MARYLAND
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GARRETT
COUNTY

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Quentin D. Singewald

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LETTER OF TRANSMITTAL

To His Excellency JOHN WALTER SMITH,

Governor of Maryland and President of the Geological Survey Commission.

Sir:—I have the honor to present herewith a report on The Physical Features of Garrett County. This volume is the third of a series of reports on county resources, and is accompanied by large scale topographic and geological maps. The information contained in this volume will prove of both economic and educational value to the residents of the region as well as to those who may be considering sites for homes or who may be contemplating the investment of capital in the county. I am,

Very respectfully,

WM. BULLOCK CLARK,

State Geologist.

JOHNS HOPKINS UNIVERSITY,

BALTIMORE, *December, 1902.*

CONTENTS

ILLUSTRATIONS

PREFACE

The present volume on Garrett County is the third of a series of reports dealing with the physical features of the several counties of Maryland. Not only the geology and mineral resources of Garrett County will be considered but also the physiography, soils, climate, hydrography, magnetic declination and forests.

The *Introduction* contains a brief statement regarding the location and boundaries of Garrett County and its chief physical characteristics.

The Physiography of Garrett County, by Cleveland Abbe, Jr., embraces a discussion of the surface characteristics of the region, including a description both of the outward forms and also of the reasons for their existence. Dr. Abbe's general report on the physiography of the whole state in Vol. I of the Maryland Weather Service and his detailed discussion of the physiography of the adjacent region of Allegany County are here supplemented by a detailed discussion of the physiography of Garrett County.

The Geology of Garrett County, by George Curtis Martin, deals with the stratigraphy and structure of the county. An historical sketch is given of the previous work done in this field, to which is appended a complete bibliography. The chapter dealing with the interpretation of the sedimentary record deserves especial mention since it gives an interesting history of this portion of Western Maryland.

A preliminary survey of the geology of Garrett County was made by Mr. A. C. McLaughlin under the auspices of the survey during 1897 and 1898 and the results of this work have been incorporated in the present report.

The Mineral Resources of Garrett County, by George Curtis Martin, deals with the economic wealth of Garrett County, contained in its rocks. The existing mineral industries are described, and the possibilities of new ones are suggested.

The Soils of Garrett County, by C. W. Dorsey, contains a discussion of the leading soil types of the county and their relation to the several geological formations. This investigation was conducted under the direct supervision of Prof. Milton Whitney, Director of the Bureau of Soils of the U. S. Department of Agriculture.

The Climate of Garrett County, by O. L. Fassig, is a valuable digest of the leading climatic features of the county. Dr. Fassig is a Section Director of the U. S. Weather Bureau in charge of the Baltimore Office of that organization and has a thorough knowledge of Maryland Climate.

The Hydrography of Garrett County, by H. A. Pressey and E. G. Paul, gives an excellent account of the available water power in the upper Potomac basin. The authors are members of the Division of Hydrography of the U. S. Geological Survey and their paper is an important contribution to the hydrography of Garrett County.

The Magnetic Declination in Garrett County, by L. A. Bauer, contains much important information for the local surveyors of the county. Dr. Bauer is the Chief of the Division of Terrestrial Magnetism of the U. S. Coast and Geodetic Survey and has been engaged for several years past in making a magnetic survey of Maryland under the auspices of the State Geological Survey.

The Forests of Garrett County, by H. M. Curran, with an introduction by G. B. Sudworth, is a contribution of much significance to the forestry interests of Maryland. Mr. Curran has studied the forestry conditions of the county with much care and has brought together many important facts regarding the present and future prospects of the lumber industry. Mr. Curran is a member of the Forestry Bureau of the U. S. Department of Agriculture.

The State Geological Survey desires to extend its thanks to the several National organizations which have liberally aided it in the preparation of many of the papers contained in this volume. The Director of the U. S. Geological Survey, the Superintendent of the U. S. Coast and Geodetic Survey, the Chief of the U. S. Weather Bureau and the Chiefs of the Bureaus of Soils and Forestry of the Department of Agriculture have granted every facility in the conduct of tho several investigations, and the value of the report has been much enhanced thereby.

THE

PHYSICAL FEATURES

OF

GARRETT COUNTY

SWALLOW FALLS, YOUGHIOGHENY RIVER.

THE PHYSICAL FEATURES OF GARRETT COUNTY

INTRODUCTION.

Garrett county is the westernmost of the three mountainous counties of Western Maryland. It is located between the parallels 39° 12′ and 39° 44′ north latitude and the meridians 78° 54½′ and 79° 30½′ west longitude, and covers an area of 681 square miles. The county is bounded on the north by the Mason and Dixon line, which runs between it and Somerset and Fayette counties, Pennsylvania; on the west by Preston county, West Virginia, from which it is separated by an arbitrary line running north from the headwaters of the Potomac river to the Mason and Dixon line; on the southeast and south by the Potomac river, separating it from Grant and Mineral counties, West Virginia; and on the east by Allegany county, Maryland, the boundary being a straight line drawn from the top of Savage Mountain where it is crossed by the Mason and Dixon line to the middle of the mouth of Savage river.

Garrett county was formerly a part of Allegany county, which as an independent division of the state, dates from 1789, when an act was passed by the General Assembly creating out of the then existing confines of Washington county a new county which should include all that portion of the state lying to the west of Sideling Hill Creek. This continued to be the limits of Allegany county until 1872, when the General Assembly of that year created out of the western part of the county the new county of Garrett, which was to include all that portion of Allegany county lying to the north and west of "a line beginning at the summit of Big Backbone, or Savage Mountain, where that mountain is crossed by Mason and Dixon's line

P.23

and running thence by a straight line to the middle of Savage river where it empties into the Potomac river." Several attempts were made to establish this line, but they were unsuccessful until 1898, when the Maryland Geological Survey was requested by Governor Lowndes, in accordance with an act of the General Assembly of that year, to accurately locate the boundary. The line was an extremely difficult one to run since the points were not intervisible, and the country rough and mountainous. The work was successfully accomplished at the close of the summer of 1898 and the line marked with suitable monuments.

