INTRODUCTION
LOCATION AND AREA

The Fairfield and Gettysburg quadrangles are in the south-central part of Pennsylvania, between parallels 39° 47' and 40° and meridians 77° and 77° 30', and together contain about 438 square miles. They embrace the larger part of Adams County, the east side of Franklin County, and the south corner of Cumberland County. The southern border of the area is within 2 miles of the Maryland State boundary. (See fig. 1.)

DESCRIPTION OF THE FAIRFIELD AND GETTYSBURG QUADRANGLES

By George W. Stose and F. Bensem

The Appalachian Highlands include these well-marked longitudinal subdivisions, each characterized by a general similarity of sedimentary deposits, geologic structure, and topography. The western subdivision includes the Appalachian Plateaus; the middle subdivision is the Appalachian Valley and Ridge province; the eastern subdivision includes the Blue Ridge and Piedmont provinces. Topographically the Blue Ridge and Piedmont provinces are distinct, but geologically they are so closely allied that they may be better treated as a unit. These three subdivisions are well defined from Alabama to southern New York, and the following description applies chiefly to that part of the Appalachian Highlands. (See fig. 2.) Further north and east are the St. Lawrence Valley, Adirondack, and New England provinces.

APPALACHIAN VALLEY AND RIDGES

The middle subdivision has generally been called the Appalachian Valley province, but in Pennsylvania, especially in the vicinity of Pittsburgh, the term has been extended to include the Allegheny Plateau. The Appalachian Valley province, usually referred to as the Appalachian Valley, is a large part of the Appalachian Valley and Ridge province. The eastern part of the province is marked by great valleys; these range in width from 8 to 13 miles and include the Shenandoah Valley, the Cumberland Valley of Maryland and southern Pennsylvania, the Lehigh Valley of eastern Pennsylvania, and the Kittanning Valley of New Jersey. The west side of this part of the province throughout most of its extent is a variety of upland known as the plateaus, which is characterized by small, parallel ridges. Its general altitude, however, is marked lower than that of the mountainous provinces on both sides. The rocks of the Appalachian Valley and Ridges are almost wholly sedimentary and consist of limestone, shale, sandstone, and conglomerate. The strata were deposited in nearly horizontal beds, but they are now inclined at various angles, and their outcrops form narrow belts of the different kinds of rock. The surface relief depends upon the differences in hardness and solubility of the representing rocks. In the southeastern part of the province, owing to the absence of some of the resistant sandstones that occur farther north, and to the correspondingly large amount of more soluble and shaly rocks which are brought up in the natural folds and exposed by erosion, the surface has been more rapidly worn down and is lower and generally less varied than that of the adjacent mountains and plateau provinces. This is true likewise of the northeastern part of the Appalachian Valley and Ridge province, but in its northwestern part high, sharp-cast paralleled ridges and intervening valleys follow the narrow belts of upheaved hard and soft rocks respectively.

BLUE RIDGE AND PIEDMONT PROVINCES

The eastern subdivision of the Appalachian Highlands embraces the Blue Ridge and Piedmont provinces. The Blue Ridge comprises many minor ridges, which, under local names, extend from southeastern New York to northern Georgia. Chief among these are the Highlands of southeastern New York and New Jersey, South Mountain in Pennsylvania, the Blue Ridge and Catawissa Mountains in Maryland and Virginia, the Great Smoky Mountains in Tennessee and North Carolina, and the Blue Ridge in Georgia.

The Piedmont province is a wide belt of upland southeast of the Blue Ridge province. It descends gently southward and grades into the Coastal Plain, which borders the Atlantic Ocean. The Blue Ridge and Piedmont provinces grade into each other in places, with no sharp boundary. The form of the surface differs largely in accordance with the proximity of large trunk streams and their activity in wearing down the rocks. The rocks of this subdivision are largely crystalline, being either sediments that have been metamorphosed to quartzite, slate, schist, and gneiss, or igneous rocks that have solidified from a molten condition, such as granite, diorite, gabbro, rhyolite, and basalt, also more or less altered by metamorphism.

APPALACHIAN PLATEAUS

The further subdivision of the Appalachian Highlands comprises the Cumberland and Allegheny Plateaus and several lower plateaus in Tennessee, Kentucky, and Ohio. On the west it is bordered nearly by the Interior Low Plateaus and Central Lowland provinces of the Interior Plains. Its eastern border is sharply defined in most places by the Allegheny Front and the Cumberland escarpment. The rocks of this subdivision are almost entirely sedimentary and are but gently folded. The form of the surface, which is in part dependent on the character and attitude of the rocks, is that of plateaus in various stages of dissection. In the southern half of the province large portions of the plateau country are very flat, but more commonly the plateaus are dissected by many valleys and ravines into numerous small flat-topped hills. In portions of West Virginia and Pennsylvania the plateau surface is so largely dissected as to leave irregular rounded knobs and ridges that bear little resemblance to the original flat surface. The western part of the province has been extensively eroded, and portions of its surface are of much lower altitude but are still comparatively level or rolling.

ALTITUDE

The Appalachian Highlands attain their greatest height in North Carolina, where Mount Mitchell, in the Blue Ridge province, reaches an altitude of 6,684 feet. From this culminating point the mountains descend to less than 1,000 feet at the south end of the province in Alabama. The highest mountains in Virginia is Mount Rogers, in the Blue Ridge, which is 5,710 feet above sea level. The valley ridges in Virginia reach over 4,000 feet, but in Maryland and Pennsylvania they may be above 6,000 feet. The plateau province, west of the Appalachian Valley, has at its southern limit an altitude of 500 feet, and extends to 2,000 feet in Tennessee, 4,000 feet in Kentucky, and culminates at 4,800 feet in West Virginia, whence it descends again to 3,500 feet in Maryland and 2,500 feet in north-central Pennsylvania.

The height of the floor of the Appalachian Valley is determined largely by the drainage basins of the trunk streams that cut through the mountain barrier on each side at irregular intervals, and it has therefore numerous culminating points on the watershed between these streams. Thus it rises from less than 500 feet in Alabama to 2,700 feet on the divide between Tennessee and New Rivers in Virginia, whence it descends to 2,300 feet in the New River valley. It rises and falls likewise over the divides and into the valleys of James and Potomac Rives in Virginia, descending to 200 feet in the Potomac Basin. In Pennsylvania the floor of the valley does not rise above 1,000 feet. Throughout the length of the province the stream channels are cut 30 to 50 feet below this valley floor, and the ridges rise 300 to 2,000 feet above it.

DRAINAGE

The drainage of the Appalachian Highlands south of New York flows in part westward to the Atlantic Ocean, in part southward to the Gulf of Mexico, and in part westward to Mississippi River. The greater part of the Appalachian Plateaus is drained by streams flowing westward to Ohio River.
The northern portion of the Blue Ridge province is drained almost due northwest to the Atlantic, but south of New River all except the eastern alpines is drained westward to the Ohio by tributaries of the Tennessee or southward to the Gulf by tributaries of the Coosa.

In general the streams of the Appalachian Valley and Ridge provinces flow for long distances in the lesser valleys of the Tennessee, or southward to the Gulf by tributaries of the Tennessee or southward to the Gulf by tributaries of the Ohio or Allegheny rivers, which cross one or the other of the mountain barriers. From the northern portion of the province Dela­ware, Potomac, James, and Rappahannock river passes through the Blue Ridge and Piedmont provinces in narrow gaps or gorges and flow outward to the sea. In the central portion, in Virginia, the longitudinal stream systems flow New River, which flows westward in a deep, narrow gorge through the Allegheny Plateau to Ohio River. In southwest Virginia and Tennessee the Appalachian Valley is drained by tributaries of Tennessee River, which at Chattooga leaves the broad valley and, converging streams through the Cumberland Plateau, flows westward to the Ohio. Further south the streams flow directly to the Gulf of Mexico.

Geologic History

The rocks that appear at the surface of the Appalachian Highlands comprise sedimentary rocks, igneous rocks, and certain other crystalline rocks which, on account of their age and extensive distribution, are of mountain origin. The geologic history of the region is preserved in these rocks, but at no one place is the record complete. Only by combining the facts obtained from different parts of the region can the general sequence of geologic events be determined.

