DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

GEOLOGIC ATLAS

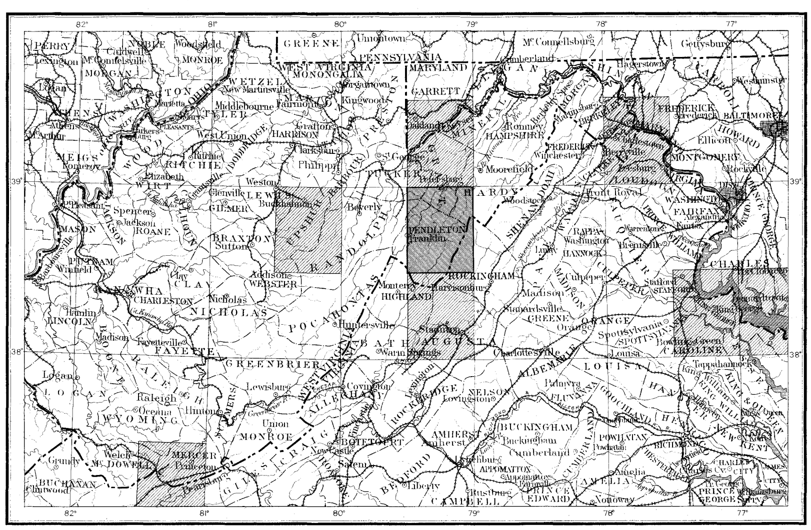
OF THE

UNITED STATES

FRANKLIN FOLIO

WEST VIRGINIA - VIRGINIA

INDEX MAP



SCALE: 40 MILES-1 INCH

AREA OF THE FRANKLIN FOLIO

AREA OF OTHER PUBLISHED FOLIOS

LIST OF SHEETS

DESCRIPTION TOPOGRAPHY AREAL GEOLOGY ECONOMIC GEOLOGY STRUCTURE SECTIONS

COLUMNAR SECTION

FOLIO 32 LIBRARY EDITION FRANKLIN

WASHINGTON, D. C.

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY

BAILEY WILLIS, EDITOR OF GEOLOGIC MAPS S. J. KÜBEL, CHIEF ENGRAVER

1896

EXPLANATION.

The Geological Survey is making a geologic map of the United States, which necessitates the preparation of a topographic base map. The two are being issued together in the form of an atlas, the parts of which are called folios. Each folio consists of a topographic base map and geologic maps of a small area of country, together with explanatory and descriptive texts.

THE TOPOGRAPHIC MAP.

The features represented on the topographic map are of three distinct kinds: (1) inequalities of surface, called *relief*, as plains, plateaus, valleys, hills, and mountains; (2) distribution of water, called *drainage*, as streams, lakes, and swamps; (3) the works of man, called *culture*, as roads, railroads, boundaries, villages, and cities.

Relief.—All elevations are measured from mean sea-level. The heights of many points are accurately determined, and those which are most important are given on the map in figures. It is desirable, however, to give the elevation of all parts of the area mapped, to delineate the horizontal outline, or contour, of all slopes, and to indicate their grade, or degree of steepness. This is done by lines connecting points of equal elevation above mean sea-level, the lines being drawn at regular vertical intervals. These lines are called *contours*, and the uniform vertical space between each two contours is called the *contour interval*. Contours and elevations are printed in brown.

The manner in which contours express elevation, form, and grade is shown in the following sketch and corresponding contour map:

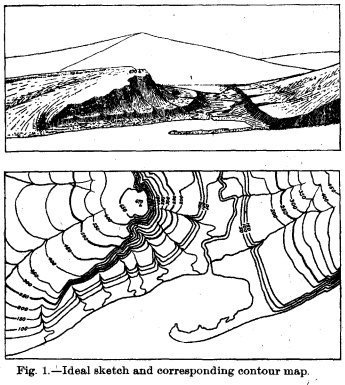


Fig. 1.—Ideal sketch and corresponding contour map.

The sketch represents a river valley between two hills. In the foreground is the sea, with a bay which is partly closed by a hooked sand-bar. On each side of the valley is a terrace. From the terrace on the right a hill rises gradually, while from that on the left the ground ascends steeply to a precipice. Contrasted with this precipice is the gentle descent of the left-hand slope. In the map each of these features is indicated, directly beneath its position in the sketch, by contours. The following explanation may make clearer the manner in which contours delineate elevation, form, and grade:

1. A contour indicates approximately a certain height above sea-level. In this illustration the contour interval is 50 feet; therefore the contours are drawn at 50, 100, 150, 200 feet, and so on, above sea-level. Along the contour at 250 feet lie all points of the surface 250 feet above sea; and similarly with any other contour. In the space between any two contours are found all elevations above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, while that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 but less than 200 feet above sea. The summit of the higher hill is stated to be 670 feet above sea; accordingly the contour at 650 feet surrounds it. In this illustration nearly all the contours are numbered. Where this is not possible, certain contours—say every fifth one—are accentuated and numbered; the heights of others may then be ascertained by counting up or down from a numbered contour.

2. Contours define the forms of slopes. Since contours are continuous horizontal lines conforming to the surface of the ground, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines, and project in passing about prominences. The relations of contour curves and angles to forms of the landscape can be traced in the map and sketch.

3. Contours show the approximate grade of any slope. The vertical space between two contours is the same, whether they lie along a cliff or on a gentle slope; but to rise a given height on a gentle slope one must go farther than on a steep slope, and therefore contours are far apart on gentle slopes and near together on steep ones.

For a flat or gently undulating country a small contour interval is used; for a steep or mountainous country a large interval is necessary. The smallest interval used on the atlas sheets of the Geological Survey is 5 feet. This is used for regions like the Mississippi delta and the Dismal Swamp. In mapping great mountain masses, like those in Colorado, the interval may be 250 feet. For intermediate relief contour intervals of 10, 20, 25, 50, and 100 feet are used.

Drainage.—Watercourses are indicated by blue lines. If the stream flows the year round the line is drawn unbroken, but if the channel is dry a part of the year the line is broken or dotted. Where a stream sinks and reappears at the surface, the supposed underground course is shown by a broken blue line. Lakes, marshes, and other bodies of water are also shown in blue, by appropriate conventional signs.

Culture.—The works of man, such as roads, railroads, and towns, together with boundaries of townships, counties, and States, and artificial details, are printed in black.

Scales.—The area of the United States (excluding Alaska) is about 3,025,000 square miles. On a map with the scale of 1 mile to the inch this would cover 3,025,000 square inches, and to accommodate it the paper dimensions would need to be about 240 by 180 feet. Each square mile of ground surface would be represented by a square inch of map surface, and one linear mile on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the scale of the map. In this case it is "1 mile to an inch." The scale may be expressed also by a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, the scale "1 mile to an inch" is expressed by $\frac{1}{63,360}$. Both of these methods are used on the maps of the Geological Survey.

Three scales are used on the atlas sheets of the Geological Survey; the smallest is $\frac{1}{250,000}$, the intermediate $\frac{1}{125,000}$, and the largest $\frac{1}{62,500}$. These correspond approximately to 4 miles, 2 miles, and 1 mile on the ground to an inch on the map. On the scale $\frac{1}{62,500}$ a square inch of map surface represents and corresponds nearly to 1 square mile; on the scale $\frac{1}{125,000}$, to about 4 square miles; and on the scale $\frac{1}{250,000}$, to about 16 square miles. At the bottom of each atlas sheet the scale is expressed in three different ways, one being a graduated line representing miles and parts of miles in English inches, another indicating distance in the metric system, and a third giving the fractional scale.

Atlas sheets and quadrangles.—The map is being published in atlas sheets of convenient size, which are bounded by parallels and meridians. The corresponding four-cornered portions of territory are called *quadrangles*. Each sheet on the scale of $\frac{1}{250,000}$ contains one square degree, i. e., a degree of latitude by a degree of longitude; each sheet on the scale of $\frac{1}{125,000}$ contains one-quarter of a square degree; each sheet on the scale of $\frac{1}{62,500}$ contains one-sixteenth of a square degree. The areas of the corresponding quadrangles are about 4000, 1000, and 250 square miles, respectively.

The atlas sheets, being only parts of one map of the United States, are laid out without regard to the boundary lines of the States, counties, or townships. To each sheet, and the quadrangle it represents, is given the name of some well-known town or natural feature within its limits, and at the sides and corners of each sheet the names of adjacent sheets, if published, are printed.

Uses of the topographic sheet.—Within the limits of scale the topographic sheet is an accurate and characteristic delineation of the relief, drainage, and culture of the district represented. Viewing the landscape, map in hand, every characteristic feature of sufficient magnitude should be recognizable. It should guide the traveler; serve the investor or owner who desires to ascertain the position and surroundings of property to be bought or sold; save the engineer preliminary surveys in locating roads, railways, and irrigation ditches; provide educational material for schools and homes; and serve many of the purposes of a map for local reference.

THE GEOLOGIC MAP.

The areal geologic map represents by colors and conventional signs, on the topographic base map, the distribution of rock formations on the surface of the earth, and the structure-section map shows their underground relations, as far as known, and in such detail as the scale permits.

KINDS OF ROCKS.

Rocks are of many kinds. The original crust of the earth was probably composed of *igneous rocks*, and all other rocks have been derived from them in one way or another.

Atmospheric agencies gradually break up igneous rocks, forming superficial, or *surficial*, deposits of clay, sand, and gravel. Deposits of this class have been formed on land surfaces since the earliest geologic time. Through the transporting agencies of streams the surficial materials of all ages and origins are carried to the sea, where, along with material derived from the land by the action of the waves on the coast, they form *sedimentary rocks*. These are usually hardened into conglomerate, sandstone, shale, and limestone, but they may remain unconsolidated and still be called "rocks" by the geologist, though popularly known as gravel, sand, and clay.

From time to time in geologic history igneous and sedimentary rocks have been deeply buried, consolidated, and raised again above the surface of the water. In these processes, through the agencies of pressure, movement, and chemical action, they are often greatly altered, and in this condition they are called *metamorphic rocks*.

Igneous rocks.—These are rocks which have cooled and consolidated from a liquid state. As has been explained, sedimentary rocks were deposited on the original igneous rocks. Through the igneous and sedimentary rocks of all ages molten material has from time to time been forced upward to or near the surface, and there consolidated. When the channels or vents into which this molten material is forced do not reach the surface, it either consolidates in cracks or fissures crossing the bedding planes, thus forming dikes, or else spreads out between the strata in large bodies, called sills or laccoliths. Such rocks are called *intrusive*. Within their rock enclosures they cool slowly, and hence are generally of crystalline texture. When the channels reach the surface the lavas often flow out and build up volcanoes. These lavas cool rapidly in the air, acquiring a glassy or, more often, a partially crystalline condition. They are usually more or less porous. The igneous rocks thus formed upon the surface are called *extrusive*. Explosive action often accompanies volcanic eruptions, causing ejections of dust or ash and larger fragments. These materials when consolidated constitute breccias, agglomerates, and tuffs. The ash when carried into lakes or seas may become stratified, so as to have the structure of sedimentary rocks.

The age of an igneous rock is often difficult or impossible to determine. When it cuts across a sedimentary rock, it is younger than that rock, and when a sedimentary rock is deposited over it, the igneous rock is the older.

Under the influence of dynamic and chemical forces an igneous rock may be metamorphosed. The alteration may involve only a rearrangement of its minute particles or it may be accompanied by a change in chemical and mineralogic composition. Further, the structure of the rock may be changed by the development of planes of division, so that it splits in one direction more easily than in others. Thus a granite may pass into a gneiss, and from that into a mica-schist.

Sedimentary rocks.—These comprise all rocks which have been deposited under water, whether in sea, lake, or stream. They form a very large part of the dry land.

When the materials of which sedimentary rocks are made are carried as solid particles by the water and deposited as gravel, sand, or mud, the deposit is called a mechanical sediment. These may become hardened into conglomerate, sandstone, or shale. When the material is carried in solution by the water and is deposited without the aid of life, it is called a chemical sediment; if deposited with the aid of life, it is called an organic sediment. The more important rocks formed from chemical and organic deposits are limestone, chert, gypsum, salt, iron ore, peat, lignite, and coal. Any one of the above sedimentary deposits may be separately formed, or the different materials may be intermingled in many ways, producing a great variety of rocks.

Sedimentary rocks are usually made up of layers or beds which can be easily separated These layers are called *strata*. Rocks deposited in successive layers are said to be stratified.

The surface of the earth is not fixed, as it seems to be; it very slowly rises or sinks over wide expanses, and as it rises or subsides the shore-lines of the ocean are changed: areas of deposition may rise above the water and become land areas, and land areas may sink below the water and become areas of deposition. If North America were gradually to sink a thousand feet the sea would flow over the Atlantic coast and the Mississippi and Ohio valleys from the Gulf of Mexico to the Great Lakes; the Appalachian Mountains would become an archipelago, and the ocean's shore would traverse Wisconsin, Iowa, and Kansas, and extend thence to Texas. More extensive changes than this have repeatedly occurred in the past.

The character of the original sediments may be changed by chemical and dynamic action so as to produce metamorphic rocks. In the metamorphism of a sedimentary rock, just as in the metamorphism of an igneous rock, the substances of which it is composed may enter into new combinations, or new substances may be added. When these processes are complete the sedimentary rock becomes crystalline. Such changes transform sandstone to quartzite, limestone to marble, and modify other rocks according to their composition. A system of parallel division planes is often produced, which may cross the original beds or strata at any angle. Rocks divided by such planes are called slates or schists.

Rocks of any period of the earth's history may be more or less altered, but the younger formations have generally escaped marked metamorphism, and the oldest sediments known, though generally the most altered, in some localities remain essentially unchanged.

Surficial rocks.—These embrace the soils, clays, sands, gravels, and bowlders that cover the surface, whether derived from the breaking up or disintegration of the underlying rocks by atmospheric agencies or from glacial action. Surficial rocks that are due to disintegration are produced chiefly by the action of air, water, frost, animals, and plants. They consist mainly of the least soluble parts of the rocks, which remain after the more soluble parts have been leached out, and hence are known as residual products. Soils and subsoils are the most important. Residual accumulations are often washed or blown into valleys or other depressions, where they lodge and form deposits that grade into the sedimentary class. Surficial rocks that are due to glacial action are formed of the products of disintegration, together with bowlders and fragments of rock rubbed from the surface and ground together. These are spread irregularly over the territory occupied by the ice, and form a mixture of clay, pebbles, and bowlders which is known as till. It may occur as a sheet or be bunched into hills and ridges, forming moraines, drumlins, and other special forms. Much of this mixed material was washed away from the ice, assorted by water, and redeposited as beds or trains of sand and clay, thus

(Continued on third page of cover.)

forming another gradation into sedimentary deposits. Some of this glacial wash was deposited in tunnels and channels in the ice, and forms characteristic ridges and mounds of sand and gravel, known as osars, or eskers, and kames. The material deposited by the ice is called glacial drift; that washed from the ice onto the adjacent land is called modified drift. It is usual also to class as surficial rocks the deposits of the sea and of lakes and rivers that were made at the same time as the ice deposit.