The county seat and largest town of Garrett county is Oakland, which has a population of 1170 and is a prosperous summer resort and local trading center. Other towns are Deer Park and Mountain Lake Park, which are prominent summer resorts; Friendsville, Grantsville and Accident, which are business centers; and Bloomington, Barnum and Blaine, which are mining towns.

Garrett county is essentially an agricultural region, the bulk of the population being on the farms. Lumbering has been a leading industry in the past and is still of much importance. The mining industries are rapidly increasing in significance and will in the not very distant future make this the leading mining region of the state. About half the area of the county is underlain by workable coal, which is as yet almost entirely undeveloped. There is also an inexhaustible amount of the highest grade of fire-clay, none of which has been mined, except in the northeast corner of the county. Other mineral products which may be made the basis of important industries are limestone and shale. Much of the shale is suitable for the manufacture of brick of various kinds and some of the limestones may be used in the manufacture of cement.

The facilities for transportation consist of the main line of the Baltimore and Ohio Railroad which crosses the county from east to west, the West Virginia Central and Pittsburg Railroad which follows the Potomac river along the entire southeastern boundary of the county, the Confluence and Oakland branch of the Baltimore and Ohio Railroad which extends up the Youghiogheny valley as far as

Krug, and Jennings Bros. R. R. which extends up the Castleman valley from a Baltimore and Ohio connection at West Salisbury, Pennsylvania. The old National Road which extends across the northern part of the county from east to west caused an early agricultural development of that section, before the construction of the railroads, and its rehabilitation to-day would be of much economic importance.

The succeeding chapters are devoted to a consideration of the physiography, the geology, the soils, the hydrography, the climate, the terrestrial magnetism and the forestry of the county.

W. B. C.

THE PHYSIOGRAPHY OF GARRETT COUNTY

BY

CLEVELAND ABBE, Jr.

Geographic Position.

Garrett county is the westernmost of the three Appalachian counties of Maryland. The eastern boundaries of the county, viz., the North Branch of the Potomac river and the arbitrary line running from the crest of Big Savage Mountain, where it is crossed by the Mason and Dixon Line, to the mouth of the Savage river, lie to the west of the Alleghany Front, composed in Maryland of Dans and Little Allegheny mountains. As these two mountains mark the eastern boundary of the Alleghany Plateau subprovince in Maryland [1] it is evident that Garrett county lies wholly within the confines of that division of the Appalachian Province. It is not confined to Maryland, but may be traced into the adjacent states of Pennsylvania and West Virginia. Indeed, it is known to exist from the Hudson and Mohawk rivers on the north, to Alabama on the south, and many miles westward across West Virginia, Kentucky and Tennessee to the Ohio river. Garrett county must therefore be regarded as only a small triangular section of a very extensive topographic feature.

Topographic Districts of the County.

Although the general surface features of Garrett county cause it to be classed with the plateau type, still it is found to be divided into a number of smaller areas whose boundaries are well defined, owing to marked changes in the character of the topography. These

[1] Md. Weather Service, vol. i, pt. ii, 1899.

topographic changes are produced by the marked differences in the resistance to weathering and erosion offered by the various strata which lie at the surface, as the result of the two or three broad gentle waves into which the whole group of strata have been thrown, and from the peculiarly marked discrimination in choosing locations for their channels which the streams of the county have shown.

The topographic districts into which the county may be subdivided are most conveniently designated by the chief streams draining them, and are as follows:

The Potomac Valley district, including all that portion of the county lying between Great Backbone and Big Savage mountains on the west and the Potomac-Georges Creek gorges on the east.

The Savage Valley and the Glades district, including the area lying between the Backbone or Big Savage mountain on the east and the Meadow Mountain-Roman Nose-Halls Hill range on the west.

The Castleman Valley district, bounded on the east by Meadow Mountain, on the west by Negro Mountain and on the south by the confluent southern ends of these two gradually converging ridges.

The Youghiogheny Valley district, or the western plateau region, including the Hoyes-Accident amphitheater. This district embraces all that part of the county which lies west and northwest of the Halls Hill-Roman Nose range and of Negro Mountain.

THE POTOMAC VALLEY DISTRICT.

TOPOGRAPHY.—The topographic features of the Potomac Valley district are very simple. Along the western boundary of the district runs the long straight crest-line of Great Backbone and Big Savage mountains which maintain a remarkably uniform elevation of about 3000 feet above sea-level throughout their length. There is, however a slight increase in elevation southward, for the crest rises gradually from a level of 2900 feet near the Pennsylvania line to 3400 feet at the southwest corner of the county. This long even crest is practically continuous save for the gorge cut in it by Savage river just above its junction with the Potomac.

Between Great Backbone and Big Savage mountains, composed

FIG. 1.—YOUGHIOGHENY RIVER CROSSING A NATURAL DAM OF MAHONING SANDSTONE AT OAK SHOALS.

FIG. 2.—YOUGHIOGHENY RIVER PONDED BEHIND A NATURAL DAM OF MAHONING SANDSTONE ABOVE OAK SHOALS.

DRAINAGE OF GARRETT COUNTY.

of Pottsville sandstone or conglomerate, and the eastern bounds of the county, lies a range of broad flat-topped or gently arching hills, of less resistant rocks, between 2600 and 2700 feet in altitude near Savage river and to the north, but gradually increasing in elevation to the south. These hills are in many instances capped by the sandstones of the Conemaugh and Allegheny formations and apparently owe their table-like tops to the resistant nature of their cappings. Between these hills, and nearly at right angles to the crest-lines on the west, are deep ravines, often narrow and bounded by steep slopes, and having flat bottom-lands. On the east all the hills slope down steeply and often precipitously, forming the western walls of the deep narrow gorges occupied by Georges Creek and the North Branch of the Potomac river.

As a rule these broad, flat hills are but expansions of more or less narrow spurs which reach eastward from the crests of Great Backbone and Big Savage mountains. Sometimes the connecting ridges are very narrow, due to the headwater growth of the same streams which have just been mentioned as dividing these hills one from another. This set of headwater tributaries has developed along yielding strata in the Allegheny formation which come to the surface just east of the crests of the Backbone range itself. Thus a set of short, shallow, subsequent valleys often appears between the broad eastern hills and the upper eastern slopes of the bounding range.