The oldest rocks of the region consist largely of gneisses and schists and occur in most of the Piedmont province. In general the original character of most of these rocks is entirely obliterated by the processes that have taken place along since their formation. Some are undoubtedly sediments laid down in the earliest seas, and others were ancient deep-seated intrusive bodies. The great pressure that these rocks were subjected to while deeply buried in the earth recrystallized them, and they now possess a gneissic and schistic structure. The igneous rocks are mostly granite, diorite, and pegmatite. This complex of ancient rocks is regarded as belonging to the Archean epoch.

After the uplift and erosion of these deep-seated rocks were poured out upon them. These ancient erosive rocks and the associated sedimentary rocks, which are most common in the Piedmont province, are believed to be of Appalachian age. They are separated from the overlying Cretaceous strata by an unconformity, and their fragments form local interruptions in the Cretaceous.

In general, the oldest rocks appear at the surface on the east side of the region, and successively younger strata appear upward to the west.

After a period of uplift and erosion a portion of the Appalachian Valley and Ridge province was submerging beneath the sea, and the sand, gravel, and coals were successively laid down in the form of marine sediments. In these deposits, which are now reduced to muds, clays, and shales, and limestones, can be seen fragments of plants from the ancient forests which extended from the mountains to the sea. In many localities these sediments were laid down upon a shallow basin in the interior of the American continent, and its eastern shore continued along the eastern part of the state, and was thus continuous with the sea. During this period there was renewed erosion on the land, which brought considerable quantities of debris into the sea. This was followed by a change from brackish-water marsh conditions, for with the sand and silt that were deposited were buried occasionally occur layers of loess, a fine silt and clay representing dunes of vegetation, which now constitute the great coal beds of the Appalachian region.

Deposition in the Appalachian Highlands practically ceased at the end of the Carboniferous period, when the region was uplifted, the inland sea was drained, and the sea bottom was added permanently to the land. In the process of the uplift the previously deposited sediments were highly compressed and folded. Later, during Triassic time, certain narrow basins in the Piedmont province received large quantities of distinctive red sediments brought in by floods. In the age since that time the whole region except the portions bordering the ocean has been above the sea and has been continuously subjected to erosion, and no deposits except stream gravel, lead like sediments, and glacial drift have been left to record its history, which is, how­ever, preserved in the present topography.

TOPOGRAPHY

Division.—The Fairfield and Gettysburg quadrangles lie in the Blue Ridge and Piedmont provinces of the Appalachian Highlands. An extensive map showing the two provinces are quite distinct, the mountains standing in sharp relief above the plains. (See fig. 1.) The northwestern three- fourths of the Fairfield quadrangle is occupied by South Mountain, the local representative of the Blue Ridge; the rest of the county is a dissected plain, a low part of the Piedmont Plateau proper. The Pigeon Hills, at the eastern border of the area, its altitude ranges between 1,700 and 1,900 feet. Many of these hills are foothills of South Mountain. A hilly tract extends from Mt. Kisco, at the southern edge of the Fairfield quadrangle, to Ornstein, and includes the sharp tops of McKeen Knob, 1,400 feet in altitude; Hunterville, 700 feet; Sugarloaf, 1,200 feet; and Wilson Hill, 900 feet. North of the Chasapeake pike are other groups of hills, of which the larger are the hills near Rock Grove School, 800 feet; Yellow Hill, 1,600 feet; Wolfpit Hill, 900 feet; and Chestnut Hill, 985 feet. Second hills farther out in the valley, although much lower, are conspicuous because they rise abruptly from the surrounding lowlands. (See pl. 12.) They include Round Top (south of Gettysburg), 785 feet; Granite Hill, 720 feet; and Round Hill, 947 feet.

The wide hills that appear in the southeast corner of the Gettysburg quadrangle form the eastern margin of the Gettysburg Plateau. The general altitude of the hillslopes outside the area is 900 feet, and the upland surface is part of the Piedmont Plateau. The Figure 3 shows the eastern border of the Gettysburg quadrangle, which lie within the general area of the Gettysburg Plain and Hanover-Tack Valley, are cut 1,000 feet in altitude and stand distantly above the plain.

Drainage

The area is drained by the watershed between two main drainages, about one-half of it draining north into Susque­hanna River, and the other half south into the Potomac, as shown in Figure 2. In the mountains the streams flow mostly in narrow valleys with steep gradients, and the flow is generally swift. In the lower drainages the grades are much reduced, the valleys are wider and flatter bottomed, and many have wide flood plains that are cultivated. The streams that flow in the mountains are generally bordered here and there by terraces covered with sand, gravel, and cobble derived from the hard rocks of the mountains. The streams were formerly dammed at many places, and considerable water power was thus developed and utilized in local grist and saw mills.

Susquehanna drainage.—The drainage into Susquehanna River goes chiefly through Conococheague Creek, which heads in the Alleghany Mountains, in the Fairfield quadrangle, and flows out of South Mountain through the cleft in the Big Hill-Bear Mountain ridge, and then takes a winding course eastward across the Juniata Valley, into the Conococheague Creek and thence into the Potomac River. Vegetable remains found in the debris in the valley south of the mountains indicate that the region was once covered with forest of New World. Other tributaries from the south are relatively short and drain only small areas.

The advent of the Carboniferous period was marked by a new and continuous period of sedimentation. This was followed by a vast accumulation of fine silt and sand on the slowly sinking bottom of the shallow interior sea during Devonian time. The sand and silt were broken up by the movements of the continental crust, and a second cycle of erosion and deposition was started. The second cycle of sedimentation was followed by a new and continuous period of erosion and deposition, which continued until the end of the Carboniferous period. This cycle of sedimentation was followed by a new and continuous period of erosion and deposition, which continued until the end of the Carboniferous period.
The chief northern tributary of the Conewago in this area is Opossum Creek, which heads in the valley west of Bear Mountain, passes out of the mountains through a low gap near the north edge of the Quadrangle, and joins the main stream in the Gettysburg Quadrangle. Hemlock Run and Mill Run, which drain most of the northern part of the Gettysburg quadrangle, join the Conewago near its source. Mountain Creek, which heads in a deep, narrow valley in the mountains at the north edge of the Fairfield quadrangle, is a tributary of Yellow Brooms Creek, which joins Susquehanna River below Harrisburg. The northwest slope of South Mountain in the extreme northwest corner of the Fairfield quadrangle is drained by numerous small streams that flow into Conoconglet Creek, also a tributary of Susquehanna River, which joins at Oldскgard.
is followed by the road from Cemetery Hill to Little Round Top. (See pi. 11.) This ridge is lenticular in shape, and here also forms the edge of the diabase boulders that were used as barricades. The battle raged for about five days, the Federals using barricades of the same kind as described in the previous paragraph.

The Union forces occupied a similar elevated tract to the west, which they used as barricades. The battle raged for three days between troops occupying a similar elevated tract to the east, which was occupied by the Confederate forces. The battle raged for three days between troops occupying a similar elevated tract to the west, which was occupied by the Confederate forces.

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Distribution.—The metabasalt in South Mountain occurs in narrow belts which trend northeastward and extend intermittently from the south to the north side of the area. The wider belts, which occupy the western part of the area, become narrower toward the northeast, where the basaltic rocks have a more uniform tuffaceous character. In the eastern part of the area, the metabasalt is restricted to two narrow belts, east of the central part of the area, which is characterized by a tuffaceous felsite with scattered patches of basaltic rock. The metabasalt in the eastern part of the area is distinguished by its dark green color and its tendency to form thick, laterally extensive bodies. In the western part of the area, the metabasalt is characterized by its thinner, more discontinuous bodies and its tendency to form thinner, more discontinuous bodies. The metabasalt in South Mountain is characterized by its dark green color and its tendency to form thick, laterally extensive bodies. In the western part of the area, the metabasalt is characterized by its thinner, more discontinuous bodies and its tendency to form thinner, more discontinuous bodies.

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limestone areas just east of South Mountain, where they are also poorly exposed. In the limestone area at Fairfield County, Va., where it was first studied and is excellently exposed. According to Keith it is there composed of sandstones, arkosic schist, conglomerates, slates, and limestones. It has been traced along Catoctin and South Mountains in Maryland and Pennsylvania and is also well exposed in the Lebanon quadrangle. The formation is made up of large and small fragments of volcanic rocks, with vitreous quartz grains and pebbles in mosaic layers. Nearly all the fragments of volcanic rock are to be identified as fragments of tholeiitic and highly basic lavas. No fragments of mafic dolomite were recognized in the rock.