AGES OF ROCKS.

Rocks are further distinguished according to their relative ages, for rocks were not formed all at one time, but from age to age in the earth's history. Classification by age is independent of origin; igneous, sedimentary, and surficial rocks may be of the same age.

When the predominant material of a rock mass is essentially the same, and it is bounded by rocks of different materials, it is convenient to call the mass throughout its extent a *formation*, and such a formation is the unit of geologic mapping.

Several formations considered together are designated a *system*. The time taken for the deposition of a formation is called an *epoch*, and the time taken for that of a system, or some larger fraction of a system, a *period*. The rocks are mapped by formations, and the formations are classified into systems. The rocks composing a system and the time taken for its deposition are given the same name, as, for instance, Cambrian system, Cambrian period.

As sedimentary deposits or strata accumulate the younger rest on those that are older, and the relative ages of the deposits may be discovered by observing their relative positions. This relationship holds except in regions of intense disturbance; sometimes in such regions the disturbance of the beds has been so great that their position is reversed, and it is often difficult to determine the relative ages of the beds from their positions; then *fossils*, or the remains of plants and animals, are a guide to show which of two or more formations is the oldest.

Strata often contain the remains of plants and animals which lived in the sea or were washed from the land into lakes or seas or were buried in surficial deposits on the land. Rocks that contain the remains of life are called fossiliferous. By studying these remains, or fossils, it has been found that the species of each period of the earth's history have to a great extent differed from those of other periods. Only the simpler kinds of marine life existed when the oldest fossiliferous rocks were deposited. From time to time more complex kinds developed, and as the simpler ones lived on in modified forms life became more varied. But during each period there lived peculiar forms, which did not exist in earlier times and have not existed since; these are characteristic types, and they define the age of any bed of rock in which they are found. Other types passed on from period to period, and thus linked the systems together and formed a chain of life from the time of the oldest fossiliferous rocks to the present.

When two formations are remote one from the other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which was deposited first.

Fossil remains found in the rocks of different areas, provinces, and continents, afford the most important means for combining local histories into a general earth history.

Colors and patterns.—To show the relative ages of strata, the history of the sedimentary rocks is divided into periods. The names of the periods in proper order (from new to old), with the color or colors and symbol assigned to each, are here given. The names of certain subdivisions of the periods, frequently used in geologic writings, are bracketed against the appropriate period name.

To distinguish the sedimentary formations of any one period from those of another the patterns for the formations of each period are printed in the appropriate period-color, with the exception of the first (Pleistocene) and the last (Archean). The formations of any one period, with the exception of Pleistocene and Archean, are distinguished from one another by different patterns, made of parallel straight lines. Two tints of the

PERIOD.	SYMBOL.	COLOR.
Pleistocene	P	Any colors.
Neocene { Pliocene / Miocene }	N	Buffs.
Eocene (including Oligocene)	E	Olive-browns.
Cretaceous	K	Olive-greens.
Juratrias { Jurassic / Triassic }	J	Blue-greens.
Carboniferous (including Permian)	C	Blues.
Devonian	D	Blue-purples.
Silurian (including Ordovician)	S	Red-purples.
Cambrian	Ꞓ	Pinks.
Algonkian	A	Orange-browns.
Archean	Æ	Any colors.

period-color are used: a pale tint (the underprint) is printed evenly over the whole surface representing the period; a dark tint (the overprint) brings out the different patterns representing formations. Each formation is furthermore given a letter-symbol of the period. In the case of a sedimentary formation of uncertain age the pattern is printed on white ground in the color of the period to which the formation is supposed to belong, the letter-symbol of the period being omitted.

The number and extent of surficial formations of the Pleistocene render them so important that, to distinguish them from those of other periods and from the igneous rocks, patterns of dots and circles are used. These may be printed in any colors.

The origin of the Archean rocks is not fully settled. Many of them are certainly igneous. Whether sedimentary rocks are also included is not determined. The Archean rocks, and all metamorphic rocks of unknown origin, of whatever age, are represented on the maps by patterns consisting of short dashes irregularly placed. These are printed in any color, and may be darker or lighter than the background. If the rock is a schist the dashes or hachures may be arranged in wavy parallel lines. If the rock is known to be of sedimentary origin the hachure patterns may be combined with the parallel-line patterns of sedimentary formations. If the metamorphic rock is recognized as having been originally igneous, the hachures may be combined with the igneous pattern.

Known igneous formations are represented by patterns of triangles or rhombs printed in any brilliant color. If the formation is of known age the letter-symbol of the formation is preceded by the capital letter-symbol of the proper period. If the age of the formation is unknown the letter-symbol consists of small letters which suggest the name of the rocks.

THE VARIOUS GEOLOGIC SHEETS.

Areal sheet.—This sheet shows the areas occupied by the various formations. On the margin is a *legend*, which is the key to the map. To ascertain the meaning of any particular colored pattern and its letter-symbol on the map the reader should look for that color, pattern, and symbol in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be sought in the legend and its color and pattern noted, when the areas on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history. The formations are arranged according to origin into surficial, sedimentary, and igneous, and within each class are placed in the order of age, so far as known, the youngest at the top.

Economic sheet.—This sheet represents the distribution of useful minerals, the occurrence of artesian water, or other facts of economic interest, showing their relations to the features of topography and to the geologic formations. All the formations which appear on the areal sheet are shown on this sheet by fainter color-patterns. The areal geology, thus printed, affords a subdued background upon which the areas of productive formations may be emphasized by strong colors. A symbol for mines is introduced at each occurrence, accompanied by the name of the principal mineral mined or of the stone quarried.

Structure-section sheet.—This sheet exhibits the relations of the formations beneath the surface. In cliffs, canyons, shafts, and other natural and artificial cuttings, the relations of different beds to one another may be seen. Any cutting which exhibits those relations is called a *section*, and the same name is applied to a diagram representing the relations. The arrangement of rocks in the earth is the earth's *structure*, and a section exhibiting this arrangement is called a *structure section*.

The geologist is not limited, however, to the natural and artificial cuttings for his information concerning the earth's structure. Knowing the manner of the formation of rocks, and having traced out the relations among beds on the surface, he can infer their relative positions after they pass beneath the surface, draw sections which represent the structure of the earth to a considerable depth, and construct a diagram exhibiting what would be seen in the side of a cutting many miles long and several thousand feet deep. This is illustrated in the following figure:

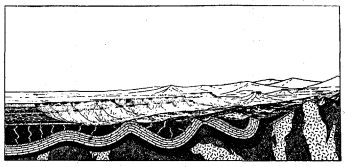


Fig. 2.—Sketch showing a vertical section in the front of the picture, with a landscape above.

The figure represents a landscape which is cut off sharply in the foreground by a vertical plane that cuts a section so as to show the underground relations of the rocks.

The kinds of rock are indicated in the section by appropriate symbols of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

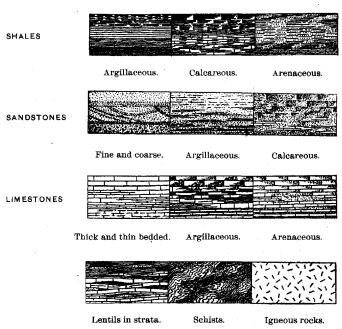


Fig. 3.—Symbols used to represent different kinds of rock.

The plateau in fig. 2 presents toward the lower land an escarpment, or front, which is made up of sandstones, forming the cliffs, and shales, constituting the slopes, as shown at the extreme left of the section.

The broad belt of lower land is traversed by several ridges, which are seen in the section to correspond to beds of sandstone that rise to the surface. The upturned edges of these beds form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shales.

Where the edges of the strata appear at the surface their thickness can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred.

When strata which are thus inclined are traced underground in mining, or by inference, it is frequently observed that they form troughs or arches, such as the section shows. But these sandstones, shales, and limestones were deposited beneath the sea in nearly flat sheets. That they are now bent and folded is regarded as proof that forces exist which have from time to time caused the earth's surface to wrinkle along certain zones.

On the right of the sketch the section is composed of schists which are traversed by masses of igneous rock. The schists are much contorted and their arrangement underground can not be inferred. Hence that portion of the section delineates what is probably true but is not known by observation or well-founded inference.

In fig. 2 there are three sets of formations, distinguished by their underground relations. The first of these, seen at the left of the section, is the set of sandstones and shales, which lie in a horizontal position. These sedimentary strata are now high above the sea, forming a plateau, and their change of elevation shows that a portion of the earth's mass has swelled upward from a lower to a higher level. The strata of this set are parallel, a relation which is called *conformable*.

The second set of formations consists of strata which form arches and troughs. These strata were once continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first set, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second set at the left of the section. The overlying deposits are, from their position, evidently younger than the underlying formations, and the bending and degradation of the older strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger strata thus rest upon an eroded surface of older strata the relation between the two is an *unconformable* one, and their surface of contact is an *unconformity*.

The third set of formations consists of crystalline schists and igneous rocks. At some period of their history the schists were plicated by pressure and traversed by eruptions of molten rock. But this pressure and intrusion of igneous rocks have not affected the overlying strata of the second set. Thus it is evident that an interval of considerable duration elapsed between the formation of the schists and the beginning of deposition of the strata of the second set. During this interval the schists suffered metamorphism; they were the scene of eruptive activity; and they were deeply eroded. The contact between the second and third sets, marking a time interval between two periods of rock formation, is another unconformity.

The section and landscape in fig. 2 are ideal, but they illustrate relations which actually occur. The sections in the structure-section sheet are related to the maps as the section in the figure is related to the landscape. The profiles of the surface in the section correspond to the actual slopes of the ground along the section line, and the depth of any mineral-producing or water-bearing stratum which appears in the section may be measured from the surface by using the scale of the map.

Columnar-section sheet.—This sheet contains a concise description of the rock formations which occur in the quadrangle. The diagrams and verbal statements form a summary of the facts relating to the character of the rocks, to the thicknesses of the formations, and to the order of accumulation of successive deposits.

The rocks are described under the corresponding heading, and their characters are indicated in the columnar diagrams by appropriate symbols. The thicknesses of formations are given under the heading "Thickness in feet," in figures which state the least and greatest measurements. The average thickness of each formation is shown in the column, which is drawn to a scale—usually 1000 feet to 1 inch. The order of accumulation of the sediments is shown in the columnar arrangement: the oldest formation is placed at the bottom of the column, the youngest at the top, and igneous rocks or other formations, when present, are indicated in their proper relations.

The formations are combined into systems which correspond with the periods of geologic history. Thus the ages of the rocks are shown, and also the total thickness of each system.

The intervals of time which correspond to events of uplift and degradation and constitute interruptions of deposition of sediments may be indicated graphically or by the word "unconformity," printed in the columnar section.

Each formation shown in the columnar section is accompanied by its name, a description of its character, and its letter-symbol as used in the maps and their legends.

CHARLES D. WALCOTT,
Director.

Revised March, 1897.

DESCRIPTION OF THE FRANKLIN QUADRANGLE.

GEOGRAPHY.

General relations.—The Franklin quadrangle embraces the quarter of a square degree which lies between the parallels 38° 30′ and 39° north latitude and the meridians 79° and 79° 30′ west longitude. It measures approximately 34.5 miles from north to south and 26.9 miles from east to west, and its area is about 931 square miles. Of the counties in West Virginia, it includes the greater part of Pendleton and Grant and small portions of Hardy, Tucker, and Randolph. In Virginia it comprises the western portion of Rockingham County. The greater part of its area is a region of Appalachian ridges separated by valleys of branches of the upper Potomac River. In its northwestern corner it is traversed by the front of the Allegheny* Mountains, down the western slope of which flow small affluents of Cheat River, a branch of the Ohio River drainage.

In its geographic and geologic relations this quadrangle forms a part of the Appalachian province, which extends from the Atlantic coastal plain on the east to the Mississippi lowlands on the west, and from central Alabama to southern New York. All parts of the region thus defined have a common history, recorded in its rocks, its geologic structure, and its topographic features. Only a part of this history can be read from an area so small as a single quadrangle; hence it is necessary to consider the individual quadrangle in its relations to the entire province.

Subdivisions of the Appalachian province.—The Appalachian province may be subdivided into three well-marked physiographic divisions, throughout each of which certain forces have produced similar results in sedimentation, in geologic structure, and in topography. These divisions extend the entire length of the province, from northeast to southwest.

The central division is the Appalachian Valley. It is the best defined and most uniform of the three. In the southern part it coincides with the belt of folded rocks which forms the Coosa Valley of Georgia and Alabama and the Great Valley of East Tennessee and Virginia. Throughout the central and northern portions the eastern side only is marked by great valleys—such as the Shenandoah Valley of Virginia, the Cumberland Valley of Maryland and Pennsylvania, and the Lebanon Valley of northeastern Pennsylvania—the western side being a succession of ridges alternating with narrow valleys. This division varies in width from 40 to 125 miles. It is sharply outlined on the southeast by the Appalachian Mountains and on the northwest by the Cumberland Plateau and the Allegheny Mountains. Its rocks are almost wholly sedimentary and in large measure calcareous. The strata, which must originally have been nearly horizontal, now intersect the surface at various angles and in narrow belts. The surface differs with the outcrop of different kinds of rock, so that sharp ridges and narrow valleys of great length follow the narrow belts of hard and soft rock. Owing to the large amount of calcareous rock brought up on the steep folds of this district its surface is more readily worn down by streams and is lower and less broken than the divisions on either side.

The eastern division of the province embraces the Appalachian Mountains, a system which is made up of many minor ranges and which, under various local names, extends from southern New York to central Alabama. Some of its prominent parts are the South Mountain of Pennsylvania, the Blue Ridge and Catoctin Mountain of Maryland and Virginia, the Great Smoky Mountains of Tennessee and North Carolina, and the Cohutta Mountains of Georgia. Many of the rocks of this division are more or less crystalline, being either sediments which have been changed to slates and schists by varying degrees of metamorphism, or igneous rocks, such as granite and diabase, which have solidified from a molten condition.

The western division of the Appalachian province embraces the Allegheny Mountains and the Cumberland Plateau, also extending from New York to Alabama, and the lowlands of Tennessee, Kentucky, and Ohio. Its northwestern boundary is indefinite, but may be regarded as an arbitrary line coinciding with the Tennessee River from northeast Mississippi to its mouth, and then crossing the States of Indiana and Ohio to western New York. Its eastern boundary is defined by the Allegheny Front and the Cumberland escarpment. The rocks of this division are almost entirely of sedimentary origin and remain very nearly horizontal. The character of the surface, which is dependent on the character and attitude of the rocks, is that of a plateau more or less completely worn down. In the southern half of the province the plateau is sometimes extensive and nearly flat, but oftener it is much divided by streams into large or small flat-topped hills. In West Virginia and portions of Pennsylvania the plateau is often sharply cut by streams, leaving in relief irregularly rounded knobs and ridges which bear but little resemblance to the original surface. The plateau once extended much farther westward, but the rocks beyond its present border have been completely removed by erosion, and the surface is now comparatively low and level, or rolling.