Structure.—The arrangement of the strata of this district is quite as simple as the topography. The whole district lies in the western half of a broad flat-bottomed trough or syncline made up of several series of limestones and weak shales, alternating with strong sandstones and conglomerates. Where the upper resistant sandstone of the Pottsville formation is tilted upwards to the west, there the even and enduring crest of Great Backbone-Big Savage Mountain has been located. Since these beds dip toward the southeast and come to the surface along a line bearing about 30° east of north we find that the mountain formed by them has a relatively gentle eastern, and a steep, even precipitous western face, and that its crest follows the same trend towards the northeast as do the beds themselves.

The even-topped hills lying to the east of the Backbone range are cut from a series of shales, sandstones and limestones which lie above the strong Pottsville rocks and have gentle eastward dips. The horizontal position of these beds near the Potomac and Georges Creek valleys seems to have influenced the character of the hills. Where these horizontal beds begin to curve upward along the eastern flanks of the Backbone range, the weak shales of the Allegheny formation are exposed, lying just above the heavy Pottsville sandstone. This series of weak rocks extends in a band parallel with the crests of the mountains, and it is along this band that the subsequent valleys of the headwaters referred to above have been developed.

Drainage.—The drainage of this district is accomplished through the North Branch of the Potomac river on the south and Georges Creek on the north, the whole being ultimately carried off through the Potomac river. The Savage river, which cuts a deep gorge through the Great Backbone-Big Savage mountain range and divides the district into a northern and a southern half, does not play any important part in its drainage.

The precipitation falling on the eastern slopes of Great Backbone-Big Savage mountain range, and on its bordering hills, is drained off by means of a large number of short streams mutually parallel and entering the North Branch of the Potomac river or Georges Creek at right angles to the course of the latter channels. These streams thus have courses down the dip of the strata and therefore have an apparently consequent character. Their valleys, as has been remarked above, are generally narrow, steep-sided and ravine-like in character, with little or no flood-plain area and decidedly steep grades. Occasionally, as in cases of Glade Run and Laurel Run, some more yielding strata in the Conemaugh and Allegheny formations give opportunity for lateral widening of the valley. Then the stream reduces comparatively large areas along the course, to low rolling meadows or even to flat marshy ground. Such instances are rare and they seem to indicate local increase in the solubility of the rocks rather than decrease in resistance to mechanical corrasion, or conditions favorable to local base-levelling.

Stream terraces do not occur except along the valley of the North Branch of the Potomac, and for a few rods back from the mouths of the largest tributaries. They are very poorly marked indeed on the tributaries, although most of the streams show at their mouths distinct flood-plains of the sand and debris which has been washed down from the steep hillsides. The North Branch of the Potomac, however, shows distinct terraces at several points in addition to its well-defined but very rocky flood-plain. At Gorman there are three terraces, at altitudes of ten, twenty (the widest) and one hundred feet above the present channel. At Bloomington there are four terraces, at levels of ten, twenty, fifty and three hundred feet above the channel. The last terrace has an altitude above sea-level of about 1500 feet and is covered with gravel and cobble. These deposits occur along the river road entering Bloomington from the south, and in cuts in the streets of the village, but no traces of them were found at other points on the North Branch. No terraces of any kind were found by the writer or by Dr. C. C. O'Harra along the valley of Georges Creek.

The few occurrences are not sufficient to permit of close correlation being made with the terraces in other areas. It is quite probable, however, that there is some relation between these terrace deposits and those found in Allegany county.[1] The characters of the deposits in the two districts, and more particularly the relative heights above sea-level, faintly suggest some possible former relation between the 1500 feet terrace at Bloomington and the 820 feet terrace at Cumberland.

Stream Adjustments.—There are no striking relations between stream courses and rock structure in the Potomac Valley district, except in the cases of the North Branch and of Georges Creek themselves.

Georges Creek occupies an axial position with reference to the broad syncline lying between Dans and Little Allegheny mountains on the east and the Great Backbone and Big Savage mountains on

[1] See Md. Geol. Survey, Allegany Co., 1900, pp. 27-54.

the west. In direction of flow it is in accord with the pitch of the synclinal axis, thus it may be considered as a counterpart of the ideal consequent stream.[1] The long and complex topographic history of the Appalachians would throw doubt upon any attempt to show that any stream is an ideal consequent axial stream. Nevertheless since this basin contains the youngest Paleozoic rocks found in this portion of the Appalachians it seems safe to say that Georges Creek is the oldest apparent consequent stream here, if it is not really a survivor of the ideal original consequent drainage which probably existed for a time at least after the Appalachian folding attained its maximum. The small tributaries to Georges Creek confirm its present classification as a consequent stream, for they all enter at right angles to its general direction, after having themselves followed apparently consequent courses down the gently dipping limbs of the syncline.

The North Branch of the Potomac also occupies in part an axial position with reference to the southern portion of the same syncline as that occupied on the north by Georges Creek. It presents, moreover, an important point of resemblance to the latter stream in that its northward course is also with the pitch of the axis of the fold. The meandering character of its now deep and narrow gorge points to the conclusion that the stream assumed its present direction of flow at a period when the constructional deformation of the land surface had almost if not quite disappeared.

The smaller headwater streams of the tributary branches flowing in from the west present the best examples, in this district, of accurate subsequent adjustment to structure. The best of these are to be found at the heads of Sand Run, Glade Run, Shields Run, Threefork Run and Laurel Run. All of these belong to the North Branch of the Potomac river. Among the Georges Creek tributaries, Koontz Run and Wrights Run show adjustment in its advanced stages.

In no instance has any one of these side streams succeeded in pushing its headwaters to the west of the Great Backbone-Big

[1] See W. M. Davis, in Nat'l. Geogr. Mag., vol. i, 1888, p. 203.

FIG. 1.—SAVAGE RIVER, BELOW CRABTREE.