Character and thickness.—The oldest sedimentary formation in the area north of South Mountain is a series of gray and purplish feldspathic sandstones, quartzites, and conglomerates called the Weverton formation. Correlation of the formation was made on the basis of the presence of rare and minute fossils. The formation is composed of gray to purple feldspathic sandstones, quartzites, and conglomerates with numerous straight or curved, slender tubes, 6 inches long, and 0.060 inch in diameter, that form a concretionary hard conglomerate, which is composed of the lower conglomeratic sandstone.

Weverton Formation

Character and thickness.—Overlying the Loudoun formation throughout South Mountain area is a series of gray and purplish feldspathic sandstones, quartzites, and conglomerates called the Weverton formation. Good sections of the formation are few, and it is difficult to construct a complete correlation of the sequence of beds. The best place to determine the sequence and thus the thickness of the formation is at the north edge of Boulder Mountain, in the Chambersburg quadrangle, where the beds are exposed along the eastern edge of the State Park. In this area the formation is well exposed and is composed of gray to purple feldspathic sandstones, quartzites, and conglomerates, which form a sharp, well-defined contact with the underlying sandstone. The thickness of the formation is estimated at 3,000 feet, of which quartzite constitutes about 75 per cent in the greater part of the area. In the adjacent Chambersburg quadrangle its thickness is estimated to be about 1,200 feet. The Weverton formation is distinguished by its dip and width of outcrop at several places in the Fairfield quadrangle, and also along the north edge of South Mountain, where it was first studied and is excellently exposed. According to Keith it is there composed of sandstones, arkosic schists, conglomerates, slates, and limestones.
In the southwest corner of the Fairfield quadrangle and the adjacent part of the Chambersburg quadrangle the structure is well brought out by these parallel curved ridges and valleys. (See fig. 3.) Further north, on the west side of the river, the Mont Alto quartzite member forms two lines of knolls and ridges, due to two sandstone beds, which apparently enclose at the north the river. The largest mass of the formation is that which forms Big Pine Flat Ridge and the associated spurs in the northwest corner of the quadrangle. The thin, curving upper part of the formation occupies much of the Antietam sandstone. The writer regards the formation as synchronous with the Tornstown dolomite of the Fairmont quadrangle. The relations of the two quadrangles is shown in Figure 5.

The schist in the eastern part of the formation is more than 2,500 feet thick, of which the Hellam conglomerate member makes up about 500 feet thick. The Hellam conglomerate member contains the main mass of the hills in this quadrangle and is estimated to be 500 feet thick.

**Antietam Sandstone**

Character and thickness.—The Antietam sandstone is the uppermost of the mountains-making formations of South Mountain. It is a pure coarse-grained quartz sandstone composed of two distinct members—lower dense, resistant sandstone, in places bluish to pink, and an upper granular white or pinkish sandstone that forms Big Flat Ridge the lower schist of the Harpers sandstone.

In the southwest corner of the Fairfield quadrangle and the adjacent part of the Chambersburg quadrangle the structure is well brought out by these parallel curved ridges and valleys. The narrow area of the Antietam sandstone in the extreme northeast corner of the Fairfield quadrangle is part of a continuous band that forms the line of foothills almost all the way west of this part of South Mountain. The narrow area of the Antietam sandstone in the extreme northeast corner of the Fairfield quadrangle is part of a continuous band that forms the line of foothills almost all the way west of this part of South Mountain. (See fig. 6.) Another small area of the formation forms Green Ridge and associated small knobs and ridges in the valley of Mountain Creek, the north border of the quadrangle.

The narrow area mapped on the east side of Antietam Cove only fragments of the sandstone were seen on the lower slopes of the mountain, and the formation is probably either partly faulted or weakened by cutting and faulting. Pre-Cambrian fossils, limestones, and limestones of the Antietam are seen in the foot of the Pigeon Hills in the eastern part of the Gettysburg quadrangle. It forms the lower western spurs of the hills and two outlying foothills to the south, the Hosky Hills, which just enter the Gettysburg quadrangle. It overlies schist of Harpers type and schistosus-bearing Chickies quartzite, probably equivalent to the Mont Alto. The sandstone is fine-grained and elsewhere resembles the fine-grained sandstone of the Antietam on the west slope of Green Ridge, and it is therefore mapped as Antietam.

**Correlation**.—The Antietam sandstone is named from Antietam Creek, in the Harpers Ferry quadrangle, in the valley of which good exposures of the formation occur. In this there is a thickness of 600 feet. In the Antietam on the east slope of Green Ridge, the distance between the two is not far, but it is faulted, and probably faulted in part to the part in the story that pure sand was not everywhere deposited, but the character of the formation here described is identical with that of the Antietam, and its equivalence is established. It is known to extend continuously beyond the Fairfield and Chambersburg quadrangles. It is represented by the Antietam sandstone in the Antietam Cove, on the north side of Conococheague Creek at the west side of the Fairfield quadrangle, and in the foothills of the Pigeon Hills. These fossils determine the age of the formation to be Lower Cambrian.

**TOMTOMS DOLomite**

Character and thickness.—The Tomtown dolomite, the lowest of the formations of the Shermansdale group, in the Fairdield quadrangle gives a very incomplete idea of the composition of the formation, showing only coarse glauconitic gray dolomite. Fossils are common in the upper beds, but the lower beds are not fossiliferous. It is a fine-grained dolomite, composed largely of dolomite and limestones, with considerable sandy dolomite interbedded in the lower part. The dolomite is gray, with some darker gray streaks, and some of it has a yellow odor. The rock is fine-grained and contains a small amount of black chert.

On account of the relatively soluble character of the formation it forms a depression between South Mountain and an irregular line of low ridges and knobs of the Wonsadnock formation further out in the valley. Its thickness determined near Tomtown, in the Chambersburg quadrangle, is about 1,000 feet, and it is about 200 feet toward the south of the formation in Antietam Cove, in the Fairfield quadrangle. Distribution and surface form.—The Tomtown dolomite forms the valley floor at the foot of the Antietam sandstone ridges. Only five small areas of the formation are shown on the map. The largest area is a wedge-shaped area lying north of Antietam Cove. A small area in the extreme southwest corner of the Fairfield quadrangle is part of the larger belt of the formation that follows the foot of this part of South Mountain. The mapping of the small area in the valley of Conococheague Creek, the lower section of the valley of Wonsadnock, and the narrow area in the valley of Mountain Creek is based solely on the topography and the adjacent formations, and on the presence of pre-Cambrian fossils, in no localities are exposed at these places
Waynesboro formation

Character and distribution.—The Waynesboro formation is a series of grayish argillaceous sandstone, hard purple to red shaly shales, and minor limestones, which overlie the Tomstown dolomite and form a line of hills and knobs in the Lime-
stone Valley. The formation consists of two periods, the one east of the Triassic, and the other south of Bittinger. Each area lies between hills composed of Antietam sandstone and a semi­
circular line of hills of overlying shale. These upper shales and slabby sandstones are circular in character. These thick layers of shale and sandstone occur light-blue limestone and dolomite mapped as the Vintage dolomite. The formation is poorly exposed, as it

Kinzers formation

Character and distribution.—The Kinzers formation is at present classified as Lower and Upper, the former being excellently exposed in two parallel concentric ridges with a
circular line of hills of overlying Kinzers shale. The next traceable bed is a light-gray even-grained sandy dolomite that lies between Antietam sandstone and a fossiliferous Triassic limestone called the Vintage dolomite, which is poorly exposed, as it

Triassic conglomerate

Character and distribution.—Triassic conglomerate is known locally on the north border of the formation. They form the conspicuous hill of Billings, which indicates Lower Cambrian age and probable

Elbrook formation

Character and distribution.—The Elbrook formation is a soft shaly limestone, light-blue in color, which is well exposed in the vicinity of York. It is composed largely of interbedded soft red argillaceous sandstone and friable fine red sandstone, with numerous beds of gray, white, green, and buff sandstone, some of which are arkose. Locally there are beds of fine red conglomerate, conglomerate to black and green shales, rounded quartz-pebble conglomerates, thick coarse conglomerates composed largely of pebbles of quartz and Conglomerate, and in the southeastern part of the Gettysburg quadrangle. Two formations of this group are recognized in the Fairfield

Beekmantown (?) limestone

Character and distribution.—No fossils have been found in the limestone of this area, although the formation is known to be present in the vicinity of Lancaster, to the east, and which contains plentiful