Altitude of the Appalachian province.—The Appalachian province as a whole is broadly dome-shaped, its surface rising from an altitude of about 500 feet along the eastern margin to the crest of the Appalachian Mountains, and thence descending westward to about the same altitude on the Ohio and Mississippi rivers.

Each division of the province shows one or more culminating points. Thus the Appalachian Mountains rise gradually from less than 1000 feet in Alabama to more than 6600 feet in western North Carolina. From this culminating point they decrease to 4000 or 3000 feet in southern Virginia, rise to 4000 feet in central Virginia, and descend to 2000 or 1500 feet on the Maryland-Pennsylvania line.

The Appalachian Valley shows a uniform increase in altitude from 500 feet or less in Alabama to 900 feet in the vicinity of Chattanooga, 2000 feet at the Tennessee-Virginia line, and 2600 or 2700 feet at its culminating point, on the divide between the New and Tennessee rivers. From this point it descends to 2200 feet in the valley of New River, 1500 to 1000 feet in James River basin, and 1000 to 500 feet in the basin of the Potomac, remaining about the same through Pennsylvania. These figures represent the average elevation of the valley surface, below which the stream channels are sunk from 50 to 250 feet, and above which the valley ridges rise from 500 to 2000 feet.

The plateau, or western, division increases in altitude from 500 feet at the southern edge of the province to 1500 feet in northern Alabama, 2000 feet in central Tennessee, and 3500 feet in southeastern Kentucky. It is between 3000 and 4000 feet in West Virginia, and decreases to about 2000 feet in Pennsylvania. From its greatest altitude, along the eastern edge, the plateau slopes gradually westward, although it is generally separated from the interior lowlands by an abrupt escarpment.

Drainage of the Appalachian province.—The drainage of the province is in part eastward into the Atlantic, in part southward into the Gulf, and in part westward into the Mississippi. All of the western, or plateau, division of the province, except a small portion in Pennsylvania and another in Alabama, is drained by streams flowing westward to the Ohio. The northern portion of the eastern, or Appalachian Mountain, division is drained eastward to the Atlantic, while south of the New River all except the eastern slope is drained westward by tributaries of the Tennessee or southward by tributaries of the Coosa.

The position of the streams in the Appalachian Valley is largely dependent upon the geologic structure. In general they flow in courses which for long distances are parallel to the sides of the Great Valley, following the lesser valleys along the outcrops of the softer rocks. These longitudinal streams empty into a number of larger, transverse rivers, which cross one or the other of the barriers limiting the valley. In the northern portion of the province they form the Delaware, Susquehanna, Potomac, James, and Roanoke rivers, each of which passes through the Appalachian Mountains in a narrow gap and flows eastward to the sea. In the central portion of the province, in Kentucky and Virginia, these longitudinal streams form the New (or Kanawha) River, which flows westward in a deep, narrow gorge through the Cumberland Plateau into the Ohio River. From New River southward to northern Georgia the Great Valley is drained by tributaries of the Tennessee River, which at Chattanooga leaves the broad valley and, entering a gorge through the plateau, runs westward to the Ohio. South of Chattanooga the streams flow directly to the Gulf of Mexico.

Geographic divisions of the Franklin quadrangle.—The area of the Franklin quadrangle consists of a continuous succession of high mountain ridges sloping steeply into relatively narrow valleys. The general course of these valleys and ridges is northeast to southwest, but many of the minor valleys, with their intervening spurs and knobs, have a transverse direction, presenting considerable diversity of trend. The larger topographic features are Shenandoah Mountain, South Fork Mountain and its southern extension in Long Ridge and associated ridges, Middle Mountain, Jack Mountain, Castle Mountain, North Fork Mountain, Allegheny Front, and Spruce Mountain.

The North Fork of the Potomac River flows in a nearly straight course between Shenandoah and South Fork mountains. Next west is the irregular valley of the South Branch of the Potomac River, which crosses Cave Mountain twice, cuts off the southern end of the Middle Mountain ridges, and branches south of Franklin around the northern extension of the Jack Mountain region. The North Fork of the Potomac River flows in a valley along the west side of North Fork Mountain and cuts across that mountain in a great gorge below Hopeville to join the South Branch above Petersburg. Dry River is a branch of the Shenandoah River. East of Shenandoah Mountain there is a region of high, rough ridges along Dry River and the headwaters of German River and Bear Creek. The most prominent of these ridges is Second Mountain, north of Rawley Springs, which rises steeply above the Great Valley. Its highest altitude is only 3400 feet, but its prominence is due to its steep rise above the lowlands to the eastward. Dundore Mountain, with an altitude of 4100 feet, the Slate Spring Range, from 4300 to 4400 feet, and High Knob, 4200 feet, are the highest points in the Dry River region. Along the northern end of Shenandoah Mountain the altitudes diminish to about 3000 feet on the higher points and 2400 feet at the lowest gap.

South Fork Valley has an altitude of 1900 feet near Sugar Grove, 1500 feet at Fort Seybert, and 1000 feet near the northeastern corner of the Franklin quadrangle.

South Fork Mountain consists of an irregular group of ridges, the higher summits of which attain an altitude of 3000 feet. The region southward, between the South Branch and the South Fork, contains a series of irregular ridges crossed by many gaps, some of which are as low as 2300 and 2400 feet above tide. The higher summits are over 3000 feet.

Middle Mountain is a range lying between North Mill Creek and South Mill Creek. Its highest knob has an altitude of 2500 feet. The South Branch of the Potomac River has an altitude of 2100 feet near Cave, 1750 near Franklin, 1400 feet at Upper Tract, and 1000 feet near its confluence with the North Fork. North Fork Mountain has a uniform crest-line, over 3000 feet high to the northward and 4000 feet to the southward. At Kile Knob it attains an altitude of 4700 feet; at Panther Knob, 4500 feet. In the great gap east of Hopeville it is cut down to an altitude of less than 1100 feet. North Fork Valley lies between a line of steep ridges to the east and long high slopes to the west. Its altitude at Circleville is 2000 feet, at the Mouth of Seneca 1500 feet, and at its confluence with the South Branch 1000 feet. To the west of the North Fork rise the steep slopes of the Allegheny Front, Timber Ridge, and Spruce Mountain. The Allegheny Front attains an altitude of 4300 feet, and in Roaring Plains, its southwestern extension, its elevation is over 4400 feet. In Green Knob the altitude is over 4600 feet. This range is cut across by Seneca Creek, a branch of the North Fork, south of which rise Timber Ridge and Spruce Mountain, with summits over 4700 feet above sea-level. West of Allegheny Front are the headwaters of Red Creek and its branches, affluents of Cheat River, which flow out of a rough region of high ridges.

GEOLOGY.

STRATIGRAPHY.

THE GENERAL SEDIMENTARY RECORD.

Most of the rocks appearing at the surface within the limits of the Franklin quadrangle are of sedimentary origin—that is, they were deposited by water. They consist of sandstone, shale, and limestone, all presenting great variety in composition and appearance. The materials of which they are composed were originally gravel, sand, and mud derived from the waste of older rocks, chemical precipitates from enclosed seas, and the remains of plants and animals which lived while the strata were being laid down. Some of the beds of limestone were formed in part from the shells of various sea animals, and the beds of coal are the remains of a luxuriant vegetation which covered extensive swamps.

The rocks afford a record of sedimentation from early Silurian to late Carboniferous time. Their composition and appearance indicate at what distance from shore and in what depth of water they were deposited. Sandstones marked by ripples and cross-bedded by currents, and shales cracked by drying on mud flats, indicate shallow water; while limestones, especially by the fossils they contain, indicate clear water and scarcity of sediment. The character of the adjacent land is shown by the character of the sediments derived from its waste. The sand and pebbles of coarse sandstones and conglomerates, such as are found in the lower Carboniferous, may have been originally derived from higher land, on which stream grades were steep, and they may have been repeatedly redistributed by wave action as the sea migrated back and forth over a rising and sinking coastal plain. Red sandstones and shales, such as make up some of the Silurian, Devonian, and Carboniferous formations, result from the revival of erosion on a land surface long exposed to rock decay and oxidation, and hence covered by a deep residual soil. Limestones, on the other hand, if deposited near the shore, indicate that the land was low and that its streams were too sluggish to carry off coarse sediment, the sea receiving only fine sediment and substances in solution.

The seas in which these sediments were laid down covered most of the Appalachian province and the Mississippi basin. The Franklin quadrangle was near its eastern margin at certain stages of sedimentation, and the materials of which its rocks are composed were probably derived largely from the land to the east. The exact position of the eastern shore-line of this ancient sea is not known, but it probably varied from time to time within rather wide limits.

Pursuing these general ideas more in detail, one finds that the strata of the Appalachian province record many variations in the ancient geography and topography of the continent. In general it is true that fine-grained sediments, such as form calcareous shale and limestone, are free from coarser detritus, such as sand, only because no sand reached the place of deposit. This condition may arise when materials accumulate far from shore, but it may also extend to areas near shore when the land is low, the rivers are accordingly sluggish, and the waves are inactive along the coast. Therefore, when it is known that the shore was not very remote from the place of limestone deposition, it is reasonable to infer that the coast and a stretch of land behind it were generally low.

Coarse detritus is often largely composed of quartz-sand or quartz-gravel, the most obdurate

*This spelling is in accord with a recent decision of the Board on Geographic Names, which was made too late for correction of the name on the maps of this folio.

of stones. Such material is derived from igneous and metamorphic rocks, including quartzite, being set free as they break down. Somewhat steep river slopes are required to carry it to the sea, and it may thus give evidence of elevated lands from which it was derived. But when sands and pebbles are once deposited in a coastal plain such as that which forms the Atlantic Coast from New York to Florida, they may be handled by the waves again and again as the margin of the sea migrates back and forth over the gentle slope. They may thus come to form part of coarse deposits much younger than the date of their first accumulation, and their significance as to the elevation of the land becomes vague. Nevertheless, when formations are of great volume, of somewhat mingled coarse and fine materials, and of rapid accumulation, they indicate a rate of erosion which implies that they represent a mountain range of at least moderate elevation.

Reasoning thus from the texture and bulk of sediments, and also from their distribution, the principal geographic changes of the Appalachian continent can be made out. One of the great events of North American geology is the expansion of the interior sea during Cambrian time. Early in the Cambrian period a narrow strait extended from the region of the Gulf of St. Lawrence southwestward to Alabama. It divided a western land area covering the central States from an eastern continent of unknown extent. The eastern shore of the strait was probably about where the Appalachian Mountains now extend. The great Appalachian Valley approximately coincides with the position of the strait. During Cambrian and Silurian time the Appalachian strait widened westward to Wisconsin and beyond the Mississippi. It probably also expanded eastward, but there is no evidence remaining of its farthest limit in that direction.

Before the widening of the Appalachian strait, in early Cambrian time, the land to the eastward was probably somewhat mountainous. The region of the central States was comparatively low land. The continued activity of the agents of erosion reduced the mountain range, whose bulk is represented in the Cambrian sediments. Before the beginning of deposition of the great Cambro-Silurian limestone the eastern land had become a low plain, whose even surface, subsiding, permitted probably extended transgression of the sea.

Following the Cambro-Silurian limestone in the sedimentary series, there is a mass of shale of widespread occurrence and of great thickness locally in the Appalachian Valley. It marks uplift of the eastern land and erosion of the residual material, perhaps together with the Silurian sediments, then lately accumulated over the surface. Thus there was toward the close of the Silurian period a restoration of moderate elevation to the eastern land and a return of the shore from its eastward excursion to a position approximately along the eastern margin of the Appalachian Valley. The changes of topography and geography from early Cambrian time to this epoch of Silurian time have been called a first cycle in Appalachian history.

The later Silurian sediments are of meager volume as compared with those that preceded them, and of variable coarseness. They represent the varying conditions of a zone across which the shore migrated back and forth. To the eastward lay the generally low continental area, margined by a coastal plain which stored the coarsest detritus of the land. Westward extended the shallow interior sea. The migrations of the shore are marked in variations of coarseness of the sandstones and sandy shales up to and including the Rockwood formation, as well as by overlaps of strata, with an incomplete sequence due to erosion of the missing members.

The moderate elevation of the eastern land had again been canceled by erosion before the beginning of the Devonian, and the low level is recorded in the fine shaly and calcareous deposits of the last Silurian epoch and the widespread black shale herein called the Romney. The intermediate sandstone, the Monterey, marks an oscillation of the shore, with contributions of sands from the coastal plain and an overlap of later strata.

The lowlands of the early Devonian were general from New York to Georgia. This topographic phase continued throughout the Devonian period in the region south of Virginia, but in the northeast, in Pennsylvania, New York, and New England, there occurred an uplift of considerable magnitude. In middle Silurian time the interior sea had been cut off from the Gulf of St. Lawrence by an elevation of New England and northern New York which closed the Lake Champlain strait. The sea, thus limited, received Devonian sediments which attained a maximum thickness of 9000 feet in Pennsylvania. They are composed of poorly assorted sands and shale, derived from the degradation of a mountain mass, probably several thousand feet in height. These Devonian mountains were possibly higher than those of the early Cambrian, though less extensive. In the interval between the two generations of mountains the land had not attained any considerable elevation.

Above Devonian strata throughout the province occur calcareous shales and fine-grained limestones of early Carboniferous age. This gradation in sediments from heterogeneous, coarse materials to fine silts corresponds to the similar change from lower Cambrian sandstones to Cambro-Silurian limestone; and it marks the degradation of the Devonian mountains to a general low level. In the early Carboniferous time the relations of land and sea were stable, as they had been during much of the Cambro-Silurian periods and throughout the early Devonian.

During middle and later Carboniferous time, however, there ensued that general vertical movement of the eastern land area and the region of the interior sea which resulted in the withdrawal of the sea to the Mississippi embayment. The movement was not simple; it was composed of many episodes of uplift and subsidence, among which uplift preponderated. In the repeated oscillations of level the sea swept back and forth over wide areas. It received from the coastal plain the coarse quartz detritus which had accumulated during previous ages, and the waves and currents of the shallow sea spread the concentrated sands and pebbles in beds which alternated with materials of less ancient derivation. The Carboniferous strata include shale and sandy shale, derived more or less directly from lands of moderate elevation, and also the coal beds, each of which marks the prolonged existence of a marsh in which peat-making plants grew. When the marsh sank beneath the sea the peat beds were buried beneath sands or shales, and the peat by a process of gradual distillation became coal. At the close of the Carboniferous a great volume of varied sediments had accumulated. It represents a correspondingly deep erosion of the land mass; but the uplift thus indicated appears to have gone on slowly, and it may be that the surface was not raised to the height of the mountains of to-day. The vertical movements giving rise to variations in strata, and even to mountain ranges, appear to have been independent of the horizontal movements which caused the folding of the Appalachian strata. There is at least no apparent direct connection between the two phases of earth movement.

The strata exposed in the Franklin quadrangle have a thickness of about 14,000 feet. The order of succession of the limestone, shales, sandstones, and quartzites, and their general character, are shown on the Columnar Section sheet.

SILURIAN PERIOD.