FIG. 2.—CRABTREE CREEK.

DRAINAGE OF GARRETT COUNTY.

P. 92 B

Savage crest except the Savage river, which is fully discussed in the following chapter. In one case only has a stream of the Glades district established its sources to the east of that crest, and that case is where a small tributary of Toms Lick Run has crossed the crest just east of the Deer Park station of the Baltimore & Ohio railroad.

THE SAVAGE VALLEY AND THE GLADES DISTRICT.

TOPOGRAPHY.—This district lies parallel with and west of the Potomac Valley district. It is, therefore, bounded on the east by the Great Backbone-Big Savage mountain range, while on the west the long crest of Meadow mountain and its southern continuation in the Roman Nose-Halls Hill range forms an equally prominent topographic boundary. Thus the district is seen to extend from the southern corner of the county in a northeasterly direction to and beyond the Pennsylvania line. Throughout this distance the district maintains an almost uniform width of about six miles.

As seen from the west the eastern boundary of the Savage river district is much more striking than is that same boundary when seen from the eastern or Potomac side. This is owing to the fact that the west slope of the Backbone range descends much more abruptly than does the east slope. This western view is also distinguished from the eastern by the presence, half way up its ascent, of a range of long low ridges or conical hills, called Little Savage Mountain, Fourmile Ridge, Elbow Mountain, and the Little Mountain. This range of subordinate elevation is always separated from the higher one by a narrow valley of varying but always slight depth.

The western boundary of the district is similar to the eastern boundary. The long even crest of Meadow Mountain on the north, continued southward in the serrated crest of the Roman Nose-Halls Hill range, descends sharply on its eastern face. This descent is always interrupted by the presence of a range of lower hills or ridges, such as Hoop Pole Ridge and Red Ridge, while between these ranges and the main crest there is a much better defined narrow valley corresponding to the one on the eastern boundary.

Between these two double crested boundaries lies a long shallow trough drained by the Savage and the Youghiogheny rivers. In the northern portion of this trough the true valley floor is to be seen in the broad, flat tops of numerous ridges, which extend southeastward from the Meadow Mountain boundary.

TABLE OF ELEVATION OF MOUNTAIN CRESTS AND WIND-GAPS IN SAVAGE VALLEY DISTRICT, GARRETT COUNTY.

Floors of Wind-Gaps in Meadow Mountain.	Red Ridge, aver. elev. 2700'.	Range of Central Hills.	Little Savage, aver. elev. 2800'.	Floors of Wind-Gaps in Big Savage Mountain.
		2600' Pennsylvania line.		2750'
2800'				2720'
2781'		2700' Walnut Hill 2600'		2860'
		2600' Pea Ridge.		2860'
2780'		Turkey Lodge 2600' The Elbow.		2820'
		2500' Jenkins Hill.		2820'
2720'		2600' Peapatch Ridge 2550'.		
		2550' Soloman Ridge.		
		2650' Tom Ridge.		

From the middle column of the accompanying table it will be seen that the crests of these central hills are remarkably accordant in lying for the most part between the 2500 feet and the 2600 feet contours. It is also to be noted that numerous low gaps in the crest of Meadow Mountain have an average elevation of 2770 feet, an elevation somewhat above that of Red Ridge (2700 feet), but only slightly below that of Little Savage Mountain (2800 feet) and of the gaps in Big Savage Mountain (av. 2805 feet). Although, as may be inferred from this table, the old valley-floor is evident enough in this portion of the district, it is by no means continuous at the present time.

Between the hills of the central range the present streams have cut narrow valleys to depths varying between 300 feet and 900 feet. These valleys are least deep in that portion of the district to the north of Pea Ridge and increase in depth southward as far as the Savage watergap in the Great Backbone-Big Savage mountain range.

The southern portion of the district, where it is drained by Green Glade Run, Little Youghiogheny river and Cherry Creek, has the same average elevation of about 2650 feet as that of the central northern section. In this portion, however, the valley floor is a distinctly continuous and gently rolling surface, with a few hills rising to levels of 2800 feet or 2900 feet. The drainage is not incised upon the surface at all noticeably in this part, except where the southern tributary of the Savage river is at work and in the extreme western corner of the district, where tributaries of Rhine Fork are at work upon hills rising somewhat above the general level.

Structure.—The rocks of the district are the sandstones, limestones and shales of the Lower Carboniferous formations which occur in the Backbone range beneath the Pottsville formation, and in addition the sandstones and shales of the Hampshire and the Jennings formations of Upper Devonian age.

This whole series of originally horizontal strata has here been arched into a long anticline whose axis runs approximately parallel with the axis of the Potomac synclinal trough to the east. Formerly this arch was roofed over by the strong thick-bedded Pottsville sandstone and supported the Allegheny, Conemaugh, Monongahela and Dunkard formations above, while its core was composed of the weak red and gray shales of the Hampshire and Jennings formations. At the present time the arch is without a roof and only its two limbs or sides remain in the resistant crests of the two parallel ranges of Meadow and Backbone mountains. Much of the soft yielding core of the old arch has also been removed and the beds have been worn down to the almost even surface of the valley floor.

Since the parallelism of the boundaries of this district and the direction of the main valley itself are so striking, it is of interest to know that they are both traceable to the same cause, which, as shown above, is the folding of the rocks into an arch and their subsequent denudation, with the resulting parallel mountain ranges and valleys.

Drainage and Stream Adjustment.—The drainage of this district and the problems dealing with its development and adjustment are of particular interest because here, in the form of a low divide between the Savage and the Youghiogheny rivers, occurs a part of the great continental divide between the waters flowing into the Chesapeake Bay by the Potomac river and the waters flowing into the Ohio river by the Youghiogheny river. As a rule great divides as well as small ones are located upon some stratum or mass of comparatively resistant rock. In a region which has long been exposed to subaërial denudation this is so commonplace an occurrence that an exception in a single case is sufficient to attract attention. In this case where the divide between two streams of considerable size lies neither along the strong crest of Meadow Mountain nor along the equally suitable crest of the Great Backbone-Big Savage mountain range, but upon the low-lying weak rocks intervening, the problems become doubly interesting. Some consideration of the adjustments existing among the smaller streams may throw light upon the problem.