Newark group

Character and distribution.—The Newark group in the Fairfield-Gettysburg area is com­posed largely of interbedded soft red argillaceous sandstone and friable fine red sandstone, with numerous beds of gray, white, green, and buff sandstone, some of which are arkose. Locally there are beds of fine red conglomerate, conglomerate to black and green shales, rounded quartz-pebble conglomerates, thick coarse conglomerates composed largely of pebbles of quartz and Conglomerate, and in the southeastern part of the Gettysburg quadrangle. Two formations of this group are recognized in the Fairfield

Keweenawan system

Character and distribution.—The Keweenawan system is a series of red conglomerates, from the vicinity of Conococheague and Elbrook and should be separated from the Beekmantown formation by a striking

Delaware formation

Character and distribution.—The Delaware formation is a series of red conglomerates, from the vicinity of Conococheague and Elbrook and should be separated from the Beekmantown formation by a striking
west and ranges in general from 10° to 35°, with an average of about 20°. Locally, adjacent to interfluvial basins, dips as high as 50° have been observed. The total thickness, computed from the dips and width of cuts, is about 25,000 feet. It is evident, however, from a study of the geologic map and Figure 6, illustrating the mode of deposition, that at no one place does this thickness of stones occur. The sediments were deposited in a top, narrow basin that pro-

gressively deepened westward, the first deposits being laid down only in the eastern part of the basin and later deposits spreading progressively farther west. Only a small part of the total thickness of sediments should therefore be found at any one place.

**Table:**

<table>
<thead>
<tr>
<th>Formation</th>
<th>Thickness (feet)</th>
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<tbody>
<tr>
<td>New Oxford</td>
<td>6,900</td>
</tr>
<tr>
<td>Stockton</td>
<td>3,500 to 4,000</td>
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<tr>
<td>Pottsville</td>
<td>2,500 to 3,000</td>
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**Character and thickness:** The New Oxford formation is composed of red shale and sandstone containing many beds of light-colored micaceous sandstones, arkoses, and conglomerates, which distinguish it from the overlying formation. In the lower 6,000 feet conglomerates are abundant, and the rest of the formation is characterized by a variety of sands and shales. The upper formation of the sequence is made up of fine-grained sandstone, and the underlying formation is composed of coarse-grained sandstone.

**Approximate total thickness:** 9,600 feet

**From the fact that in New Jersey there are numerous strike faults which repeat strata, it is evident that the upper member of the formation, which is generally thicker than the lower member, may be considered as having been deposited in a series of short distances to the southwest.** It is a hard resistant rock forming hills around Philadelphia and parts of the uplands of New Jersey and New York. The sediments were deposited in a top, narrow basin that progressively deepened westward, the first deposits being laid down only in the eastern part of the basin and later deposits spreading progressively farther west. Only a small part of the total thickness of sediments should therefore be found at any one place.

**New Oxford Formation**

**Character and thickness:** The New Oxford formation is composed of red shale and sandstone containing many beds of light-colored micaceous sandstones, arkoses, and conglomerates, which distinguish it from the overlying formation. In the lower 6,000 feet conglomerates are abundant, and the rest of the formation is characterized by a variety of sands and shales. The upper formation of the sequence is made up of fine-grained sandstone, and the underlying formation is composed of coarse-grained sandstone.

**Approximate total thickness:** 9,600 feet

**From the fact that in New Jersey there are numerous strike faults which repeat strata, it is evident that the upper member of the formation, which is generally thicker than the lower member, may be considered as having been deposited in a series of short distances to the southwest.** It is a hard resistant rock forming hills around Philadelphia and parts of the uplands of New Jersey and New York. The sediments were deposited in a top, narrow basin that progressively deepened westward, the first deposits being laid down only in the eastern part of the basin and later deposits spreading progressively farther west. Only a small part of the total thickness of sediments should therefore be found at any one place.

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occur in valleys between the hills of conglomerate and are deeply covered with the middle or at least 5 inches. They are largely composed of light and dark gray to pink fine sand, silt, and alluvial fan of coarse unsorted material derived from a gorge in the mountains on the west. The conglomerates pass into limestone conglomerate. The Arendtsville fanglomerate begins at the southwest corner of the area but in general is too thin for quarries east of Fairfield, where at most 20 to 25 feet is present. Some conglomerates contain limestone pebbles that have been altered some of the strata to hard white porcelainite. Most of the observed conglomerates consist of limestone pebbles, the mountain streams evident elevations on the wa...
given the same name Gettysburg, from the town of that name where deposits of significant extent and thickness are mapped, although one dike has been traced into the pre-Cambrian rocks in the northwest corner of the Gettysburg quadrangle. The local name of this sandstone is Beulah sandstone, but it is also called "basal sandstone.

The dikes and thin sills are dark and dense throughout and are coarsely foliated at their contacts, some of the rock being so fine that its igneous character is not easily detected even with a hand lens. Some of the thin sills have a finely veined structure, and the thin sills have a finely veined structure.
Gatnsburg sill.—The main body of diabase in the area is a large sill which crosses the Gettysburg quadrangle from its southwestern to its northeastern corner. It has a general thickness of about 1,500 feet, and a width of about 10 miles, which widens at the north to 20 miles. The sill dips northwestward, with the included section of the intrusive mass in the upper part being about 20° in the Gettysburg Battlefield. For 5 to 8 miles through Newcouch the outlines of the sill are straight and its width remains uniform, but toward the southwest the outlines become tortuous and the width increases. This change is not due to folding of the including strata but apparently is largely caused by the crossing of the intrusive body to higher horizons, as is shown on the geologic map by the higher position of the sill in the Gettysburg shale toward the southeast. The offsets of the sill near Rocky Grove School, east of Gettysburg, are apparently due to cross faulting. At the northeast, where the outcrop of the sill widens to 21 miles, the base of the sill remains at the same horizon and the upper surface apparently does not change, the widening being probably due to the elimination of the covering body higher where the sill is wider, and the strata on opposite sides of the crossing body southeast of Heidlersville do not match but are offset.

Middle Creek crosscutting body.—Of the several crosscutting bodies which have been identified, the sill of the Gettysburg sill is the most extensive and relatively thick, that is, of laccolithic habit and the limestone is exposed beneath the horizontal overlapping Triassic sediments north of Chestnut Hill. This limestone is overlapped by the nearly horizontal contact between the overlapping Triassic sediments and the Paleozoic limestone floor. This relation is more convincing. For 3 miles along the creek valley northward, which extends northward as far as Orrtanna, terminating abruptly about 1 mile east of that place. It is about a mile thick through its entire length of 8 miles. Several small dikes break from it at right angles toward the solantoliths. One of these dikes is partly altered to a sill of the sill. The crosscutting body is to the north of the sill, which forms a sill along the contact of the gently over­lapping Triassic sediments, and the Paleozoic limestone floor. This relation is well shown in the detailed broken mass resting on the free surface of the sill. This is apparent on the western side, as well as in the northern part of the Gettysburg quadrangle. Nearly all of them can be traced to some larger body with which they are connected. The northwest end of this sill is a maximum width of about 11 miles.

Still at western overlap contact.—Northwest of Gettysburg the west side of the intrusive mass takes the form of a sill along the nearly horizontal contact between the overlapping Triassic sediments and the Paleozoic limestone floor. This relation is well shown in the detailed broken mass resting on the free surface of the sill. This is apparent on the western side, as well as in the northern part of the Gettysburg quadrangle. Nearly all of them can be traced to some larger body with which they are connected. The northwest end of this sill is a maximum width of about 11 miles.

Another dike, which extends many miles into Maryland, enters the Gettysburg quadrangle at its southwestern corner and forms a prominent ridge which extends from the base of Gettysburg, and is about 50 feet thick at the southwest of Gettysburg sill, and represents a still later erosion of the molten magma from which it is formed. This sill is about 1,800 feet and a width of outcrop of 1 mile, which is the base of the sill remains at the same horizon and the upper surface apparently does not change, the widening being probably due to the elimination of the covering body higher where the sill is wider, and the strata on opposite sides of the crossing body southeast of Heidlersville do not match but are offset.