Shenandoah limestone.—The lowest rocks which appear at the surface in this quadrangle are exposed in the center of the great anticline of North Fork Mountain, where a long, rolling valley has been excavated along the wider part of the fold. There is also another small area southeast of Second Mountain. The rocks are limestones, in greater part quite pure, and they give rise to fertile soils for farms and pastures. The limestones are mainly dark-blue, drab, or gray in color, and weather to slightly darker tints on exposure. The beds vary from a few inches to several feet in thickness, and they are mainly quite regular. The principal area of outcrop extends from opposite the Mouth of Seneca to a point about 2 miles northeast of Circleville, a distance of about 12 miles. The limestone has a width of about 2 miles on the road which crosses from the North Fork Valley to Ruddell, and tapers toward each end. There are two other small areas of outcrop in the bottoms of the depressions east of Circleville. In the wider part of the larger area a thickness of about 1000 feet of the limestone is exposed on the western side of the arch, where the dips are steep to the west. All the beds observed are very similar in character. As usual in limestone areas, the surface is characterized by the presence of sinks, many of which occur on the western slopes of North Fork Mountain. This limestone contains fossils, principally among the upper beds, where there occur many species of the Trenton fauna.

Martinsburg shale.—This formation is extensively uplifted by the anticline of North Fork Mountain, where for many miles along the crest of the arch the overlying beds have been eroded and the Martinsburg shale exposed at the surface. From the northward, the first exposure is in the deep, wide gorge cut by the North Fork of the Potomac River in its passage across the mountain. This area is not a large one, but, owing to the steep dips on the western side of the fold, a considerable thickness of the shale is visible. Thence southward nearly every stream flowing down the mountain westward cuts so deeply as to expose small areas of the shales. In the southern portion of Grant County the shales are bared continuously along the crest of the fold, and from there southward for 5 miles into Pendleton County they outcrop along the center of the anticline. Then they are overarched for a short interval by overlying beds. Beyond this interval they outcrop again and extend along both sides of the limestone valley. On the west side of this valley they dip at a very steep angle westward, so that their outcrop is comprised within a narrow belt. On the east side, where the dip is gentle, they extend far up the western slope of North Fork Mountain, and on all the small spurs encroach more or less widely on the area of the limestone which they overlie. East of Circleville they extend across the center of the anticlinal arch, at first only on the divides between the small depressions, but finally in a wide area between the main mountain and the western ridge. Another small area is bared by Dry Run at the south end of Simmons Mountain, in the next anticline eastward. There is also a narrow belt along the fault east of Second Mountain.

The Martinsburg beds consist of gray shales, in greater part thinly bedded and fissile, and presenting great uniformity of character. Their basal members often contain a few thin layers of impure limestone, which constitute beds of passage from the Shenandoah limestone. Often, however, these formations are more abruptly separated and there is a marked change in the character of the materials within a short distance. In the upper portions of the Martinsburg the beds become more massive, and fine-grained dark-gray sandstones are intercalated among the shales in the upper 50 or 60 feet. These beds vary from a few inches to as much as 4 feet in thickness, and they are usually very compact and hard. Most portions of the Martinsburg shales are fossiliferous, and the fossils include species which are found in the Hudson formation of New York.

Juniata formation.—The principal area of this formation is in the great anticline of North Fork Mountain. There it extends many miles in a narrow belt along the western side of the principal mountain, near its top, and along the eastern side of the series of high, sharp ridges which mark the western limb of the anticline. Northeast of the Mouth of Seneca the two narrow belts unite for a short distance, and in the gorge east of Hopeville they again join over the great arch where it is crossed by the North Fork of the Potomac. East of Circleville the formation is so bared as to extend through shallow depressions which cross the main crest of North Fork Mountain, and it is in several cases also exposed again in the deeper portions of gorges cut by streams flowing down the east slope of the mountain. In Castle Mountain a small area of Juniata beds is exposed in the gorge of Friends Run and for some distance along the west side of the mountain in the neighborhood of Smith Creek. Small areas are also exposed in the centers of the narrow gorges of each of the streams crossing the Wagner Knob - Simmons Mountain - Bobs Mountain range, notably along Dry Run, which cuts through to the underlying Martinsburg shale. Other small exposures of middle and upper beds occur in gorges across the western ridge of Jack Mountain, in Props Gap, and in the two deep gaps in Long Ridge northeast of Franklin.

The rocks of the formation are red sandstones and shales, interbedded in no regular succession. The sandstones are hard, moderately coarse-grained, and occasionally cross-bedded. They vary in thickness from 1 to 20 feet, and are in greater part in beds from 1 to 4 feet thick. The shales vary in thickness from 6 or 8 feet to a thin parting between sandstone layers. Much of the formation consists of alternations of 4 or 5 feet of shales and 8 to 10 feet of sandstone. The proportion of shale increases to the northwest, and the sandstone beds become thinner in that direction.

The formation varies in thickness mainly by a regular decrease in amount from northeast to southwest. In the great gorges east of Hopeville the exposures across the Juniata beds are nearly continuous, and the thickness was found to be 1125 feet. In a gap through the west ridge of North Fork Mountain 6 miles south of Hopeville the amount is 900 feet; in two gorges near Mackville the measurement gave 825 feet. Three miles north of Circleville the amount is 850 feet; west of Kile Knob a very satisfactory series of exposures shows 685 feet; and in Dry Run Gap, at the south end of Simmons Mountain, an approximate measurement gave about 700 feet. Extensive exposures are frequent all along North Fork Mountain, particularly in the gaps through the ridges on the west limb of the anticline. On the upper slopes of the high, main ridge of the mountain the formation is often overlain by talus from the overlying white quartzite.

Tuscarora quartzite.—This is the very hard, white rock which gives rise to the high, rugged crests of North Fork, Castle, Bobs, Simmons, Raleman, and Jack mountains, Wagner Knob, Elkhorn Rock, Long Ridge, and some minor ranges. In the ridge west and north of Deer Run post-office it is bared in three small gaps.

The formation consists almost entirely of a homogeneous mass of coarse, white or gray sand in a very hard, siliceous matrix. Widely scattered, small pebbles occur frequently, and occasional local thin conglomeratic beds were observed. The beds are mostly very thick or massive, particularly in the upper portion of the formation. At the top and toward the base there are some thinner-bedded members, usually of somewhat darker gray color.

The thickness of the formation gradually decreases to the southward. In the gap east of Hopeville the amount is 440 feet; 6 miles south it is 475 feet; in the vicinity of Mackville it varies from about 280 to about 225 feet; 3 miles north of Circleville it is about 350 feet; and west of Kile Knob it is 220 feet. In Castle, Jack, Simmons, and Bobs mountains no precise measurements could be made, but the formation was found to average about 300 feet in thickness. In Raleman Mountain it is about 250 feet thick. In the ridge east of Franklin the thickness is about 350 feet, as nearly as could be ascertained, but it may be slightly more.

The most extensive exposure of the formation is along the crest of the main ridge of North Fork Mountain, and notably in the superb arch in the gorge by which this mountain is crossed by the North Fork of Potomac River. This arch is complete on the north side of the gorge, where its great cliffs, over 400 feet high, rise nearly 2000 feet above the river, in the center of the anticline. On the south side of the gorge the quartzite rises equally high to the crest of the mountain, but it is broken through on the west slope of the arch. Along the mountain crest it extends continuously to the edge of the quadrangle. For several miles it presents to the westward an imposing cliff of snowy white quartzite, but to the southward this cliff, although often quite high, is usually lower and broken by shallow gaps. This diminution of prominence is due to the decrease in thickness.

The line of ridges on the west side of North Fork Mountain is mainly due to the Tuscarora quartzite, which stands vertical and outcrops in jagged ledges along the center of the ridges. These ledges are often very prominent, notably at the famous "Rocks of Seneca" at the Mouth of Seneca, where there are vertical walls of white quartzite over 200 feet in height, facing westward. The crest line is quite jagged, and the white surface is beautifully mottled with streaks of yellowish, greenish, and brownish hues, due to lichens and iron stains.

In Castle Mountain at the gap cut by Friends Run, in Simmons Mountain in the gap of Dry Run, and on either side of Wagners Knob are fine arches of Tuscarora quartzite, and there are other arches exposed in the western ridge of Jack Mountain and along the ridges east of Franklin. In the Elkhorn Rock there is a fine high cliff of the quartzite, facing westward.

Cacapon sandstone.—This formation is a thin series of red beds overlying the Tuscarora quartzite. It is brought to the surface along both sides of North Fork Mountain, Castle, Simmons, Bobs, and Jack mountains, in the Long Ridge uplift east of Franklin, in the Elkhorn Rock area and in smaller areas along the South Branch in the Smoke Holes, west of Ruddle, at Deer Run post-office, and northwest of Sugar Grove. The beds consist of hard, thin-bedded, deep reddish-brown sandstones with occasional thin intercalations of red or buff shales. Usually the sandstones are slabby and weather out in fragments from 1 to 2 inches in thickness, but some of the beds are somewhat more massive. The thickness varies considerably, lessening toward the southwest. Owing to scarcity of continuous exposures across the formation, but few measurements were obtained, and these were only approximations. The thickness appears to be about 350 feet in the vicinity of Elkhorn Rock, but it is less in the Long Ridge ranges. Just east of Hopeville the thickness is estimated at 300 feet, and it may be slightly greater in a gap 6 miles south. In the vicinity of Mackville it is very much less, but no fair approximation could be made. Six miles south of Circleville a fairly satisfactory estimate was 135 feet.

The Cacapon sandstone usually outcrops as a talus of slabby red sandstone fragments with a few scattered exposures of the middle and lower beds. Sometimes the sandstones are so red that they are thought to be iron ore, but their sandstone nature is clearly evident throughout.

Rockwood formation.—The Cacapon sandstone gives place to a thick series of gray shales, which mainly lie along the middle slopes of the mountains of Tuscarora quartzite and Cacapon sandstone. The formation outcrops in that relation along North Fork Mountain, Castle, Raleman, Bobs, Simmons, and Jack mountains, Elkhorn Rock ridge, and Long Ridge. It occupies the greater part of the lower slopes of the valleys between North Fork Mountain and Castle Mountain, Raleman and Bobs mountains, and the two ridges of Jack Mountain. One of the most extensive exposures is on the slopes and among the longitudinal valleys in the Long Ridge region, extending from southeast of Franklin through Deer Run to a point northeast of Klines Cross-roads. There are other areas of considerable extent in the Smoke Holes along the South Branch, west of Ruddle, and west of Sugar Grove. Smaller areas occur at the ends of the Buffalo Hills, in the South Branch Mountain, and southeast of Masonville.

The materials of the Rockwood formation are mainly shales of dark-gray to olive-gray color, but there are usually also thin beds of iron ore and limestone, and at the top a persistent bed of gray sandstone. The iron ores are generally in two beds in the upper third of the formation. One bed is thicker than the other, usually with only a few inches of shale intervening. The thicker bed has been reported to be 30 inches in thickness at some points. The ore is characterized by its blood-red color when scratched or crushed and by its block-like fragments with smooth sides. The limestones are of rather variable occurrence and thickness and have no prominent features. They are quite fossiliferous. An 8-foot bed was observed $2\frac{1}{4}$ miles east of Hopeville. The top sandstone is usually about 15 feet thick; locally it is slightly more. It is gray in color, quite hard, sometimes almost a quartzite, usually moderately massive or cross-bedded. It is a characteristic feature, and it generally gives rise to a small ridge or escarpment. The thickness of the formation is difficult to determine owing to obscurity of outcrops of boundaries and its more or less crushed condition. In the northern and eastern part of the area 400 to 500 feet is a fair average, but to the southwestward the amount rapidly decreases. East of Hopeville the thickness is about 400 feet; 6 miles south it is considerably more than 500 feet; 1 mile south of Macksville a complete exposure gave a thickness of 325 feet; a few miles south of Circleville the thickness was found to be only 65 feet, but this is probably a local thinning.

Exposures of Rockwood beds are not so frequent as those of the adjoining formations, for the shales occur mainly on the mountain slopes and are extensively concealed by talus of harder materials. The streams usually expose at least a portion of the shales, and the top sandstone frequently outcrops as a ridge of small size but considerable persistence. In the long uplift east of Franklin the shales often rise in ridges and rolling hills, which expose shale areas of considerable extent.

Lewistown limestone.—This important and extensive member outcrops in many areas in the belt lying between the North and South forks of the Potomac River. It extends along both sides of the uplifts of North Fork Mountain, Long Ridge, and the Jack Mountain ridges, and for many miles along portions of the summit and flanks of South Fork Mountain and Cave Mountain. Owing to the thinness of the overlying sandstone and the complexity of folding, the outcrops east of North Fork Mountain and Castle Mountain are too irregular in outline for detailed description. They lie on mountain slopes, constitute high ridges or knob-like mountains, extend along valleys, or are revealed in gorges, in different parts of the region.

The formation consists of limestones which are very cherty above, massive in the middle, and thinner-bedded below. The basal portion of the cherty beds is often quite thin-bedded, but the upper beds are massive and give rise to ridges. The medial series usually comprises shaly limestones near its middle, an upper member of coarsely crystalline, light-colored, and very fossiliferous beds, and a basal member of darker-colored and less fossiliferous beds. The basal series of the formation consists of a considerable thickness of flaggy beds merging downward into several feet of interbedded calcareous shales and thin, impure limestones, which lie on the gray sandstone of the Rockwood formation. The flaggy beds are quite pure limestones, dark on fresh fracture, but weathering quite light-colored on exposure. The beds are mainly from one-half inch to 2 inches thick, with smooth surfaces along which the layers readily separate.

The thickness of the Lewistown limestone averages about 1000 feet in the greater part of the Franklin quadrangle. The northern part of South Fork Mountain, and apparently also Cave Mountain, contain a thickness of 1250 feet. To the extreme southwest it thins quite rapidly, and in the vicinity of Circleville it is not over 750 feet thick. In the region between Sugar Grove and Jack Mountain its thickness was found to be from 800 to 850 feet. The cherty series constitutes about one-quarter of the thickness of the formation, and the basal slabby series varies from one-half to three-fifths of the total thickness.

Extensive exposures of the Lewistown limestone occur throughout its area, but on some of the steeper mountain slopes and along some of the narrower valleys there are usually greater or less amounts of sandy or rocky detritus from the slopes above. Cliffs and steep ledges are of frequent occurrence, notably in gorges along streams which cross the longitudinal ridges. The limestones are cavernous, and many extensive caves have been discovered. Springs, sinks, and other evidences of underground drainage are of general occurrence in the limestone areas.

Fossil molluscan and crustacean remains occur abundantly in the limestones, particularly in its medial members. These fossils include many distinctive species of the Helderberg fauna.

DEVONIAN PERIOD.