It is found that on either side of the central valley the tributaries of the two principal rivers have developed along lines determined by the position and direction of a series of weak shales and limestones (the Mauch Chunk and Greenbrier formations) which lie between the strong Pottsville sandstone forming the crests of Backbone and Meadow mountains and the resistant but thinner and somewhat weaker Pocono sandstone which maintains the lower crests of Little Mountain, Little Savage Mountain and the Hoop Pole Ridge ranges. The series of slight conical hills forming the Little Mountain range owes its serration to the transverse cutting of the Youghiogheny headwaters as they have struggled to wear down the Pocono sandstone and to establish themselves behind it upon the Greenbrier limestone. In the northern part of the district, and at the same level above the sea, we find similar gaps cut into the Pocono ridges of Elbow Mountain and Red Ridge, Little Savage Mountain and Fourmile Ridge. These gaps, however, are not all occupied by streams at present, as their counterparts to the south. On the other hand, along the limestone and shale behind these ridges there are found long stream-filled valleys such as are not to be found behind the Little Mountain range.

The dry wind-gaps of Elbow Mountain and Red Ridge were probably cut by streams in much the same fashion as the watergaps of Little Mountain are now being worn down to the general level of the valley floor. After being cut down to the general level they would continue to wear away only as fast as the general level subsided.

Having brought their gaps to the general level, the tributaries of the Savage river seem to have gone to work more vigorously upon their outer channels, cutting the deep trenches below the general level which now characterizes this region. During this period of trench-cutting some of the streams, working at greater advantage than others, pushed out their headwaters rapidly along the valleys, already started on the weaker rocks. The result was that the more active streams captured and led off by easier paths the headwaters of the less favored streams. The watergaps occupied by the weaker streams thus came to be deserted and now appear as wind-gaps while the pirate streams increased their volumes and deepened both gap and valleys occupied by them. For example, a deep dry wind-gap just east of New Germany indicated the point where Elklick Run formerly crossed Red Ridge. The more powerful and more favored Poplarlick Run has worked around the corner of the ridge, intercepted the Elklick Run waters and carried them off behind the ridge, leaving the trunk of the shrunken beheaded stream to drain only the eastern slope of the ridge. In a somewhat similar way Twomile Run has been beheaded at Piney Grove by the encroachments of Red Run.

Similar rearrangements of stream courses with reference to underlying rock-structures, resulting always in more perfect adjustment of streams and divides to the bands of strong and weak rocks, may be traced in various portions of this district. The eastern tributaries of the Savage river, its enterprising southern tributary Crabtree Creek, and the Youghiogheny headwaters all exhibit rather close adjustment to structure. In frequent association with these readjusted streams, and particularly with the subsequents of the Savage river system, are found marshy and swampy regions. They usually occur along those portions of the present streams which were captured from earlier transverse streams. Marshy and swampy lands are to be expected along certain streams, where readjustment of courses by stream piracy has been going on, but not in the locations where they here occur. The capture of headwaters involves a decrease in volume of the beheaded stream and a consequent decrease in its carrying power, while at the same time there occurs an increase in volume and an increase in power of the pirate stream. The shrunken and weakened stream might well be characterized by swamps about its head since there it is now subject to overloading with the waste from its valley slopes. On the other hand the increased power of the pirate stream should tend to remove any extra load about its headwaters and not to accumulate debris there in sufficient quantity to obstruct its flow. It is, therefore, important to note that in this district nearly every one of the swampy areas, located on the topographic map, belong to the original headwaters of the beheaded streams and also are situated above the points at which the diversions must have been effected. They cannot, therefore, be regarded as the results of the stream-captures which have taken place.

A reasonable explanation for the marshy characters of the subsequent headwaters of these streams may be found, however, by appealing to the solvent power of underground and soil waters, particularly in regions of limestone rock where the rapid flow of surface water is hindered. All these streams have valleys located on the Greenbrier limestone and its adjacent shales, and the captured headwaters were thus located for some time while the trunk of the beheaded stream was at work, unavailingly, upon the resistant Pocono sandstone in the present wind-gap. Thus there was sufficient time for the production of a flat swampy head valley even before the capture took place. After the capture the pirate stream may have been slow in pushing headwards its lower channel, or the whole upper portion of the subsequent valley may have been lowered rapidly through the agency of solution to the new and lower level determined by the level of the channel at its new point of crossing the resistant and less soluble sandstone. In short, these marshy subsequents may be explained as the result of chemical action, which, together with mechanical corrasion, has progressed faster in the upper part of the valley than in the lower. In some cases the present level of these marshy tracts indicates that they antedate the stream diversion, in other cases they seem to have been produced since. In one case, that of Poplarlick Run, marshy ground occurs at both an old and a new level. For a mile above the mill-pond at New Germany there is a marsh at the new level which has clearly been produced since the diversion of the stream. At the 2500 feet contour the channel rises rapidly until at 2620 feet it reaches the apparent old level still occupied by Wolf Swamp, which belongs also to the Red Run drainage.

The southern half of this district from Beckman to the West Virginia boundary is drained by various tributaries of the Youghiogheny river; among them are Deep Creek, the Little Youghiogheny river and Cherry Creek. These streams all break through the Pottsville ridge which forms the western boundary of this district and drain into the Youghiogheny river.

This part of the district differs very strikingly in its topographic form from the portion which is drained by the Savage river. These westward-flowing streams are all small and sluggish and meander through broad swampy valleys and have not cut any such deep gorges as those occupied by Savage river and its tributaries.

This part of the district is in its topographic form a broad and gently-rolling valley, flanked on either side by a double ridge. The inner and lower ridge is formed of the Pocono sandstone, while the outer and higher ridge is formed of the Pottsville sandstone and conglomerate. Parts of this same general level, which is still so perfectly preserved in the southern half of the district, may be seen on the flat tops of the ridges between the tributaries of the Savage river.