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localities in the Atlantic States have been analyzed, and some of the variety with abundant olivine. These varieties have not been separately or anorthosite, consisting chiefly of plagioclase; (3) quartz diabase, with above, we may name additional varieties as follows: (2) feldspathic diabase, pyroxene phenocrysts, with only here and there a large feldspar crystal, quartz were the last to crystallize, first in micrographic intergrowth, where crystallization. (2) In the fine-grained contact facies of the larger masses rock it is evident that the crystallization of the plagioclase was generally sills show all gradations to typical basalt with glassy groundmass. In the fine-grained and aphanitic varieties, on the other hand, the texture other minerals occupying the interstitial spaces. Where the pyroxene shaped crystals of plagioclase lying in all directions, with pyroxene and they contain in places much hypersthene or olivine, or both; in the lighter-bodies has as a rule a coarse grain and a color ranging from light gray and united in a similar manner at no great depth. The diabase of the larger 5. Aplite, Goose Creek, Va. Analyst, E. V. Shannon (U. S. Nat. Mus. 46.87 60.05 1.40 37 1
   Quartzoi 19 19
   Biotite 12 12 1
   Magnetite 8 8 8
   Oxygen 8 8 8 46.87 60.05 1.40 37 1
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Closely compressed syncline incloses Tomstown dolomite, and it will be called the Hosack syncline. The syncline rises by faults from Wildcat Hill northeastward far beyond the edge of the Fairfield quadrangle. The Hosack syncline is the most marked offsets in the mountain front in this region.

The massive rhyolite floor of the fault dips 40° SE., and remnants of the Cambrian quartzite which is overthrust on it are shown in Plate 14. The rhyolite is very massive, but another anticline is indicated by the rise of the quartzite at Buzzard Peak. This fold may be called the Buzzard Peak syncline, inclosing Antietam sandstone and Tomstown dolomite, but this is not likely, because all known folds in this part of the Appalachian region are overturned southeastward.

The syncline is cut off on the northwest by two faults, one of which is an overthrust fault where the syncline was thrust westward against the Rupp Hill anticline. The other fault is represented by the narrow bands of sericite schist and quartzite which form a line of high knobs near the east edge of South Mountain. The quartzite which is overthrust on it are shown in Plate 14. The rhyolite is very massive, but another anticline is indicated by the rise of the quartzite at Buzzard Peak. This fold may be called the Buzzard Peak syncline, inclosing Antietam sandstone and Tomstown dolomite, but this is not likely, because all known folds in this part of the Appalachian region are overturned southeastward.

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The tendency, therefore, was for the rocks south of Conococheague Creek to move bodily westward past those that were blocked by the Big Flat Ridge butts against north of the creek, resulting in a great shearing movement that produced the Conococheague Creek fault. The strata were first sharply flexed along this line and then broken and offset along a nearly vertical plane, the strata on the south moving 2 miles or more to the west of those on the north. The axis of the Big Hill-Bear Mountain anticline was shifted to Stongy Ridge, the Weverton sandstone of Piney Mountain to Rocky Mountain, and the Big Flat Ridge anticline to the limestone from Ausa through New Franklin and from Aula to Clay Hill.

**Normal faulting.**—The belt of Triassic rocks is bounded on the west by a normal fault or chain of faults. Nowhere was this fault plane or even the contact between the Triassic and the adjacent rocks observed, for the conglomerates that compose most of the western border of the Triassic are largely unconsolidated at the surface. The fault is established by several criteria. (1) Gently folded intrusive sills forming crescentic hills (near the alluvial fan of Orrtanna, the larger sheet south of Mount Royal) are normally aligned along this line; (2) nowhere in the area do the Triassic rocks overlap and rest on the pre-Cambrian rocks west of this line, but they terminate abruptly at the foot of steep slopes of these rocks; (3) the conglomerates and coarse sediments adjacent to the mountains are not composed chiefly of fragments of pre-Cambrian rocks, as they would be if they were derived from the rocks exposed hundreds of feet higher on the adjacent slopes, but in most places they are made up of Cambrian quartzite and sandstone and in other places of Cambrian and Ordovician limestones, showing that when they were deposited the adjacent slopes were composed respectively of quartzite and limestone; (4) the Paleozoic limestone floor on which the Triassic sediments rest south of Orrtanna, near York Springs in the Gettysburg quadrangle, and presumably elsewhere throughout the Triassic basin, now stands at the foot of mountains composed of pre-Cambrian rock, whereas formerly it was continuous with the limestones which was on top of the pre-Cambrian and Cambrian rocks and from which the Triassic limestones conglomerate was derived. (See Fig. 15.) The limestone floor has therefore been dropped an amount equal at least to the thickness of the Cambrian alluvial sediments and the rocks west of it. The height of the present mountain above the plain, probably more than 6,000 feet.

**FIGURE 14.** Sketch map showing the theoretical restoration of the folds in the Conococheague Creek shear fault. The restored Cambrian sandstone passes beneath the limestones at Conococheague Creek. These overlapping limestone beds are perpendicular to the bedding and do not resist enough to stop the westward movement of the rocks. (See Figs. 15, 14.)

The rock plane follows the valley of upper Marsh Creek across the low divide near Newman School and down the valley of Conococheague Creek as far as the ridge formed by Conococheague Creek on the west. The Cambrian at this point is cratered and rotated about 5°. The unperceived normal northward dip suggests at first that the apparent axis of the Cambrian basin passes along an axis that is uniformly straight for long distances, and that the dip is so uniform—make this explanation untenable. Beyond doubt the inclination of the Cambrian rock is not the same as that of the Belding Hill-Bear Mountain thrust fault, which is much more steep. This is the fault plane that was laid down and is not that of the original sedimentation.
stands South Mountain, an unknown extent of the region to
and occupied by a shallow arm of the sea, while the land still
grains and rounded quartz pebbles, which formed the upper
of the Loudoun formation; then, as the height of the land
inhabited by crustaceans and simple forms of life, whose
epochs. During these epochs the sea was shallow and was
quartz sand to fine argillaceous sand. Alternating slight uplift
preserved in the rocks. Marine worms burrowed in the sand
forming the thick calcareous deposits that constitute the Shen-
other parts of the Appalachian Valley province. They com-
the Fairfield-Gettysburg area, for it had been uplifted in Ordo-
the later part of Paleozoic time, and a great volume of sediment,
较长的时期内形成，它使沉积物层次分明，可以清楚地看到沉积物的原始状态。

Cambrian and Ordovician lime deposit
Long before the end of Lower Cambrian time the deposition
and clay was succeeded by that of cherty siliceous dolomite in
shallow inland sea that covered this area, and sedimen-
other parts of the Appalachian Province. They com-
the southeast corner of the Gettysburg quadrangle
the sea floor was uplifted slightly
the western margin, but that the latest deposits

Cambrian and Ordovician lime deposit
The sea covered the Cumberland Valley and a large part of
the interior of this area was occupied by a shallow sea
during the later part of Paleozoic time, and a great volume of sediment,
chiefly argillaceous and siliceous, was deposited over that area
and in now restricted lakes and bays and sand-
newly deposited sediments, which
were, however, not greatly deformed by this early uplift, and in
and in some parts of the region deposited.

Post-Carboniferous folding and faulting
Carboniferous sedimentation was terminated by great moun-
tain-making movements, which affected the whole Appalachian
area. Local uplift, mostly of a minor character, accompanied
by slight folding and erosion of the sedimentary rocks, had
occurred earlier in Paleozoic time, chiefly in the eastern
part of the region, and had caused local irregularities of depo-
sition, overlaps, unconformities, and absence of the later sedi-
ments along the eastern margin of the sea, but most of the
incised valleys themselves were filled by the newly deposited
sediments so that the strata of the later periods of sedimentation
were exposed only in this highland. The torrential rains
constantly washed down alluvial mud, pebbles, and fine sand,
which were washed into the sea and deposited on the
bottom of the basin.

Accompanying the faulting and probably in part preceding
it was the inversion of large quantities of molasse rock into the
Trisassic sedimentary beds. In eastern Pennsylvania and New
Jersey some of the molasse rock reached the surface as large
Deposition of sand and clay was succeeded by that of cherty
siliceous dolomite in a shallow sea, and then by that of cherty
siliceous limestone in a deeper sea. During this latter period
the sea floor was uplifted slightly along a series of fault lines
that formed a nearly continuous line. The Protecting of the
part of South Mountain lying to the northwest of the
Fairfield-Gettysburg area was uplifted so much that the terrestrial rains swept
from it into the basin large amounts of course and poorly
As the molasse rock was being deposited, a great volume of siliceous mud,
which was derived from the decomposed siliceous rock of the land
edges of all the older limestones. Its impurities consist of
many of the purer beds are made up almost entirely of the
chiefly argillaceous and siliceous, was deposited over that area
and in now restricted lakes and bays and sand-
stone. Past beds, now changed to coal, were included among
the deposits of the Carboniferous period and form the coal beds
recently discovered in the region. During the Carboniferous
the concretions that dot the thick concretionary beds of the
Fairfield-Gettysburg area, for it had been uplifted in Ordov-
ices, and it was at times so shallow that the bot-
tom was in part covered by algae, as indicated
by the irregular bedding and ripple marks in some of the beds.