Monterey sandstone.—This sandstone occurs extensively in the ridges adjoining the Lewistown limestone areas. Owing to its hardness its outcrops give rise to knobs and ridges which are often of considerable prominence. It constitutes the southern portion of South Fork Mountain and its flanking ridges, Sweedlin Hill, Colic Mountain, Pond Range, Pickle Mountain, Sandy Ridge, Tract Hill, Timber Ridge, Big Mountain, the flanking ridges and north end of Cave Mountain, the southern termination of an extension of Patterson Creek Mountain east of Petersburg, a line of ridges of greater or less prominence along the western side of the North Fork Mountain uplift, and series of ridges flanking the limestone mountains from Sugar Grove to near Fort Seybert. It is a hard, fine-grained, calcareous sandstone of dark blue-gray color, which weathers to a dirty-buff, porous, sandy rock of varying hardness. Much of the rock, especially in its weathered condition, exhibits large numbers of casts and impressions of fossil molluscan and crustacean remains. The thickness of the formation varies from 300 to 200 feet, with the decrease fairly regular to the west or southwest. It is owing to this small thickness, and also in some measure to the complexity of flexing, that the surface distribution of the formation is so irregular. This is a conspicuous feature in the Franklin region, where the formation sheathes the slopes of the ridges but is cut through by many streams, even those of small size. Excellent exposures of the formation are general in much of its area, especially in the gorges and along the steeper mountain slopes. On the gentler slopes the formation is usually quite deeply disintegrated into sand and loose fragments. The fossil remains in this formation are in greater part those which are typical of the Oriskany of New York.

Romney shale.—Lying on the surface of the Monterey sandstone there is an extensive series of shales, which is a prominent feature in many of the valleys of the central portion of the Franklin quadrangle. The greater part of the valley of the South Fork of the Potomac and much of the South Branch and North Fork valleys are excavated in these shales. The most extensive areas are about Petersburg and along both sides of Middle Mountain to above Upper Tract. The shales extend in a narrow belt along the western side of the North Fork Mountain uplift, and above the Mouth of Seneca the North Fork Valley lies mainly upon them. In the vicinity of Franklin they underlie a number of irregular valleys among the Monterey ridges, and they extend along the base of Second Mountain east of Rawley Springs. The rocks consist of dark shales, black and fissile below, but somewhat lighter and more compact above; the basal beds are usually carbonaceous to a moderate degree, and they have been worked at several points with the mistaken idea that they might prove to be coal-bearing. The formation includes occasional thin beds of fossiliferous limestone near its base; and the upper members contain alternations of pale-brown or dark-buff, sandy beds which constitute beds of passage into the next succeeding formation, the Jennings. The vertical range and stratigraphic position of these passage beds are variable, so that there is no definite line of demarcation between the two formations. Owing to this fact no precise upper limit can be assigned to the Romney shale, and on the map the Romney and Jennings patterns have been merged to indicate the intergrading of the two formations. The approximate average thickness of the distinctive members of the Romney shale is about 1200 feet, although there are local variations in this amount. The Romney shale contains fossils, including species distinctive of the Hamilton group; those in the lowest beds comprise some species characteristic of the Marcellus. There is no evidence of structural unconformity between the Romney shales and the Monterey sandstone, but the contact between these formations is characterized by a most abrupt change from the underlying massive sandstones to the black fissile shales at the base of the Romney.

Jennings formation.—The Jennings formation is a prominent member in the Franklin quadrangle. It constitutes the wide area of steep slopes and high ridges extending along the west declivity of Shenandoah Mountain. It occupies the lower middle slopes of the Allegheny Front and Timber Ridge and the summit and higher slopes of Middle Mountain, and it is spread out over an area of considerable width about the east side of Shenandoah and Second mountains. The formation consists of light-colored shales, with interbedded light-colored sandstones in its upper part. The local sequence of beds is somewhat variable, but there are certain general characteristics which are quite constant. The shales are mainly of olive-gray and buff tints. The lower members contain layers of light-colored sandstone, but they are soft and usually thin. The upper members are gray sandstone with occasional thin layers or lenses of conglomerate interbedded with olive and gray shales. Some of these sandstones, although fine-grained, are so hard and massive that they give rise to high ridges with very steep rocky surfaces. This is particularly the case on the west side of Shenandoah Mountain, where the outcrop of a series of sandstone beds is marked by a line of high ridges and knobs which extend entirely across the Franklin quadrangle parallel to the main crest line. This hard sandstone also predominates in the rough region of knobs and ridges lying east of the headwaters of German River. The presence of this hard series has also aided greatly in giving prominence to Middle Mountain, but it is not so important to the westward along the Allegheny Front and the base of Timber Ridge.

The upper limit of the Jennings formation is not well defined, for usually there is an extensive series of beds of passage into the next succeeding formation. It is on account of this indefiniteness that the boundary of the formation is shown on the map by a zone in which the pattern is merged into the adjacent one. North of the road across Shenandoah Mountain east of Fort Seybert the upper limit of the Jennings formation appears to be more distinct, and it is so indicated on the map.

The thickness of the Jennings formation varies from 3800 feet on the flanks of Shenandoah Mountain to about 2000 feet west of the North Fork of the Potomac. Fossils occur in various beds in the Jennings formation and represent the Chemung fauna.

Hampshire formation.—The red beds of this formation constitute the greater part of the summit of Shenandoah Mountain, Tomahawk, Brush, and Dundore mountains and other ridges about the head of Dry River, and the eastern slopes of Second Mountain, Timber Ridge, and Allegheny Front. It also outcrops in the region about the headwaters of Seneca Creek and along the lower part of Red Creek Valley near the mouth of Big Run. In Second Mountain, Dixon Ridge, Riven Rock Mountain, Feedstone Mountain, Dundore Mountain, and Slate Spring Mountain the formation is overlain by Carboniferous sandstones, and in Allegheny Front and Timber Ridge it passes beneath a considerable mass of Carboniferous beds, to reappear again in the Seneca Creek and Red Creek valleys. The rocks are largely sandstones and shales of red color, with some beds of greenish-gray, buff, and brownish-gray colors. The sandstones vary from slabby to massive, with layers usually from 15 to 30 feet thick. They are also extensively cross-bedded. Reddish-brown is the predominant color, but dark grays are frequent, particularly in the more massive beds. The shales are generally of quite bright brownish-red color, fissile, and in masses from a few inches to 10 or 15 feet thick. They occur throughout the formation, but predominate in the lower portion. Greenish and greenish-gray and brown shales are not uncommon, but they are thin and of local occurrence. The relation of sandstones to shales is very irregular, and there appears to be no constant stratigraphic succession of distinctive beds.

The thickness of the Hampshire deposits varies from 1600 to 2200 feet. The greatest thickness is in Shenandoah Mountain in the vicinity of Dry River.

CARBONIFEROUS PERIOD.

Pocono sandstone.—This basal member of the Carboniferous formation is a prominent feature in the southeastern corner of the Franklin quadrangle, and it underlies a region of considerable extent west of the North Fork of Potomac River. It has a thickness of about 700 feet in the vicinity of Rawley Springs, but the amount decreases to the westward, and in the region west of the North Fork it is only from 80 to 100 feet. In its greater development it constitutes the high, rough ranges of Second Mountain, Dixon Ridge, Riven Rock Mountain, and some adjacent ridges. Freestone, Dundore, and Goods mountains, and High and Bald knobs and some other summits in their vicinity, are capped by greater or less thicknesses of the formation. Dry River crosses the formation in a great gorge from the foot of Dixon Ridge to below Rawley Springs.

The western extension of the Pocono sandstone outcrops continuously along the Allegheny Front and the east side of Timber Ridge, where it caps a series of knobs of considerable prominence. The eastern and lateral flanks of these knobs consist of the Hampshire red beds, and the Pocono cap extends from the crest down the western slope, where it passes beneath the overlying Greenbrier limestone. Seneca Creek cuts through to the sandstone for 2 miles in the vicinity of Onego, and Brushy Creek and Roaring Creek cut down to it at frequent intervals along the middle and lower portions of their courses. About the upper valley of Seneca Creek and its branches the Pocono sandstone extends along the sides of the mountains, usually giving rise to a narrow shelf, which is especially distinct along the base of the limestone summits to the westward. A similar shelf of sandstone extends along the slopes of Red Creek Valley, in the northwestern corner of the quadrangle. This shelf is characterized by a precipitous face, of crenulated outline where the streams cross it, and a quite level surface extending back to the limestone slopes. In Red Creek Valley it descends gradually to the eastward, and merges into the bottom-land a mile and a half below the mouth of Gandy Run. On Seneca Creek it descends very rapidly and reaches the creek level a mile above Onego.

The Pocono sandstone consists in greater part of hard, gray or buff sandstone. Conglomerate streaks are of frequent occurrence. In the region east of Shenandoah Mountain the lower beds are a thick mass of hard sandstones, conglomerates, and quartzites, mainly of light-gray color and massively bedded. The upper beds infolded along the western slope of Second Mountain are soft, buff sandstones with streaks of buff-gray and black shales and thin seams of coal. This coal is much too thin and broken to be of economic value. The stratigraphy of the formation in this region is irregular, and owing to great masses of talus and much crushing and contortion of the overturned beds definite exposures are rare. In Dixon Ridge, Riven Rock Mountain, and the two ridges next south, the basal quartzitic beds, in part conglomeratic, extend up the dip to the mountain crests. The same beds cap the summits westward and Feed Stone Mountain, and in most cases they are so thick that they can not be mistaken for the gray sandstone beds in the Hampshire formation. The materials of these caps are coarse sandstones, in part quartzitic and often cross-bedded. High Knob is capped by a very massive white quartzite. Many of the other summits of Shenandoah Mountain near Bald Knob and northward are capped by gray sandstones of little thickness, but they all appear to be of the Hampshire formation.

Greenbrier limestone.—The Greenbrier limestone underlies the higher portions of the elevated region west of the North Fork, in the northwestern corner of the quadrangle. Its outcrop extends along the upper middle slopes of the Allegheny Front, Timber Ridge, and the spurs west of Roaring Plains and about Red Creek. Along the Brushy Creek and Roaring Creek valleys the limestone occupies wide areas of lower slopes, which extend to and along Seneca Creek for some distance in the vicinity of Onego. Southwest of Green Knob it occupies the crest of Allegheny Mountain in an area of considerable width which extends northward by Days Mills and Big Run Valley and crosses Red Creek just below the mouth of Gandy Run. It gives rise to slopes, often quite steep, but generally cleared and supporting a rich growth of grass for pasture.

The formation consists of heavy beds of light-blue limestones with intercalations of brownish-red shales and occasional red sandy shales. The limestone predominates. The lower series consists of a considerable thickness of massive limestones, somewhat siliceous in part; the medial series contains alternations of shales in thick masses and limestones mainly in thin masses; the upper series comprises alternations of shales and limestones, mainly in thicker masses, the limestones predominating. The stratigraphy presents more or less local variation, particularly in the medial beds, and the upper limits are not clearly defined owing to gradation into the Canaan beds.

The thickness of the Greenbrier limestone averages about 400 feet, but at some localities it appears to be somewhat less, mainly on account of admixture of shale and sandy beds in its upper portion.

The limestone contains some fossils of species of Lower Carboniferous age.

Canaan formation.—Overlying the Greenbrier limestone there is an extensive series of red shales and brown and gray sandstones, known as the Canaan formation. It extends along the higher slopes of the Allegheny Front and Spruce Mountain and the headwaters of Red Creek, and constitutes the summits of Timber Ridge, the ridge east of Roaring Creek, and a wide area of spurs and ridges north and west of Green Knob and Roaring Plains.

The shales predominate in the lower portion of the formation and the sandstones in its upper portion. Four heavy beds of sandstone with moderately thick shale and sandy shale intercalations constitute the upper two-fifths of the formation, and this series is a maker of prominent and relatively rocky ridges. Some thin beds of dark shales with thin showings of coal also occur near the top of this series. The lower series contains thin beds of softer sandstone, and toward its base occasional thin beds of limestone. The total thickness of the formation averages 1250 feet with a fair degree of uniformity.

Blackwater formation.—Allegheny Front, Roaring Plains, Green Knobs, and the higher summits of Spruce Mountain are capped by this formation. There is another area about the headwaters of Gandy Run. The greatest thickness observed is on the Allegheny Front, where about 400 feet occur, very nearly the entire thickness of the formation. The rocks are white conglomerates and gray sandstones, the latter containing some irregular beds of soft buff sandstone and black shale with local beds of coal. The conglomerate forms the crest of the Allegheny Front and Roaring Plains and part of the ridges north of Gandy Run. It consists of white quartz pebbles, mainly less than an inch in diameter, and coarse sand in a siliceous matrix. On surface outcrops these pebbles weather out, often to a depth of several inches, and produce bare, barren, pebbly surfaces of considerable extent, as on the Roaring Plains. The beds are massive and their aggregate thickness is about 100 feet. They give rise to high, steep cliffs, which extend for many miles along the Allegheny Front and finally terminate at the western end of the Roaring Plains. The underlying beds are gray sandstones of considerable hardness, but usually only moderately massively bedded and frequently cross-bedded. This series caps the higher summits of Spruce Mountain and the summits of Green Knob and its associate. It extends along the south face of the Roaring Plains and the eastern face of the Allegheny Front below the conglomerate crest. There it exhibits intercalated beds of softer buff sandstone and dark shale with coal beds. These coal beds are usually not over a few inches or a foot thick, and they appear to be of limited extent. Along the southern front of Roaring Plains, about 300 feet below the crest, there is exposed an alternation of shale, bone, and thin coal beds which has an aggregate thickness of nearly 9 feet. There is, however, only a limited supply of good coal.

STRUCTURE.

Definition of terms.—As the materials forming the rocks of this region were deposited upon the sea-bottom, they originally extended in nearly horizontal layers. At present, however, the beds are usually not horizontal, but are inclined at various angles, their edges appearing at the surface. The angle at which they are inclined is called the *dip*. A bed which dips beneath the surface may elsewhere be found rising; the fold, or trough, between two such outcrops is called a *syncline*. A stratum rising from one syncline may often be found to bend over and descend into another; the fold, or arch, between two such outcrops is called an *anticline*. Synclines and anticlines side by side form simple folded structure. A synclinal *axis* is a line running lengthwise in the synclinal trough, at every point occupying its lowest part, toward which the rocks dip on either side. An anticlinal axis is a line which occupies at every point the highest portion of the anticlinal arch, and away from which the rocks dip on either side. The axis may be horizontal or inclined. Its departure from the horizontal is called the *pitch*, and is usually but a few degrees. In districts where strata are folded they are also frequently broken across and the arch is thrust over upon the trough. Such a break is called a *thrust*, an *overthrust*, an *overthrust fault*, or simply a *fault*. Fault, however, is a term applied to many forms of dislocation in rocks. If the arch is worn and the syncline is buried beneath the overthrust mass, the strata at the surface may all dip in one direction. They then appear to have been deposited in a continuous series despite the thrust which divides the whole mass. Folds and faults are often of great magnitude, their dimensions being measured by miles, but they also occur on a very small, even a microscopic, scale. In folds strata change their relations mainly by motion on the bedding planes, and overthrusts arise frequently where the direction of such movement intersects the bedding.

Structure of the Appalachian province.—Three distinct types of structure occur in the Appalachian province, each one prevailing in a separate area corresponding to one of the three geographic divisions. In the plateau region and westward the rocks are generally flat and retain their original composition. In the valley the rocks have been steeply tilted, bent into folds, broken by thrusts, and to some extent altered into slates and schists. In the mountain district faults and folds are important features, but cleavage and metamorphism are equally conspicuous.