These broad, flat, marshy meadows are locally known as "The Glades." They represent former local base levels which the new drainage has not yet destroyed.

At the State Dam, Deep Creek cuts through Hoop Pole Ridge and spreads out to the east a number of weak streams to collect what waters they can from the low rolling country to the north of Oakland and Mountain Lake Park. From its uppermost sources down to the mouth of Marsh Run the channel of Deep Creek meanders over marshy flood-plains of varying widths which are situated in moist low meadow-lands called Glades. In another place[1] these Glades have

[1] Md. Weather Service, 1898, vol. i, pt. ii, pp. 164, 165.

been explained as basins of local base-levelling through meehanical and chemical agencies, aided by the retardation of vertical downcutting at their outlets.

At Oakland the Little Youghiogheny river breaks through the ridge in a similar manner and with its many meandering tributaries drains a large area occupying the entire width of the valley for a length of about 8 miles from northeast to southwest. The general character of the topography and drainage is similar to that of the headwaters of Deep Creek.

About 4 miles southwest of Oakland, Cherry Creek breaks through the ridge and carries in a northwest eourse a drainage from a large Glade area. The region southwest of Redhouse is drained by a similar stream which is tributary to Cherry Creek and finally through it to the Youghiogheny river.

Returning to the problem presented by the location of the Savage-Youghiogheny divide upon the shales of the Hampshire and Jennings formations, rather than upon the hard crest of either the Backbone or the Roman Nose ranges. It is clear from what has been said eoncerning the Savage river tributaries that they are at present aggressive streams which are extending their drainage area both by capture and by encroachment. Their activity and that of the Savage river itself are further evidenced by the deep narrow ravines they are cutting below the general valley-floor and by the deep gorge the Savage river has cut across Backbone Mountain. On the contrary the Youghiogheny headwaters everywhere show eomparatively weak currents, are assoeiated with much more mature topography whose hollows lie anywhere from 200 feet to 400 feet above the adjacent valleys of the Savage river tributaries, and thus lie in general mueh eloser to if not upon the old valley-floor. Thus the characters of both systems indicate that the Youghiogheny river produced and occupied the valley lowland between the Backbone and the Meadow Mountain ranges, that Savage river has recently begun to encroaeh upon the territory of the Youghiogheny, that the continental divide at this point once rested upon the Backbone erest and that now Savage river is gradually transferring it to the Meadow Mountain-Roman Nose range.

THE CASTLEMAN VALLEY DISTRICT.

Just west of the valley of the Savage river lies another valley, which is drained in large part by the Castleman river. This valley has had, probably, an origin quite different from that of the Savage river, but has been associated with the latter in its development and may therefore be considered next.

Topography and Structure.—While the headwaters of the Savage and the Youghiogheny rivers have produced a valley-form out of the soft core of a broad anticline or arch of rock which was originally roofed by the massive Pottsville sandstones, the Castleman valley occupies a natural trough or syncline, floored with a considerable thickness of the Conemaugh and Allegheny formations, but underlain by the same massive sandstone.

The trough is in shape similar to one-half of a canoe, the bow lying to the south, while the open waist lies some distance north of the Pennsylvania line. The sides of the canoe are formed by the upturned edges of the Pottsville sandstone and appear as two long even-crested mountains, Meadow Mountain on the east and Negro Mountain on the west. These ridges coalescing to the south just north of the valley of Deep Creek, are continued as one ridge in Roman Nose and beyond.

Both ridges have crest-lines of singularly uniform height. The maximum elevation of Meadow Mountain (3030 feet) is reached at a point about two miles northeast of New Germany and at a point about one mile south of the Pennsylvania line. Meadow Mountain maintains an average elevation of 2980 feet throughout, but Negro Mountain rises from an elevation of 2900 feet at its southern end to 3082 at a point about two miles south of the Pennsylvania line.

The crests of both mountains are now notched by dry wind-gaps, and just at the southern end of the trough the waters of Cherry Creek have cut a deep narrow outlet from the interior of the basin. The striking uniformity in the levels of the floors and of the gaps in Meadow Mountain has already been remarked. Their average elevation was found to be 2770 feet. Negro Mountain has three well-marked wind-gaps. One, occupied by the road between Keyser and Grantsville, has an elevation of 2880 feet; two miles south of this lies a second at 2830 feet; the third is used by the road between Keyser and Bittinger at an elevation of 2845 feet, and the tram-road of the Meadow Mountain Lumber Company crosses Negro Mountain at an elevation of 2780 feet. These gaps in Negro Mountain are thus seen to be quite uniform in elevation also, although they stand at a higher average level, 2834 feet, than do those in Meadow Mountain.

The area lying between Negro Mountain and Meadow Mountain is a region of broad hills averaging 2800 feet in altitude to the south and gradually declining to 2700 feet above sea-level to the north. The mature and accordant hills now found here, and the repetition of the almost horizontal strata in each hill from one boundary to the other, indicate that this interior region was once a gently rolling and continuous valley floor, but at present the streams are tending to incise their channels below the general level of the former floor. The resulting dissection of surface is most marked, and has been carried to the greatest depth along the northern or lower portion of the course of Castleman river, while the area to the south of "The Dunghill" is much less sharply incised.

The slight difference in elevation existing between the average height of the bounding mountain-crests and that of the included hills is a noteworthy and significant feature of this district, as is also the close accord existing between the general level of the interior and that of the wind-gaps in the same boundaries. These features will be referred to below in considering the drainage of the district.

A series of beautiful terraces of constructive origin are well developed in the broader parts of the Castleman Valley especially for about 4 miles above Grantsville. The main terrace lies at an elevation of about 2200 feet above sea-level and about 30 feet above the Castleman river. It is composed of well-stratified sand and clay with a surface of loam. It will be more fully described in the chapter on stratigraphy.

Drainage and Stream Adjustments.—The drainage of the district is, at present, accomplished by two sets of streams. Most of the surface water runs off through the channels of the headwaters of the Castleman river flowing to the north, while a small portion of the southern half is drained by Cherry Creek, which is a marshy tributary of the Deep Creek-Youghiogheny system.