Ordovician carbonaceous lime deposit
In the Cumberland Valley, west of this area, marine con-
ditions continued to the end of Ordovician time, but the
sediment changed from lime silt to dark carbonaceous
The southeastern margin of the sea floor was uplifted slightly
at about this time, and the newly deposited sediments were
were eroded, for the impure Conostoa limestones deposited
at this time in the southeast corner of the Gettysburg quadrangle
and the region to the east overlie unusually the eroded edges
of all the older limestones. Its impurities consist of
dark argillaceous matter similar to the dark clay deposited to the
northwest and probably come from the same source.

The carbonaceous silt probably came from older beds to the north,
where undecomposed organic matter was brought into the
sea, broken into small flat fragments by the returning waters,
and then precipitated by algae. It was at times so shallow that the bot-
tom was in part covered by algae, as indicated
by the irregular bedding and ripple marks in some of the beds.

Cambrian and Ordovician sand and silt deposit
At the beginning of Cambrian time the area where
stands South Mountain, an unknown extent of the region to the
southwest of it, was occupied by a shallow sea, and the land still
was elevated. Sedimentation was chiefly in the form of clay and
silt, with a minor amount of sand. The source of the detritus
was likely to the northwest, so that the newly deposited sediments,
which were washed into the sea and deposited on the
bottom of the basin, were stained deep red by iron oxide from the
weathered rock. Haury rains washed the detritus into the basin, where it
accumulated in large part in standing water, for beds of sand
alternated with beds of shale, the layers showing, little or no
sedimentary structure.

The erosion and removal of the sediment left South Mountain,
the peak of the highland, and the adjacent low areas.

During this period of erosion the adjoining low areas were
gradually worn down and occupied by a shallow sea, and the land
continued to be a small hill or low ridge. Apparently only
the land to the northwest of the highland was occupied by a shallow
sea, and the land to the south was elevated and occupied by a
shallow arm of the sea, while the land still
was elevated. Sedimentation continued chiefly in the form of clay and
silt, with a minor amount of sand. The source of the detritus
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sedimentary structure.
of the land in the Appalachian Highlands was largely reduced by weathering and stream erosion to a rolling peneplain which sloped gently toward the sea and toward the major drainage lines. Some of the usually massive resistant rocks in the upturned bed of the sea were not entirely worn away but remained above the plain and now form some of the highest mountains of the region. Where the surface passed beneath the sea it was placed off by marine erosion and received a covering of sediments from the sea brought by the streams. In early Cretaceous time the surface of the plain adjacent to the sea sank gently, so that marine deposits lapped successively farther inland and a great thickness of debris wearing down the surface of the land continued until there was renewed uplift in middle Cretaceous time, which revived active erosion, and the streams began to cut their channels into the newly formed peneplain.

This peneplain can now be seen where it emerges from beneath the Lower Cretaceous deposits in New Jersey, eastern Pennsylvania, and Maryland. Its surface formerly rose gradually inland but is now much dissected, the parts composed of softer rocks having been entirely removed and the portion cut on the hardest rocks having kept their original elevation. A remnant of an old peneplain surface preserved on the upturned beveled edges of quartzite beds composing the top of Kittatinny Mountain in New Jersey and Pennsylvania, now 1,700 feet above the sea, is believed to represent this stage of peneplanation, and this surface has been named the Kittatinny peneplain.

In the Fairfield-Gettysburg area the Kittatinny peneplain is believed to be represented by the higher flat parts of South Mountain at an altitude of 1,800 to 2,000 feet. The nearly even sky line of Green Ridge at 1,800 to 1,900 feet and the head cross of Big Flat Ridge at 1,900 feet apparently represent the surface where it was reduced nearly to a plain; the higher flat tops of South Mountain and of Big Pine Flat Ridge, which are over 2,000 feet above sea level in altitude, probably represent portions of the surface that were not completely reduced to the peneplain level because they are composed of flat-lying resistant red sandstone. Cambrian quartzite. The same smooth surface is preserved on North Mountain and associated ridges west of Cambrian Valley at about 2,000 feet.

The profile across the Fairfield and Gettysburg quadrangulas (see fig. 17) shows a remnant of the Kittatinny peneplain on the tops of South Mountain at 1,900 to 2,000 feet. East of South Mountain the highest peneplains remnants are 1,900 feet on the top of the Pigeon Hills in the eastern part of the Gettysburg quadrangle. Isolated higher peaks seem to be remnants of a still higher peneplain, possibly at 1,400 feet. This altitude is considerably lower than that of the Kittatinny peneplain on South Mountain, and if they represent the same peneplain it has apparently been faulted since its formation and uplifted. If such is not the case it will be necessary to place the Kittatinny peneplain extended over this area at an altitude of about 1,900 feet, the Triscian basin must have been filled to this level, and 900 feet higher than the undisturbed Cambrian formations. If this is the case it was covered by later sediments which have since been removed. The evidence therefore indicates that the peneplain has been faulted.

In early Cretaceous time the great trunk streams of the region, the Potomac, Susquehanna, Schuylkill, and Delaware, flowed across the Kittatinny peneplain toward the sea in open valleys with gentle gradients. In middle Cretaceous time renewed uplift tilted the land surface toward the sea and caused these trunk streams to flow directly down the gentle slope as consequent streams and to cut channels into the rocks beneath the mantle of disintegrated material on the surface of the plain. Ever since that time they have flowed in valleys that cross the rock structure and have cut their channels deeper and deeper as the land has risen. In the harder rocks their channels are in deep, precipitous gorges, and through ridges of resistant upturned quartzite there are narrow rock gaps, such as at Harpers Ferry.

Late Cretaceous Erosion and Peneplanation

A second brief halt in the uplift of the continent is indicated by a plain cut on somewhat softer geologic rocks around the South Mountain Summit and now standing at an altitude of about 1,600 feet. This plain may also be represented in the rounded summit of Big Hill, similarly dissected. For this reason on which are preserved the pre-Cambrian rocks in the hilltops east of Green Ridge and in many level benches within the mountains, notably in Buchanan Valley. Just south of the Fairfield quadrangle the Montgomery gulf links, based on this high, a terrestial altitude of 1,200 feet, have a rich well of deeply dissected depressions, including prolonged waterless weathering. Undoubtedly these benches are remnants of a broad rolling plain which was formerly extended across these valleys and above which rose the upturned ridges of resistant rocks, which probably represents erosion during the later part of Cretaceous time. It has been called the Westover peneplain, from its development on a broad alluvial fans near Westover, Md., at about 1,200 feet.

This plain is believed to have been faulted in the same manner as has been postulated for the Kittatinny peneplain, to be represented east of South Mountain by hilltops and benches at about 1,000 feet, and to pass beneath Upper Cretaceous sedimentary rocks east of Baltimore.

The Devon Reservoir, a topographic feature of considerable local interest in South Mountain, seems to have been determined by this peneplanation. It is a broad, flat-bottomed, steep-sided valley between parallel Cambrian quartzite ridges and was apparently the course of a well-graded stream at the level of the Westover peneplain. The stream had cut the hard quartzite into softer rocks beneath, in which it had created a flat-bottomed valley of gentle grade. Large masses of Cambrian quartzite derived from the adjacent cliffs accumulated on the valley floor once the water had been washed away, leaving the level plateau with bare hollows in the flat bottom of the valley. (See pl. 24.)

Early Tertiary Erosion and Harrisburg Peneplanation

The Cretaceous period was terminated by renewed uplift of the Appalachian Highlands, with filling of the surface toward the sea and the increased activity of the streams. During the quaternary epoch that followed this uplift, in early Tertiary time, the streams were gradually lowered to a new low level and the harder rocks were removed and some were partly worn down. The plain at this new lower level was especially well developed on the limestone and soft shale of the Appalachian Valley across Pennsylvania, Maryland, and Virginia. Between Harrisburg and Lebanon, Pa., this peneplain is now preserved in the plateau-like shale hillslopes. It is as well shown in the flat-topped hills at 560 to 600 feet back of the city of Harrisburg for it has been named the Harrisburg peneplain.