The folds and overthrusts of the valley region are generally parallel to one another and to the western shore of the ancient continent. They extend from northeast to southwest, and single structures may be very long. Faults 300 miles long are known, and folds of even greater length occur. The crests of many anticlines continue at nearly the same height for great distances, so that they present the same formations. Often adjacent folds are nearly equal in height, and the same beds appear and reappear at the surface. Most of the beds dip at angles greater than 10°; frequently the dip is over 45°, and generally the western dip is overturned beyond 90°. The sides of the folds are sometimes pressed together until they are parallel. Generally the folds are smallest, most numerous, and most closely squeezed in thin-bedded rocks, such as shale and shaly limestone. Perhaps the most striking feature of the folding is the prevalence of southeastward dips. In some sections across the southern portion of the Appalachian Valley scarcely a bed can be found which dips toward the northwest.

Thrusts were developed in the northwestern sides of synclines, varying in extent and frequency with the changes in the thickness of strata above the Cambro-Silurian limestone. With very few exceptions the fault planes dip toward the southeast, and are nearly parallel to the bedding planes of the adjacent rocks. The fractures extend across beds many thousand feet thick, and sometimes the upper strata are pushed over the lower as far as 6 or 8 miles. There is a progressive change in character of deformation from northeast to southwest, resulting in different types in different places. In southern New York folds and faults occur in a relatively narrow area lying mainly east of the Hudson River. The strata have nevertheless been intensely disturbed. Through Pennsylvania toward Virginia, folds become more numerous and steeper. In southern Virginia they are closely compressed and often closed, while occasional faults appear. Passing through Virginia into Tennessee, the folds are more and more broken by thrusts. In the central part of the Valley of Tennessee, folds are generally so obscured by faults that the strata form a series of narrow overlapping blocks, all dipping southeastward. Thence the structure remains nearly the same southward into Alabama; the overthrusts become fewer in number, however, and their horizontal displacement is much greater, while the remaining folds are somewhat more open.

In the Appalachian Mountains the southeastward dips, close folds, and faults that characterize the Great Valley are repeated. The strata are also traversed by minute breaks of cleavage and are metamorphosed by the growth of new minerals. The cleavage planes dip to the east at from 20° to 90°, usually about 60°. This form of alteration is somewhat developed in the valley as slaty cleavage, but in the mountains it becomes important and frequently destroys all other structures. All rocks were subjected to this process, and the final products of the metamorphism of very different rocks are often indistinguishable from one another. Throughout the eastern Appalachian province there is a regular increase of metamorphism toward the southeast, so that a bed quite unaltered at the border of the Great Valley can be traced through greater and greater changes until it has lost every original character.

The structures above described are the result chiefly of compression, which acted in a northwest-southeast direction, at right angles to the trend of the folds and of the cleavage planes. The force of compression became effective early in the Paleozoic era, and reappeared at various epochs up to its culmination soon after the close of the Carboniferous.

In addition to this force of compression, the province has been affected by other forces which acted in a vertical direction and repeatedly raised or depressed its surface. The compressive forces were limited in effect to a narrow zone. Broader in its effect and less intense at any point, the vertical force was felt throughout the province.

Three periods of high land near the sea and three periods of low land are indicated by the character of the Paleozoic sediments. In post-Paleozoic time, also, there have been at least four, and probable more, periods of decided oscillation of the land due to the action of vertical force. In most cases the movements have resulted in the warping of the surface, and the greatest uplift has occurred nearly along the line of the Great Valley.

Structure sections.—The sections on the Structure sheet represent the strata as they would appear in the sides of a deep trench cut across the country. Their position with reference to the map is on the line at the upper edge of the blank space. The vertical and horizontal scales are the same, so that the actual form and slope of the land and the actual dips of the strata are shown. These sections represent the structure as it is inferred from the position of the strata observed at the surface. On the scale of the map they can not represent the minute details of structure, and they are therefore somewhat generalized from the dips observed in a belt a few miles in width along the line of the section.

Faults are represented on the map by a heavy solid or broken line, and in the sections by a line whose inclination shows the probable dip of the fault plane, the arrows indicating the direction in which the strata have been moved on its opposite sides.

Structure of the Franklin quadrangle.—The principal structural features of this quadrangle are illustrated by the five sections on the Structure sheet.

There are six general structural provinces in the region: the wide syncline of Shenandoah Mountain; the general anticline of South Branch Mountain and Long Ridge; the syncline of Middle Mountain; the anticline of Cave Mountain; the great overturned anticlines of North Fork Mountain; and the wide undulating syncline west of the North Fork of Potomac River. These general flexures bear subordinate corrugations of various orders, which give rise to features of greater or less prominence. The axes of all the flexures trend northeast and southwest. There are three faults: one great overthrust in the extreme southeastern corner of the quadrangle, which extends for many miles along the western side of the Great Valley, another smaller overthrust along the west side of Castle and Raleman mountains, and a small slip along the South Branch in the Smoke Holes.

The syncline of Shenandoah Mountain appears west of the great overthrust fault, and has a steep-dipping eastern limb which is overturned to the west. In the vicinity of Rawley Springs this overturn reaches its culmination in the upper beds of the Pocono sandstone, which are closely bent upon one another. Some of the overturned eastern dips in this vicinity are inverted to an angle as low as 40°. To the westward the beds rise on a gentle easterly dip, pass over a very low anticline which pitches northward, and then exhibit gentle easterly dips, which begin along the summit of Shenandoah Mountain and extend westward to the Long Ridge - South Branch Mountain anticline. This easterly dip brings up the Jennings formation along the western side of Shenandoah Mountain, the Romney shale along the South Fork Valley, and thence westward the various lower beds in succession to the Tuscarora quartzite in Long Ridge and Elkhorn Rock.

The Long Ridge and South Fork anticline, which rises on the western limb of the Shenandoah syncline, presents considerable variation in the course and position of its principal axis and of its minor corrugations. The highest part of the uplift is in Long Ridge, where Tuscarora quartzite is brought up on the principal ridge to an altitude of over 3200 feet, while in the transverse gorges the upper part of the Juniata beds is exposed. This axis pitches down in the vicinity of Deer Run post-office, and an axis beginning just southeast of Franklin rises to considerable prominence and continues to near the Grant – Pendleton county line. Sweedlin Hill is a subordinate flexure which rises east of Fort Seybert, and appears to be the same one that finally pitches up suddenly and carries the Tuscarora quartzite to a high altitude in Elkhorn Rock. Along the eastern side of this flexure there is also another minor anticline, which attains some prominence in the narrow limestone belt just west of Peru. In this vicinity the South Branch Mountain presents four corrugations, all relatively low, which pitch upward to the north. They are shown in Section BB.

West of Sugar Grove the general anticline of Long Ridge consists of two minor arches, the western one being an extension of the Long Ridge flexure, with decreased altitude, and the eastern one a rising axis which brings Rockwood and Cacapon beds to the surface. There are several minor flexures shown at the eastern end of Section FF, which pitch down rapidly to the north of Section EE.

The syncline of Middle Mountain is a symmetrical open fold from Upper Tract to the vicinity of Dorcas. In this region it contains along its center an area of Jennings formation of considerable extent, which gives rise to the ridge known as Middle Mountain. North of Dorcas the axis pitches up and the flexure parts around the declining anticline of the south end of Patterson Creek Mountain, here marked by the high ridge of Monterey sandstone just east of Petersburg. South of Upper Tract the syncline pitches up and presents a number of sharp corrugations marked by ridges of Monterey sandstone. These ridges are prominent in the vicinity of Ruddle. To the southward the flexure consists of a succession of small synclines and anticlines, the pitch of which rises and falls in most irregular manner. In the vicinity of Franklin there are four synclinal valleys in Romney shales, the most extensive of which is traversed by the South Branch for several miles.

In the vicinity of Pickle Mountain and Sandy Ridge the beds begin to rise rapidly to the southward and the syncline divides around the two ridges of Jack Mountain. These two ridges consist of Tuscarora quartzite, brought up by an anticline which rises very rapidly in the vicinity of Moyer Gap in a wide area of Lewistown limestone. A narrow syncline extends between the main ridge of Jack Mountain and a local anticlinal ridge of considerable prominence which rises in Moyer Gap. This syncline contains an area of Rockwood formation and several narrow belts of Lewistown limestone. The anticline of Cave Mountain rises along the North Fork west of Petersburg in a series of fingers of Monterey sandstone, and in the higher part of Cave Mountain brings to the surface quite an extensive area of Lewistown limestone. The South Branch of the Potomac cuts deeply into this anticline in the vicinity of Ketterman and exposes the Rockwood formation and a narrow area of the Cacapon sandstone. At the south end of Cave Mountain the South Branch has cut a deep gorge in the limestone, which exhibits a great arch of high cliffs. The flexure is continued southward in Big Mountain, but several minor corrugations begin along its sides, which give rise to Middle Mountain, Timber Ridge, Tract Hill, and a little ridge west of Reed Creek. These ridges consist mainly of Monterey sandstone, with narrow intervening valleys of Romney shales. To the southward the axes gradually rise, bringing up, first, a considerable area of Lewistown limestone, and then, along the westernmost corrugation, the very prominent anticline of Castle Mountain, a high ridge of Tuscarora quartzite. The principal corrugation to the eastward exhibits an area of Rockwood and Cacapon formations along Peter Run, an extensive area of Lewistown limestone in the Buffalo Hills, Rockwood beds south of Friends Run, and then the Tuscarora quartzite in the range constituting Bobs Mountain, Wagner Knob, and Simmons Mountain. Raleman Mountain, structurally the southern extension of Castle Mountain, merges into North Fork Mountain at Panther Knob.

In the valley between Bobs Mountain and Raleman and Castle mountains the syncline contains a narrow belt of Lewistown limestone, and in the synclinal valley west of Castle Mountain there is a similar belt. Along the east side of this latter belt extends an overthrust fault, which in its greatest development brings the lower part of the Juniata formation against the Lewistown limestone, as shown in Section EE. In the gorge of Friends Run across Castle Mountain there is a fine exhibition of the anticlinal structure, marked by an arch of high cliffs of Tuscarora quartzite. Similar arches, but of somewhat smaller size, are exposed on either side of Wagner Knob, and along Smith Creek at the north end of the Bobs Mountain ridge.

The most prominent structural feature in the Franklin quadrangle is the anticline of North Fork Mountain. It brings to the surface at a relatively high altitude a wide, long area of Shenandoah limestone, and it extends with almost constant magnitude for over a hundred miles through central Appalachian West Virginia. Its most prominent topographic features are the high range of Tuscarora quartzite constituting North Fork Mountain and the line of ridges to the westward. The North Fork Mountain ridge consists of a sheet of Tuscarora quartzite with eastward dips of varying but relatively moderate amount. Part way down the eastern slope of the mountain the quartzite passes beneath the red Cacapon sandstone, and then follow in succession the Rockwood formation, Lewistown limestone, and, to the northward, Monterey sandstone. Along the west slope of the mountain there is first the Juniata formation, then for the greater part of its course the Martinsburg shale, and next, in the region east of Mackville, a belt of Shenandoah limestone. West of the axis of the flexure the dips become steep and for the greater part are either vertical or slightly overturned. This limb of the anticline is marked by a line of high, steep ridges with ragged axial crest of Tuscarora quartzite, flanked on the east by Juniata, Martinsburg, and, for some miles, Shenandoah limestone, and on the west by the Cacapon, Rockwood, Lewistown, and Monterey formations. On the north side of the great gorge of the North Fork of the Potomac, east of Hopeville, the Tuscarora quartzite extends completely over the anticline in a magnificent arch of high cliffs rising 2000 feet above the Fork. Below this cliff, but much obscured by talus, are the red beds of the Juniata formation and an area of the Martinsburg shale. In the vicinity of Hopeville there is a small local anticline along the west side of the main anticline, which is strikingly exhibited in Monterey sandstone and Lewistown limestone at a number of points along the North Fork. With the exception of this small flexure, the North Fork anticline presents no corrugations until, near Panther Knob, its eastern limb merges into the anticlines of Castle Mountain and its Tuscarora quartzite extends eastward into Simmons Mountain.

The synclinal fold west of the North Fork of the Potomac River consists of a deep syncline whose axis passes through Spruce Mountain, along Roaring Creek, through Roaring Plains, and west of Allegheny Front, and a relatively flat anticline which extends along the headwaters of Seneca Creek, crosses Red Creek above the mouth of Big Run, and with gradually increasing pitch extends up the upper Blackwater Valley in the Piedmont quadrangle. Along the eastern limb of the syncline the steep dips of the western side of the North Fork uplift extend through the Romney shale far into the Jennings formation; but, with gradually decreasing rate, they become relatively gentle in the upper beds of the Hampshire formation, Pocono sandstone, Greenbrier limestone, and Canaan formation. In the Blackwater formation on the western slopes of Allegheny Front, in the Greenbrier limestone and Pocono sandstone along Roaring Creek, and in the several formations in Spruce Mountain the beds at first are level and then rise on the anticline westward. This anticline brings up a wide area of Hampshire formation along the upper waters of Seneca Creek and its branches, but to the northward it pitches down, and Pocono, Greenbrier, and Canaan formations extend across its axis in a region of high ridges; along Red Creek the Hampshire beds are again bared over the axis of the anticline.

MINERAL RESOURCES.

Iron ore.—In the shales of the Rockwood formation there is an extensive bed of iron ore which is often sufficiently pure to give promise of economic importance. It is a red hematite, occurring in regular beds and breaking out in heavy, smooth-sided blocks, a characteristic which has given it the name of "block ore." It is rusty-brown in color on exposed surfaces, but when scratched or crushed it is seen to be a bright blood-red. It is the same bed which is worked at intervals along the Appalachian region from New York, where it is known as Clinton ore, to Alabama. It is regularly stratified between the shales, about one-third way below their top.

The area of outcrop of the Rockwood formation is shown on the Areal Geology sheet, and again by a heavy tint on the Economic Geology sheet. It will be seen that it extends along both sides of the North Fork Mountain uplift, Castle Mountain, Simmons Mountain, Wagner Knob, Bobs Mountain, the two ridges of Jack Mountain, the Long Ridge and Elkhorn Rock ranges, and in some isolated areas west of Ruddle, west of Sugar Grove, near Ketterman, and south of Masonville. For the greater part of their course the Rockwood shales are often more or less completely hidden by overplaced sand and rocky talus from adjoining mountain slopes, so that exposures of the iron-ore horizon are but rarely observed. For this reason it is not possible to give a specific account of the extent and variations of the ore. It is known to be quite variable in purity and thickness, and occasionally there are intervals in which it is either absent or represented by thin beds of limestone.