The Castleman river has incised its lower course the most markedly. It is a stream overloaded by material brought in by tributaries or by the waste from the valley walls and is in only a few places incising its channel as a youthful stream. Quite in accord with this feature is the meandering course of the channel and valley, being quite suggestive of the flood-plain meandering of a stream in late maturity.

The tributaries of the Castleman as well at its headwaters exhibit in like degree the tendency to degrade their channels and fashion trenches for themselves. Many of them also show considerable adjustment to the variations in resistance offered by the underlying rocks. Thus, on the east, Chestnut Ridge and Saltblock Mountain are separated from Meadow Mountain by a subsequent valley worked out by Big Laurel and Meadow Runs. On the west the North Branch of the Castleman has worked out a similar valley between Negro Mountain and Ridgely Hill and "The Dunghill." Farther south Pleasant Valley Run and other North Branch tributaries have worked out subsequent courses. The adjusted courses of these tributaries, the meandering course of the Castleman and the mild, accordant character of the general topography indicate that this river-system and its basin have been, at one time, close to the completion of a cycle of river history. The narrower valleys, now filled by parts of the course of the Castleman and its two main branches, indicate youthful conditions, following the more advanced stages just referred to.

A consideration of Cherry Creek, the other drainage line of this district, should throw some additional light on the past topographic development of the Castleman syncline. This stream flows out from the south end of the structural canoe through a deep, wild and narrow gorge whose steep sides are formed by the same hard strong rock which forms the boundaries to the district, namely, the Pottsville sandstone. Above this gorge the stream-system is found to occupy comparatively broad and shallow valleys, located along the bands of weaker rocks. In other words the headwaters of this stream are characterized by rather advanced topographic features and adjusted courses. Just above the head of the gorge and also at or near the heads of several of the tributaries to Cherry Creek are several areas of poor drainage, as is shown by their marshy character. The largest of these is roughly triangular in outline and situated at the confluence of all the tributaries, just at the head of the gorge. The smaller areas all drain into Cherry Creek, but the second largest one drains into Pleasant Valley Run of Castleman river, as well as into Cherry Creek of the Deep Run-Youghiogheny system. It is quite possible that all these marshes, large and small, which characterize Cherry Creek are similar in origin to some of those described when considering the Savage valley district; that is, they may be marshes of excessive solution or up-stream erosion, occasioned by the retarding influence of the sandstone in the gorge of Cherry Creek. Taken in connection with the fact that wherever the one side of a divide is towards a stream of the Cherry Creek system and the other side towards a stream of the Castleman river system, the steeper slope is always towards the Castleman river, the silting up of some of the Cherry Creek streams becomes significant of quite different history. The marshes may then be fairly interpreted to mean, in part, that the encroachments of the steeper valleys upon the milder ones has resulted in decreasing the volume and the power of some of the Cherry Creek streams. Probably the true explanation for all of the marshes here would include some of both.

The adjustments and mature characters of the Cherry Creek waters harmonize then with the supposition that the Castleman river and its district have been at an advanced stage of topographic development in an epoch immediately preceding the present. This epoch would seem to have been characterized, in this district, by a broad, somewhat uneven valley of slight depth, lying between two low ridges where Negro and Meadow mountains now stand. This valley was occupied by the immediate forerunners of Castleman river and Cherry Creek, both occupying essentially the same relative positions that they now do, except that Cherry Creek probably then drained some of the region now drained by the Castleman river. Tributaries of the Castleman had at that time succeeded in pushing their sources beyond the mountain boundaries of the district, cutting gaps through the ridges where are now found the wind-gaps whose floors have been noticed as so accordant in elevation with the old valley floors within and without the district. The conversion of these old water-gaps into the present wind-gaps has probably been brought about, first by the Youghiogheny river invading their territory, as its lower outlet by Oakland gave it the power to do; second, by the final or at least most recent invasion by the young and vigorous Savage river, by means of which all lingering traces of possession of the outer regions by either the Castleman or the Youghiogheny rivers are being rapidly removed. On the west, Bear Creek seems to have played a part similar to that of the Savage river. Thus Castleman river seems to be gaining a little territory from Cherry Creek, but on the whole to be losing ground to the Savage and the Youghiogheny rivers.

THE YOUGHIOGHENY VALLEY DISTRICT.

TOPOGRAPHY.—Northwest of an almost straight line connecting the summits of Halls Hill, Roman Nose and Negro Mountain lies the deeply dissected drainage basin of the Youghiogheny river. As seen from some hill of average height, such as near Hoyes at an elevation of 2612 feet, or the hills, 2600 feet high, just north of Cove Postoffice, the county appears to be a high and rather undulating district with a range of rather higher hills, the Winding Ridge range rising above it. If the large amount of rock which has been worn away in the carving out of the present valleys could be restored, it is clear that a broad and rather strongly rolling surface, having a general elevation of 2600 feet to 2700 feet, would be restored. At the present time, however, the somewhat plateau-like landscape thus capable of restoration in imagination is very far from the mind of the traveler compelled to traverse laboriously a region of broad round or flat-topped hills separated by very deep and steep-sided valleys.

The ranges of hills remaining somewhat above the general surface of the upland are significant of the rocks which compose them, and of the arrangement of the strata in this district, just as the ridges in the other districts have been found to be significant of the same features.

Winding Ridge is the most important and most interesting, and therefore it will be considered in more detail. This ridge, composed of Pottsville sandstone along its crest, may be said to have its southern origin at Marsh Hill, where the range is separated from the same rock in Negro Mountain by the valley of Marsh Run. From Marsh Hill the sandstone, and its ever-present ridge, runs westward to Sang Run. There the ridge turns to the north, curves out to the west a little and gradually swings back to north and northeast, forming Winding Ridge proper and finally rejoins the Negro Mountain line of outcrop at some point north of the Pennsylvania line. Thus a roughly oval area of considerable extent is enclosed by the sandstone-capped crests of Winding Ridge and southern Negro Mountain. The longer axis of this oval is approximately parallel with the general trend of the Castleman and Savage valley folds, while the hard stratum forming the ridges everywhere dips away from the center of the enclosed area.

