persist chiefly because they are composed of rocks of superior resistance to erosion or they were far from the main streams in the region. One of the most outstanding of the larger monadnocks is Massanutten Mountain.

**Selected References**

The reader is referred to the following publications which contain information of probable interest and which were consulted in the preparation of this article:


Clark, W. B. and Miller, B. L., Physiography and Geology of the Coastal Plain Province of Virginia: Virginia Geol. Survey Bull. 4, 274 pp., 1912. Especially pages 13-18, 46-60, and 210-222.

TEACHING THE RISING GENERATION TO THINK

EMERSON has taught us that nothing is really known until it is seen in its relations to other things, but the application of this vital principle is often far to seek in history textbooks. The need of understanding something of world history if one is to understand one's own is generally recognized, but the need of considering one's own political history in its relations to economic and vital statistics in one's own country is less understood. The future voter is usually left grossly unprepared for making judgments on public issues. In this period of financial confusion and depression this is peculiarly so. Especially is he unable to judge matters which appeal to the emotions, like questions of danger and defence. The student with a high school or even a college diploma is often all at sea regarding the most vital matters. He has learned a mass of facts unrelated to real life and basis for judgment.

The writer has asked thousands of students in secondary schools and sometimes in colleges and in various states: "How many soldiers do you think were killed in our armies or died of disease in our War of the Revolution, our War of 1812, our Mexican War, Spanish War, and World War combined? I have told them that I have had a range of guesses from 5,000 to 6,000,000. My first question was to a high school youth of exceptional talent who guessed 2,000,000. I have then asked how many think we have had fewer than 2,000,000 killed. A few hands have usually been raised. Once not one hand was raised. Then I have asked how many think that more than 2,000,000 have been killed, and the large majority raised their hands in every single instance. Then I have told them to their amazement that the number killed is fewer than have been murdered in ten years, which is over 110,000.

The judgment of students in this matter is probably as good as that of most adults. The latter remember that when they went to school the chief part of their history had to do with wars and they have imagined that foreigners have cost us rivers of blood. It follows that when the Security League or the admirals and generals assure us that "the army is below the danger point," that our security depends on having more bombs,