Careful exploitation by trenching or shafting will be necessary at most localities for a determination of the presence and quality of the ore. In the belt east of Franklin the ore has been explored to some extent and found to average about 2 feet in thickness for a considerable distance, but this thickness is not maintained throughout. In the vicinity of Bible Knob, and at intervals to Smith Creek, the ore has been examined and a thickness of over 2 feet reported. On the road which crosses the mountain a short distance south of Elkhorn Rock, there was measured 31 inches of excellent ore. In the anticline west of Sugar Grove the ore extends just to the southern border of the Franklin quadrangle, where there was measured 27 inches of solid ore, overlain by 6 inches of soft ore, and the beds were found to constitute quite an extensive surface exposure. Moderately thick beds are also reported in the areas adjoining the two ridges of Jack Mountain.

Fragments of limonitic iron ore are occasionally found in the Monterey sandstone, and sometimes this rock is more or less deeply stained with iron, but a careful examination of the entire area of the formation indicates that there is no prospect of deposits of economic importance.

Coal.—The higher coal measures which contain workable coal beds to the north and west do not extend into the Franklin quadrangle. The Blackwater formation contains a few thin, irregular beds of coal along the Allegheny Front and Roaring Plains, but although they may possibly be of local use, they are not of wide economic importance. They are in the sandstones under the conglomerate and are associated with black shales. Owing to the heavy talus from the cliffs above, exposures are very rare, and but little could be ascertained as to the distribution of the beds. At some points they are either absent or not over 1 to 2 inches in thickness. Near the head of Roaring Creek, at the foot of the cliffs which are surmounted by the Roaring Plains, a gully reveals a series of coal-bearing beds about 9 feet thick, consisting of three thin coal beds intercalated among layers of dark shale.

The Pocono sandstone often contains thin beds of coal in the syncline which extends through Rawley Springs and along Second Mountain, but they are very thin, and usually so crushed as to be worthless for coal.

The lower members of the Romney shales have been worked at many points with the mistaken idea that they would lead to coal at a greater or less depth beneath the surface. This shale has much the appearance of the black shales occurring in connection with coal in the regular coal basins, but it was deposited long prior to the era of coal deposition. The more carbonaceous portions of the Romney shale often will burn for a few moments when placed in a hot fire, leaving a very bulky ash; but it is futile to expect that they are in any way connected with true coal deposits.

Manganese.—Fragments of pyrolusite or manganese ore of excellent quality have been found on the west slope of Bible Knob. They are derived from the cherty layers of the Lewistown limestone. The probable extent of the deposit could not be ascertained without digging trenches. More or less manganese in powdery form was seen in other localities scattered through the cherty beds of the Lewistown limestone, but in these cases there is no promise of the presence of extensive deposits.

Limestone.—There are large supplies of limestone suitable for blast furnaces and for lime for use in building and agriculture. The greater part of the Lewistown, Shenandoah, and Greenbrier limestones are available for these uses. Some of the lower beds of the Lewistown limestone may prove to be serviceable for the manufacture of cement, but they have not as yet been tested.

Building stone.—Building stones are very plentiful in the Franklin quadrangle, for they may be obtained in nearly every formation. It can not be said that any of them are particularly attractive in appearance or of special value for shipment, but they answer every purpose for local use. One of the most serviceable materials is the Monterey sandstone, which in its fresh state can often be hewn out into smooth blocks for building chimneys. It is claimed that at some localities the limestones are suitable for marble, but this claim has not been fully authenticated.

Clay.—Clay available for the manufacture of brick for local use occurs at many localities, mainly in the limestone areas and on some of the shale belts. There are quite extensive areas of brick loams among the alluvial deposits about Petersburg and farther down the South Branch. Smaller areas of alluvial clays also occur in many of the stream bottoms. It is probable that some of the dark shales of the Romney formation would, after grinding, be suitable for the manufacture of fire bricks, but they have not yet been tested for this use.

Road metal.—Throughout the Franklin quadrangle there are abundant materials of which to make smooth and durable roads. In many parts of the region there are hard shales and thin sandstones, which make almost perfect beds for roads excavated in them. For roads along the bottomlands there generally are large supplies of rocks at hand suitable for macadamizing, such as broken limestone or sandstone for the foundation and crushed rock or hard shale for a top dressing. In the limestone areas the roads ordinarily require a foundation of large fragments, a top dressing of crushed rock or shale, and adequate lateral drainage. The roads in the sandstone areas usually need only smoothing and proper drainage to prevent washing on the steep slopes.

SOILS.

Derivation and distribution.—Throughout the Franklin quadrangle there is a very close relation between the character of the soils and that of the underlying geologic formations. Except in limited areas along the larger streams and on the steeper slopes, the soils are residuary products of the decay and disintegration of the rocks on which they lie. The exceptions are the wash and talus on the steeper slopes and the flats along the streams, where there are mixtures of various materials washed from the higher lands and brought down largely at times of freshet. All sedimentary rocks such as occur in this region are changed by surface waters more or less rapidly, the rapidity depending on the character of the cement which holds their particles together. Siliceous cement is nearly insoluble, and rocks in which it is present, such as quartzite and some sandstones, are extremely durable and produce but a scanty soil. Calcareous cement, on the other hand, is readily dissolved by water containing carbonic acid, and the particles which it held together in the rock crumble down and form a deep soil. If the calcareous cement makes up but a small part of the rock, it is often leached out far below the surface, and the rock retains its form but becomes soft and porous, as in the case of the Monterey sandstone; but if, as in limestone, the calcareous material forms the greater part of the rock, the insoluble portions collect on the surface as a mantle of soil, varying in thickness with the character of the limestone, being generally quite thin where the latter is pure, but often very thick where it contains much insoluble matter.

When derived in this way from the disintegration of the underlying rock, soils are called *sedentary*. If the rock is a sandstone or sandy shale the soil is sandy, and if it is a clay-shale or limestone the resulting soil is clay. As there are abrupt changes in the character of the rocks, sandstones and shales alternating with limestones, so there are abrupt transitions in the character of the soil, and soils differing widely in composition and agricultural qualities often occur side by side. Knowing the character of the soils derived from the various geological formations, their distribution may be approximately determined from the map showing the areal geology, which thus serves also as a soil map. The only considerable areas in which the boundaries between different varieties of soil do not coincide with the formation boundaries are in the river bottoms and upon the steep slopes, where soils derived from rocks higher up the slope have washed down and mingled with or covered the soil derived from those below. The latter are called *overplaced* soils, and a special map would be required to show their distribution.

Classification.—The soils of this region may conveniently be classed as (1) Sandy soils, derived from the disintegration of the various beds of sandstone occurring at intervals from the Juniata to the Blackwater formation; (2) Clay soils, derived on the one hand from the Shenandoah, Lewistown, and Greenbrier limestones, and on the other hand from the shales mainly of the Martinsburg, Rockwood, Romney, Hampshire, and Canaan formations; and (3) Alluvial soils, deposited by the larger streams on their flood plains.

Sandy soils.—Nearly all of the larger mountain areas and many of the small ridges consist of sandstone, and their soils are sandy. Much of the land is steep and rocky, and the soils are so thin and barren that they are not available for agriculture. The Blackwater, Pocono, Upper Jennings, Tuscarora, and Juniata beds furnish the thinnest and poorest soils, and the mountains composed of these rocks are very barren. The Monterey sandstone often disintegrates quite deeply, but owing to the almost complete removal of its calcareous constituent, the residual sand is usually quite sterile. Much of the surface is so steep, also, that the sand washes away and leaves wide areas of rocky surface. The upper beds of the Canaan formation are too sandy to furnish good soil, but on the gentler slopes there are some areas which produce fairly good pasture land.

Owing to the alternation of sandstone and shale beds in the Hampshire formation, much of Shenandoah Mountain is available for pasturage, and quite extensive areas have been cleared for this purpose.

Clay soils.—The limestone lands of the Franklin quadrangle are mainly slopes of considerable steepness, but their soils are exceptionally rich. Owing to the steepness of the slopes these limestone soils are usually thin and much interrupted by outcropping ledges of rock. They are employed mainly for grazing, but they are tilled at many localities. The area of Shenandoah limestone exposed by the uplift of North Fork Mountain is the largest area of limestone land favorable for agriculture. Lewistown limestone areas are almost entirely used as pasture land, although at many points the slopes are too steep or there is extensive overplacement of sand from sandstones on higher slopes. The most extensive available areas of Lewistown limestone are in Cave Mountain, South Fork Mountain, the area adjoining the Long Ridge range, the South Branch Valley for several miles above and below Cave post-office, a number of areas west of Sugar Grove, the strip extending through Moser Knob, Bible Knob, Buffalo Hills, Reed Creek Valley, Pretty Ridge, the Smoke Hole settlement, and along the North Fork in the northern part of Pendleton County. There are many small farms along the outcrop of the Greenbrier limestone throughout its area in the Franklin quadrangle. On the steeper slopes this limestone is much overplaced by sand and talus from the sandstones above.

Clay soils from the shales occur mainly along the Romney, Martinsburg, Rockwood, and Canaan formations. The Romney shale soils lie mostly along the river bottoms, and, with the alluvium in these bottoms, make the best farming lands in the quadrangle. They extend along the South Branch in a wide area about Petersburg and to the eastward, along the valley of North Mill Creek, along South Mill Creek, in a wide area about Upper Tract and with some interruptions to and beyond Franklin, along nearly the entire course of South Fork, and up the narrow valleys of the Thorn runs, west of Sugar Grove. There are also some areas of good farming land along shale formations in the valley of the North Fork from near the Mouth of Seneca to Circleville.

The wider portion of the Martinsburg shale area in the uplift of North Fork Mountain is a succession of fine pasture lands and occasional fields of fair fertility. The soils are somewhat sandy, but on the other hand they contain considerable calcareous matter. The greater part of the area has very steep slopes, which are rather difficult to farm. On the higher portions of these slopes there is considerable overplacement by sand and talus from the overlying Juniata and Tuscarora beds. The soils from the shales of the Rockwood formation usually lie on steep mountain slopes where there is much overplacement of sandstone talus. In the vicinity of Deer Run and at intervals in this uplift east of Franklin the formation is so exposed as to afford numerous small tracts of farming or pasture land. The shales in the Hampshire formation give rise to wide areas of pasture land on the more rounded slopes and summits of Shenandoah Mountain. Along the eastern sides of the Allegheny Front and Timber Ridge the Hampshire formation outcrops in slopes too steep to be serviceable. The shaly portions of the Canaan formation lie mainly in steep slopes, but some portions of their areas are available for pasture land.

Alluvial soils.—There are wide areas of alluvial soil about Petersburg and eastward beyond the gorge through the southern end of Patterson Creek Mountain. These soils are sandy loams which were deposited by the South Branch at various periods. Their higher levels lie considerably above Petersburg, while the lower and later deposits lie in the bottom of the valley. Similar alluvial deposits, usually quite narrow, extend along the greater part of the valley of the South Fork to beyond Sugar Grove, along the South Branch from Upper Tract to beyond Franklin, and at intervals along the North Fork, mainly above the Mouth of Seneca. One of the widest and most fertile areas extends up the South Branch for 4 miles above Upper Tract. Along the smaller streams there are alluvial deposits of greater or less extent, but mainly quite narrow. The soils present considerable variability, and as a rule become predominantly sandy along the upper courses of the larger streams. Along the runs they are usually very sandy and often mixed with shingle. This admixture with shingle also occurs at intervals along the larger streams, especially on their higher courses and immediately below the numerous gorges through which the streams pass.

N. H. DARTON,
Geologist.

December, 1896.

U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

TOPOGRAPHY

WEST VIRGINIA–VIRGINIA
FRANKLIN SHEET

(St. George) (Piedmont) (Romney)

79°30' 39°00' 20' 10' 79°00' 39°00'

(Beverly) 50' 40' (Woodstock)

79°30' 38°30' (Monterey) 20' (Staunton) 10' 79°00' 38°30' (Harrisonburg)

LEGEND

RELIEF (printed in brown)

Contours (showing height above sea, horizontal form, and steepness of slope of the surface)

Depression contours

DRAINAGE (printed in blue)

Rivers

Creeks and runs

CULTURE (printed in black)

Towns

Houses

Roads

Trails

County lines

State lines

Triangulation stations

Henry Gannett, Chief Geographer.
Gilbert Thompson, Geographer in charge.
Triangulation by W.T. Griswold, S.S. Gannett, and U.S.C. and G.S.
Topography by W.T. Griswold and L.C. Fletcher.
Surveyed in 1884 and 1895.

Griswold
Fletcher

Scale $\frac{1}{125000}$

Miles / Kilometers

Contour Interval 100 feet.
Datum is mean Sea level.
Edition of July 1896.

U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

AREAL GEOLOGY

WEST VIRGINIA–VIRGINIA
FRANKLIN SHEET

Henry Gannett, Chief Geographer.
Gilbert Thompson, Geographer in charge.
Triangulation by W.T. Griswold, S.S. Gannett, and U.S.C. and G.S.
Topography by W.T. Griswold and L.C. Fletcher.
Surveyed in 1884-85.

Griswold
Fletcher

Scale $\frac{1}{125\,000}$

1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour Interval 100 feet.

Datum is mean Sea level.

Edition of July 1896.

Geology by N.H. Darton.
Surveyed in 1895.

LEGEND

SEDIMENTARY ROCKS

(Areas of Sedimentary rocks are shown by patterns of parallel lines.)