The streams of the Cretaceous genera were probably established approximately in their present position on the rocks of the peneplain, and when this plain was uplifted they became incised, so that their winding courses have become fixed in position, although slightly modified in shape in later times.

Quaternary Erosion

Since the formation of the Bryn Mawr peneplain the region has been again uplifted and tilted toward the sea. The steps in this uplift are well shown by the records preserved on the Coastal Plain of Maryland and comprise four periods of elevation, each followed by a period of quiescence or slight sinking. After each of the periods of uplift broad benches were cut into the rocks by the waves of the sea and of the estuaries, and these benches were covered by gravel, sand, and silt and are preserved today as gravel-covered terraces bordering the present level at successively higher levels. These terraces are well defined along the edges of the main streams and their tributaries above the mouths of the gorges and are recorded in portions of the region by plains and benches cut in the soft rocks. The remains of these benches or terraces along the streams are largely covered by stream gravels.

In the Fairfield and Gettysburg quadrangulas gravel-covered terraces occur along the present streams, but the region is so distant from the master streams, the Potomac and Susquehanna, that the different levels which correspond to the quater­ nary periods between the uplands can not be recognized. The highest gravel of this character is 60 feet above the present stream level, but this area has probably been elevated more than 200 feet since Bryn Mawr time. The streams emerging from the uplands cut to a new low level and have narrow, steep-sided valleys where they pass through harder rocks but in the softer rocks have widened their valley into broader and covered plains. This is well shown by Conewago Creek, which has a narrow gorge where it passes through the hard diabase sill at Newchurch and a broad flood plain on the soft Triscian sandstones above and below. This creek also illustrates the increased windings which a stream assumes as it cuts deeper into the plain and for its former shorter course being represented by the gravel-covered rocks of land on the inside of the oxbows. East of Waldron the Conewago is so rapidly cutting its right bank that before long it will undoubtedly sever the narrow neck of land and follow a short cut, abandoning the long loop past Hater Mill.
ECONOMIC GEOLOGY

The mineral deposits known to occur in the Gettysburg- 
Fiddletown area are iron ore, copper, asbestos, slate, 
greenstone, limestone, and granite. The deposits are in 
sandstone, limestone, and slate. The quartzite of the 
area is separated from the limestone by a fault.

The iron ore is found in the Caledonia and Cem- 
trum Creek belt within the Fairfield quadrangle, 
but its thickness is not known. The ore is probably 
found in a belt of deposits that extends from Littlestown eastward beyond 
the Chilesburg quadrangle. The quartz- 
ite surface of the underlying less permeable limestone, slowly dis- 
covered by solution and erosion. Most of the brown iron ores along the 
valley and were in large part formed during Tertiary epochs 
which occupy benches above the general level of the limestone 
that just enter the east side of the Gettysburg quadrangle.

Small quantities of specular hematite are associated with 
quartz veins in the pre-Cambrian volcanic rocks of South 
Mountain, and a little is also associated with the copper de- 
posits in the pre-Cambrian rocks. Most of the hematite in the area show a small amount of hematite.

The quartz vein at the head of Buchanan Valley contains an 
unusually large quantity of hematite and has been pros- 
cpected at Col's ore bank, 2 miles north of Stevenson School. Although solid chunks of good ore of the size of a man's fist are 
found, the quantity is not sufficient to be of commercial value. The vein seems to mark a fault between schistose rhyolite breccia and schistose mica-schist and just hematite is found along it and in the associated associated basalt-bearing greenstone to the north.

Good showings of hematite are present in quartz veins on the hill 1 mile west of Caledonia, which marks a fault. Hematite is also present in the pre-Cambrian quartzite of the Virginia Mountains and north of Marshall, which is believed to be 
the outcrop of a similar formation. At the west base of the Pigeon Hills, massive specular hematite is in red jasper, and one ore of fine grade, was 
found associated with the quartzite at the fault contact. It extends southwest from Mountain Home, and in the pros- 
cpects east of Jack's Mountain, but the quantity is too small to be of value. A little is also associated with the copper- 
iferous rhyolite breccia in the prospect 1 mile east of Fairfield.
MINERALS

General occurrence.—Extensive deposits of magnetite occur in the Triassic rocks of the adjacent Carlisle quadrangle near Dilliberg, Pa., and at Cornwall, Pa. For a distance of one mile along the economic-geology relations in parts of the Fairfield-Gottsburgh area are closely similar to those at Cornwall and Dilliberg, and it is not impossible that similar rich deposits exist in this area for only a few small workable deposits have been found, and none are at present (1927) being mined.

Mining industry.—The only deposits that have been worked to any extent in the area lie just west of Fox Hill, a little over a mile from Cornwall. The location of the two formerly active mines, the Peter Comfort and Adam Minter mines, as well as the other openings, is shown on the economic-geology map.

Nature and origin of the ore.—Magnetite is a conspicuous mineral in much of the diabase intrusive in the Triassic sediments. The soil in the roads cutting the diabase hills contains much magnetite, which was derived from the disintegration of the diabase and has been concentrated in the cracks and xenoliths of the surface water. Some masses of diabase are more highly charged with these crystals of magnetite than others, that of the Cornwall area the richest of all. None of the diabase, however, has sufficient iron to be classed as ore.

The known deposits of magnetite in this area are in Triassic sedimentary rocks immediately adjacent to diabase and were evidently produced by the process of direct replacement of sedimentary rock by the intrusion. In the Cornwall mine magnetite has replaced Pekovitic limestone at the upper contact of interbedded diabase slates. In the Dilliberg mines the ore is largely due to replacement of limonite pebbles in a calcareous breccia in the Triassic sedimentary rocks at the outer contact of a diabase sills. Details of these occurrences and an explanation of the origin of the ore are given by A. C. Spenard in a report on the magnetic deposits of the Cornwall type, and by E. C. Hester in a report on the magnetic deposits at Dilliberg. Spencer concludes that the ore bodies are formed by chemical solution of the pseudomorphous carbonate and are not a common variety of greenstone and also because the resulting fragmentations of the ore are those of iron. It is called piedmontite and is not a common occurrence in the Cornwall area of greenstone from the Chambersburg pike southward beyond the Maryland State line, and numerous prospects have been opened at the present time. None of these have been found on the surface almost continuously between these prospects. Only a few tons of ore has been shipped from any of these operations, although the magnetite deposit has been carried on in some, stock companies have been organized, and a furnace was constructed on Copper Run to smelt the ore. None of the openings are known clased as mines.

Origin of the ore.—The copper is believed to have been previously dissolved in the lavas in the form of sulphide and to have been concentrated and reduced to native copper in the process of metamorphism of the rocks inAlgonkin time. These old rocks, while they were deeply buried beneath the earth, were intensely compressed and heated during the orogeny and upheaval in Algonkin time, and the ore minerals were greatly altered in form and composition. The water in the rocks became heated by the intense pressure and heat from the interior and provided a reducing agent which circulated through the earth's upheaval in Algonkin time and were greatly altered. The relations observed in the Bingh- men Iron ore are those of iron ore in the Pennsylvania greenstone. At the northwest foot of Sugarloaf the fields are so filled with iron ores in the Harpers schist hills in the southeastern part of the Gottsburgh quadrangle, but not in sufficient quant­ity to be mined separately from the iron. Manganese ore, which is so abundant in this area, is found in the rhyolite near the greenstone contact at two places on the west side of Buchanan Valley, northwest of Roaring Spring. Their location is shown on the economic-geology map. The mineral has not been seen in bedrock at these places. The abrasion quality of the granite has not been tested.

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of volcanic rocks, and the location of the most prominent outcrops is shown on the corresponding map. The veins are generally associated with soft argillitic schist, which weather readily to loose residual masses of the quartz–feldspar suite of the surface. The veins are 1 to 2 feet thick, and masses several feet long are uncommon.