CARBONIFEROUS

- XII — Cbw — Blackwater formation *(conglomerate, sandstone, and shale containing thin coal seams, locally workable)*
- XI — Ccn — Canaan formation *(red and green shale and greenish and brown sandstone)*
- XI — Cgr — Greenbrier limestone *(limestone, shale, and sandstone)*
- X — Cpo — Pocono sandstone *(gray sandstone, in places conglomeratic)*

DEVONIAN

- IX — Dh — Hampshire formation *(shale and sandstone mainly red)*
- VIII — Dj — Jennings formation *(gray, olive, and buff shale and gray sandstone)*
- VIII — Dr — Romney shale *(dark shale with thin limestone beds near the base)*

TRANSITIONAL

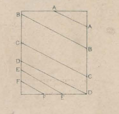
- VII — SDm — Monterey sandstone

SILURIAN

- VI — Sl — Lewistown limestone *(limestone including at the top cherty limestone, and at the base shaly and impure limestone with thin beds of cement rock)*
- V — Sr — Rockwood formation *(thin sandstone at the top and shale with iron ore below)*
- IV — Scn — Cacapon sandstone
- IV — Stc — Tuscarora quartzite
- IV — Sj — Juniata formation *(red sandstone and shale)*
- III — Smb — Martinsburg shale *(gray shale with sandy beds at the top)*
- II — Ss — Shenandoah limestone

Faults

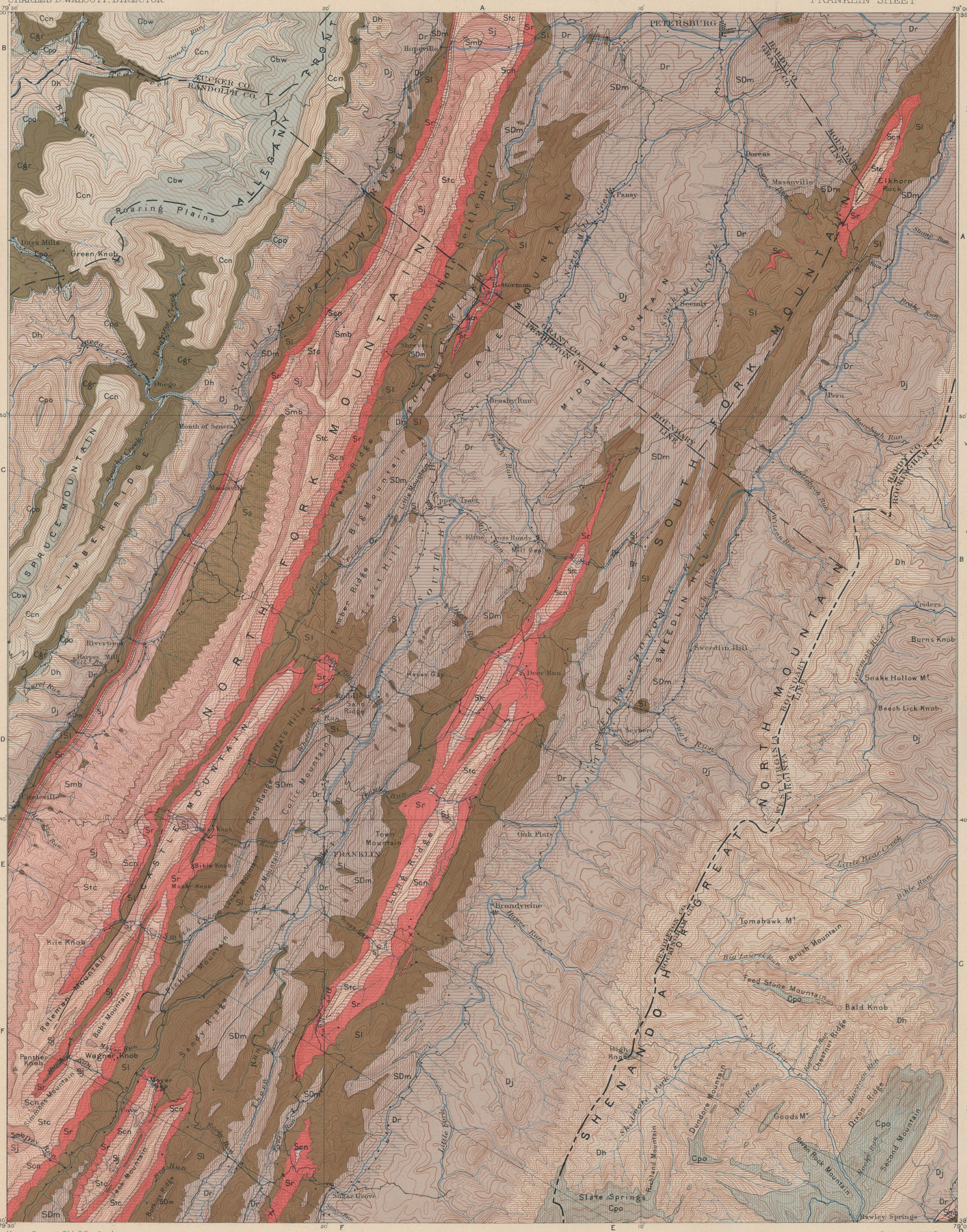
Sections



U.S. GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

ECONOMIC GEOLOGY

WEST VIRGINIA–VIRGINIA
FRANKLIN SHEET



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1 ½ 0 1 2 3 4 5 Miles

1 ½ 0 1 2 3 4 5 Kilometers

Contour Interval 100 feet.

Datum is mean Sea level.

Edition of July 1896.

Geology by N.H. Darton.
Surveyed in 1895.

LEGEND

SEDIMENTARY ROCKS

(Areas of Sedimentary rocks are shown by patterns of parallel lines.)

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XII — Cbw — Blackwater formation *(conglomerate, sandstone, and shale containing thin coal seams, locally workable)*

XI — Ccn — Canaan formation *(red and green shale and greenish and brown sandstone)*

XI — Cgr — Greenbrier limestone *(limestone, shale, and sandstone)*

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DEVONIAN

IX — Dh — Hampshire formation *(shale and sandstone mainly red)*

VIII — Dj — Jennings formation *(gray, olive, and buff shale and gray sandstone)*

VIII — Dr — Romney shale *(dark shale with thin limestone beds near the base)*

TRANSITIONAL

VII — SDm — Monterey sandstone

SILURIAN

VI — Sl — Lewistown limestone *(limestone including at the top cherty limestone, and at the base shaly and impure limestone with thin beds of cement rock)*

V — Sr — Rockwood formation *(thin sandstone at the top and shale with iron ore below)*

IV — Scn — Cacapon sandstone

IV — Stc — Tuscarora quartzite

IV — Sj — Juniata formation *(red sandstone and shale)*

III — Smb — Martinsburg shale *(gray shale with sandy beds at the top)*

II — Ss — Shenandoah limestone

Faults

Sections

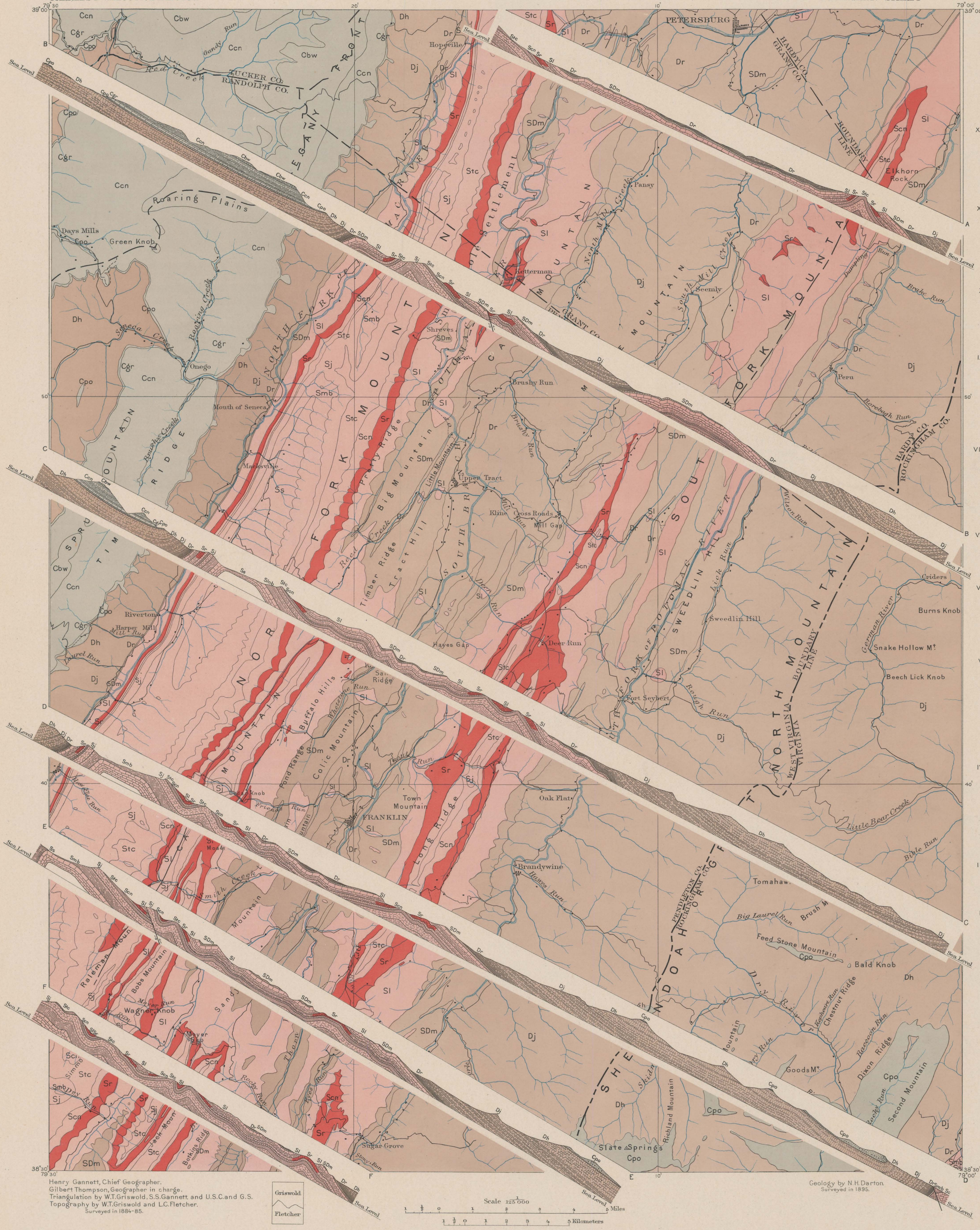
X Iron ore prospect pits

Known productive formations

Rockwood formation *(contains thin beds of hematite iron ore, Block ore)*

Limestone

STRUCTURE SECTIONS



LEGEND

SEDIMENTARY ROCKS

CARBONIFEROUS

XII — Cbw — Blackwater formation (conglomerate, sandstone, and shale containing thin coal seams, locally workable)

XI — Ccn — Canaan formation (red and green shale and greenish and brown sandstone)

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DEVONIAN

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VII — SDm — Monterey sandstone

SILURIAN

VI — Sl — Lewistown limestone (limestone including at the top cherty limestone, and at the base shaly and impure limestone with thin beds of cement rock)

V — Sr — Rockwood formation (thin sandstone at the top and shale with iron ore below)

Scn — Cacapon sandstone

IV — Stc — Tuscarora quartzite

Sj — Juniata formation (red sandstone and shale)

III — Smb — Martinsburg shale (gray shale with sandy beds at the top)

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Faults

Known productive formations

Rockwood formation (contains thin beds of hematite iron ore, Block ore)

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Griswold / Fletcher

Scale 1/125000

Miles / Kilometers

Geology by N.H.Darton.
Surveyed in 1895.

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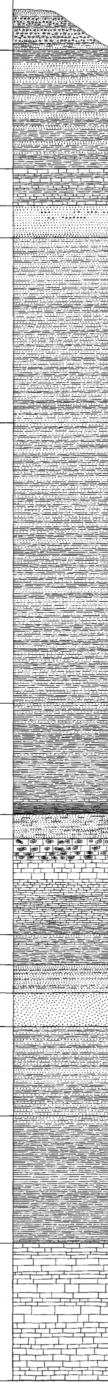
COLUMNAR SECTION

GENERALIZED SECTION FOR THE FRANKLIN SHEET.

SCALE: 1000 FEET = 1 INCH.

Period.	Formation Name.	Symbol.	Columnar Section.	Thickness in Feet.	Character of Rocks.	Character of Topography and Soils.
CARBONIFEROUS	Blackwater formation.	Cbw		400	Conglomerate, sandstone, and shale with thin impure coal in very irregular beds.	Steep mountain crests and wide, bare, rocky plains.
	Canaan formation.	Ccn		1200–1300	Red shales with brown sandstones. Thin limestone.	Steep, smooth mountain and hill slopes. Thin soil, in greater part not very fertile.
	Greenbrier limestone.	Cgr		325–410	Limestone and red shale.	Mountain slopes. Rich soil.
	Pocono sandstone.	Cpo		85–700	Coarse, hard sandstone, in part conglomeratic, and softer sandstone with thin coal seams.	High, rocky ridges, knobs, and terraces. Thin, sandy, barren soil.
DEVONIAN	Hampshire formation.	Dh		1600–2200	Sandstones and shales, mainly of red color.	Steep mountain slopes. Thin, sandy soils. In Rockingham County many of the ridges have thin, moderately fertile soil, suitable for pasture.
	Jennings formation.	Dj		2100–3800	Gray and buff sandstones and olive and gray shale.	Mountain slopes. Thin, sandy, barren soil.
	Romney shale	Dr		1000–1300	Shale, black and fissile below, lighter-colored and more sandy above. Thin bed of limestone.	Wide valleys and low, rounded ridges. Thin soil, usually clayey. The valleys generally contain alluvial deposits of greater or less width.
	Monterey sandstone.	SDm		200–300	Calcareous sandstone, weathering to dirty-buff, porous sandstone.	Knobs and ridges. Bare surfaces or thin, sandy and cherty soil.
SILURIAN	Lewistown limestone.	Sl		700–1250	Cherty limestone. Massive limestone. Flaggy limestone. Thin-bedded, impure limestone and calcareous shale.	Knobby ridges and elevated valleys. Thin, rich soil. Fertile slopes on the sides of ridges.
	Rockwood formation.	Sr		65–550	Gray sandstone. Shale with thin sandstone and limestone beds and iron ore.	Slopes and rounded hills. Thin, moderately fertile soil.
	Cacapon sandstone.	Scn		200–350	Red sandstone, mainly flaggy.	Rocky slopes. Thin, sandy soil.
	Tuscarora quartzite.	Stc		250–450	White and gray quartzite.	Rocky mountain-summits. Mainly bare surfaces.
	Juniata formation.	Sj		685–1125	Brownish-red sandstones and red shales.	Steep slopes. Thin, sandy, barren soil.
	Martinsburg shale.	Smb		1100–1500	Gray shale with sandy beds near the top.	Slopes and high rounded hills. Thin, moderately fertile soil.
	Shenandoah limestone.	Ss		1300+	Light-gray fossiliferous limestone. Darker-gray limestone.	Undulating slopes. Fertile clay-soil.

NAMES OF FORMATIONS.

A TABULAR STATEMENT OF NAMES APPLIED BY VARIOUS AUTHORS TO THE STRATA OF THE FRANKLIN DISTRICT. THE IMPLIED CORRELATIONS WITH OTHER STRATIGRAPHIC AREAS ARE NOT NECESSARILY ACCEPTED.

Period.	Names and Symbols used in this Folio.		Names used by Various Authors.	H. D. Rogers: First Report of Pennsylvania, 1836; and W. B. Rogers: The Virginias, 1838, and later.	H. D. Rogers: Final Report of Pennsylvania, 1858.
CARBONIFEROUS	Blackwater formation.	Cbw	Pottsville conglomerate	XII.	Seral.
	Canaan formation.	Ccn	Mauch Chunk shales.	XI.	Umbral.
	Greenbrier limestone.	Cgr	Greenbrier limestone.		
	Pocono sandstone.	Cpo	Montgomery grits. Pocono sandstone.	X.	Vespertine.
DEVONIAN	Hampshire formation.	Dh	Catskill.	IX.	Ponent.
	Jennings formation.	Dj	Chemung.	VIII.	Vergent.
	Romney shale.	Dr	Hamilton.		Cadent.
	Monterey sandstone.	SDm	Oriskany.	VII.	Meridian.
SILURIAN	Lewistown limestone.	Sl	Lower Helderberg. Salina. Niagara.	VI.	Premeridian.
	Rockwood formation.	Sr	Clinton.	V.	Surgent.
	Cacapon sandstone.	Scn	Medina.	IV.	Levant.
	Tuscarora quartzite.	Stc			
	Juniata formation.	Sj			
	Martinsburg shale.	Smb	Hudson River.	III.	Matinal.
	Shenandoah limestone.	Ss	Trenton. Chazy. Calciferous.	II.	Auroral.

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