Quartz veins are more plentiful in the Chambersburg pike than south of it and are especially numerous at the north end of the field. Here the quartz masses formed the barricades used by both armies during the battle of Antietam. The quartz veins are especially numerous at the north end of the field, and in the later part of the nineteenth century. Most of the high-grade stone from the Conestoga limestone in New England and from New Jersey and eastern Pennsylvania. Some thick beds of Triassic sandstone in the Fairfield–Gettysburg area were quarried locally for building, and many of the historic houses around Gettysburg and hotels and homes on the Chambersburg pike and other well-known highways were built of this rock. It was also used extensively in old arch bridges. (See pl. 20.)

The local rock is of an attractive rich reddish-brown color and is locally known as "Gettysburg granite." Because of its generally dark color it is somewhat somber for building stone, but it makes a very substantial structure. It is extensively used in Gettysburg as basement stone in retaining walls, curbs, gutter and curb stones, steps, and monuments and as rubble in foundations. Several buildings have been constructed of it.

The diorite in the vicinity of Gettysburg has a well-defined grain and texture, so that dimension blocks of wearing smooth surfaces and of uniform size can generally be quarried. Disease resists weathering about as well as granite and is not so badly affected by fire. Some of the steam stones that have been quarried also have similar qualities. Close to the mountains the stream gravel is generally too coarse for roads and concrete. Sand that is taken from the stream terraces and alluvial deposits along Conewago Creek is extensively used for gravel cemented but where disintegrated is suitable for concrete and dressing planes and expands when it freezes, creating thin sheets to scale from the bedding surface. Some layers of terrane to grains under the weathering process this weathering seams to affect the sand more noticeably than the rough dressed, and buildings made of the recently formed dress rock in time become rough surfaced and scarred by scaling, so that the stone has gradually become less popular and is used very little at present.

The thick beds of red or brown building stones occur chiefly in the Heidelberg member and the upper part of the Gettysburg group. The upper beds of this member are more coarse-grained and contain more iron oxide than the brown sandstone, occurs chiefly in the New Oxford formation. Large blocks of fine-grained stone for stone construction were quarried 1 mile west of Gettysburg, and foundations for dwellings are obtained at several small quarries near Gettysburg and New Oxford. A third small area occurs in the vicinity of Gettysburg and on the Fairfield quadrangle. The sand and gravel beds near Gettysburg have been extensively used for red and dark-colored tiles. Florida ball clay or some other plastic clay is used in the trade as "Gettysburg granite." Because of its generally dark color it is somewhat somber for building stone, but it makes a very substantial structure. It is extensively used in Gettysburg as basement stone in retaining walls, curbs, gutter and curb stones, steps, and monuments and as rubble in foundations. Several buildings have been constructed of it.

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ing the more massive beds are used in walls, fences, and monuments. Some quartzite is popular in the construction of summer homes or brown color. Irregular quartzite blocks obtained by quarrying have been produced by the United States quarry, on the southeast side of Gettysburg, southwest of Wolf Hill. Blocks of various lengths, 6 inches to 1 foot thick and 1 to 2 feet wide, were produced by the quarry of the McAllister Co., near the Baltimore Pike, 1 mile south of Gettysburg. Joshua's quarry, on the north side of Wolf Hill, 1 mile south of Gettysburg, was first worked for building stone but later furnished crushed stone for the Government roads of the Gettysburg reservation. R. F. Lightner's quarry, on the southeast side of Powers Hill, 2 miles south of Gettysburg, was worked for building stone and furnished the large-dressed stone used in the walls around the National Cemetery in the Gettysburg Military Park. Slabs suitable for gutter and curb stones have been quarried by the United States. Some stone has been used for building houses in the villages along the Chambersburg pike, 2 miles northwest of Arendtsville. The rock is hard and durable and breaks into irregular angular fragments but does not bind readily. Some of this rock is used for foundations. Similar rock material was also obtained from Joshua's quarry just east of Stills Station. The rock in this quarry is a dense dark-blue, greenish, slate-like sandstone. The rock is hard and durable and breaks into irregular angular fragments but does not bind readily.

In the southeastern part of the Gettysburg quadrangle the impure upper limestone of the Coxsackie formation was quarried at McSherrystown and at several other places southwestward toward the present axis of the Triassic diabase. A spar and for ballast on electric and steam railroads. Dolomite and limestone interbedded with the high-limestone formation are quarried for cement, and in the vicinity of Gettysburg are extensively used for road materials. Descriptions of these quarries are given under the heading "Limestones." The binding quality of the limestone is superior to that of most other kinds of rock. A sprinkling of asphaltic binder on the surface of any kind of rock, however, improves its binding qualities and makes it water-proof and more enduring.

In the southeastern part of the Gettysburg quadrangle the light-gray rock of the hill south of Butternut is especially useful for railroad ballast, as it naturally breaks up into cobble-size fragments and is conveniently located on the railroad. How it is used at the surface and to considerable depth. It might also serve for the first course of a foundation of masonry pavement. Similar broken quartzite occurs on the surface of the sandstone hills just east of Butternut.

**RLYRHODONITE**

Rhyolite, slate, and sandstone are quarried in the Gettysburg quadrangle. Rhyolite is especially useful for railroad ballast. Sandstone is used for building houses in the villages along the Chambersburg pike, and is extensively used to line limeworks, for which it is well adapted because of its rusting character.

**FLOORSTONE**

Many of the rocks here referred to as of possible value as ornamental stones are so described because of their attractive coloring and fitness of form, which permits a high polish. Up to the present they have been quarried for other purposes as small scales by blasting with dynamite, which badly shatters the rock. To determine the possible commercial value of any of these ornamental stones it is necessary first to ascertain whether the particular kind of rock can be obtained in masses large enough for the desired purpose. Even if large masses can not be obtained, some of the rock described, especially those found at the mouth of the Pigeon River, will not make good roofing slate but appear to be satisfactory for sill stock. When cut and polished will make adequate roofing slate but appear to be satisfactory for sill stock.

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Diabase from several of the quarries near Gettysburg has been dressed and worked for tombstones and monuments, and some has been polished for this purpose, but the polished stone is too dark and hard for general use. Discovered near the roads to Gettysburg, Sandown, and Little Marsh Creek, the diabase is a leucocratic syenite and is valuable as a hard, durable stone for the making of monuments. These quarries have been worked to some extent in recent years, and the diabase is now being quarried for use in the local monument factories. The diabase is of a dark gray color, and when polished it has a smooth, glossy surface. It is used for the making of monuments and other ornamental objects.

The location of the diabase is indicated on the areal-geology maps, and it is a valuable resource for the local monument factories.

The precipitation in this area is heavy, and the water supply is adequate for all purposes during most of the year. In very dry seasons, however, the water gets low in many wells in the Triassic shales area. Four-inch wells were drilled by the United States Government at the Triassic State Park in 1913, and the wells ranged from 75 to 345 feet, which was ample for the large transient gathering.

In areas where the supply of shallow-well water is uncertain, rainwater is caught in cisterns and used not only for stock and household purposes but also for garden use and even for drinking. Where large cisterns are constructed and the pipes are so arranged that the first fall of rain is allowed to pass away the dust and impurities on the roof and in the pipes before the water is turned into the cistern, rainwater is not unclean or unsuitable for domestic use, and the supply is always adequate. Rain water that is conducted from the eaves through rusty, old, and dirty pipes to a wooden cistern which is seldom cleaned out is safe for drinking and is a means of herbage and spreading disease.

The cities and principal villages of the area have waterworks, but most of them do not have proper sewer systems. Gettysburg, the largest city in the area, obtains its water supply from Marsh Creek, which issues in South Mountain. The water is pure and soft, being derived from springs in the silicious mountain rocks, and the supply is adequate for all purposes throughout the year. The water is diverted from the springs at the pumping station 4 miles west of the city and is forced directly into the mains. A reservoir at Cemetery Hill, maintained for fire protection purposes, is supplied by water from windmills that pump from two deep wells in the vicinity.

Hedgerville has a reservoir, fed by springs, in the hills about 1 mile northwest of the town, which furnishes an adequate supply of pure fresh water by gravity for domestic purposes and fire protection. Amendedville is supplied by a reservoir on the hill west of the town, fed by water piped across the valley from a spring in the Little Conewango School. The water flows by gravity, which gives adequate pressure for fire protection. Benderville has a small reservoir on a spring on the mountain side, 2 miles southeast of the town. The water flows by gravity and is used for domestic purposes and fire protection. Gettysburg gets its water supply from a spring west of the village and south of the pikes, which probably issues from the rhyolite at or near a fault. The water is soft and clean, and a water treatment is necessary at the spring.