Within and almost parallel with these ridges of Pottsville sandstone stands a second oval of less perfect ridge-like elevations and formed by the Pocono sandstone. The hills about Hoyes, George Hill, and the horseshoe ridge which encloses the head of Cove Creek, all belong to this range of inner and lesser elevations, and in this case also the maintaining sandstone stratum dips away from the central enclosure.

On the other side of the Youghiogheny the outlines of the Snaggy Mountain-Dog Ridge range present a similar configuration of surface forms, at least as far as the outer range of hills is concerned, and they probably arise from a similar underground arrangement of the strata.

The remaining well-defined and orderly group of surface forms is the Roman Nose-Halls Hill range, lying between the Youghiogheny and its tributaries, Rhine Creek and White Meadow Run. This range together with the long crest of Meadow Mountain, is due to the slight upward turning of the Pottsville formation and forms the eastern limit of the peculiarly plateau portion of the county.

Structure.—From what has necessarily been said in discussing the topography of the Winding Ridge district it is evident that the strata have there been arched into an elliptical dome whose longer axis lies about on a line running through Hoyes, Accident and Cove. A similar structure, whose major axis must be almost parallel with that of the Accident dome, lies to the west of the Snaggy Mountain range. Between these two domes, and embracing the rest of the district, the strata are arranged in a trough with the Youghiogheny river flowing very nearly along the axis.

Drainage and Stream Adjustments.—All the streams of this district belong to the Youghiogheny system, and most of them show traces of having been originally located in strictly consequent courses.

The Youghiogheny itself still maintains in part of its course what seems to be a strictly consequent course, as it flows down the axis of a northward plunging syncline. Thus in relation to underlying structure it resembles the Castleman river and the North Branch of the Potomac. Unlike these streams, however, the channel of the Youghiogheny imitates closely the course of a stream which has inherited a meandering channel from a former flood-plain state. The Youghiogheny is also peculiar in the way in which it fits into its gorge. Above Friendsville the stream has no considerable space for flood-plain between its channel and the valley walls except at one or two curves where the stream is overlooked by several terraces. From about one mile south of Friendsville to the Pennsylvania line the river is flowing through a broad valley with a wide flood-plain on one or both sides of the river channel. This flood-plain is in the nature of a terrace of very recent origin and not much above the high-water mark. There are traces of other terraces at various points, especially at the mouths of the larger tributaries. These can best be seen west of Friendsville at the mouth of Buffalo Run and at the mouth of Mill Run. As these terraces are evidently of constructive origin the description of them will be found in the chapter on stratigraphy.

Farther up stream the many rapids and falls in the channel, notably the two miles of rapids and cascades at Swallow Falls, indicate that the stream is still reducing its channel along that portion of its course in spite of occasional terraced and flood-plain stretches.

The tributary streams entering the Youghiogheny from the west all have the characters of lateral consequents, which have been recently revived into active work. Those streams entering along the lower half of the valley have deep youthful valleys, some of which are beginning to silt up a little about their mouths. Their patterns of branching are characteristic of streams in regions of almost horizontal strata, or of some approximately homogeneous rock-mass. Farther to the south the originally consequent patterns of Saltblock Run and Muddy Creek have been modified by their development into transverse streams across the Snaggy Hill-Dog Ridge range. These streams have developed headwater subsequent courses along the weak rocks lying west of this range of hills and have thus begun a series of adjustments to the structures of the Cranesville dome or anticline. In advancing towards perfect adjustment Muddy Creek has so far been the most successful. Its headwaters have worked out, levelled and broadened their valley much faster than the transverse portion of the stream has been able to reduce the resistant Pottsville formation which it crosses at or near Browning Mill. This retardation has no doubt been aided in recent times by the building of a mill dam at this point. The result of the natural and artificial damming here has been the formation of a level boggy floor of solution upon the limestone and shales above the mill, known as Pine Swamp.

The headwaters of the Youghiogheny, comprising Rhine Creek, Cherry Creek, White Meadow Run, Little Youghiogheny and other streams, constitute a series of well adjusted transverse and subsequent streams along the southwestern limb of the great Deer Park anticline. Some of them were no doubt active in unroofing that anticline and in producing the old valley along its axis. As has been indicated when discussing that valley, the topography in this portion of it retains markedly mature characteristics without any suggestion of revivals such as are found along the lower course of the Youghiogheny.

VIEW LOOKING EAST FROM MONTE VISTA.

DEVONIAN TOPOGRAPHY, OLD DRAINAGE.

Of the tributaries joining the Youghiogheny from the east the largest and most important are Mill Run, Bear Creek and Deep Creek. Mill Run, the most northern of these streams, lies chiefly between the crest of Winding Ridge and the Youghiogheny at Spielman Mills. It is therefore in large part a cataclinal and probably a consequent stream; but its headwaters have broken their way into the region behind or east of the resistant rocks of Winding Ridge and are now back to a subsequent valley on the shales and limestone of the strata between the Pottsville and the Pocono sandstones. The rock waste brought down by this stream seems to be considerable, for at its debouchement at Spielman Mills a sufficient quantity has collected to force the Youghiogheny against its left bank.

In marked contrast to Mill Run is Bear Creek, a very small portion of whose course lies in a consequent position. The extremest source of Bear Creek is near the village of McHenry, opposite the southern end of Negro Mountain. From here it takes a northeasterly direction through a deep but rather open subsequent valley lying between Negro Mountain and the inner Pocono sandstone range of George Hill. About two and one-half miles east of Accident this subsequent valley ceases, the stream turns sharp to the west, cuts a deep gorge through the George Hill range at Kaese Mill and follows a somewhat narrower and more tortuous valley through the Hampshire and Jennings formations. Three miles west of Kaese Mill, Bear Creek again crosses the Pocono hills, receives a small subsequent tributary, Feik Run, from the north, and then breaks a deep, narrow gorge across the Winding Ridge range, emerges from the Accident dome and joins the Youghiogheny at Friendsville. Just after breaking through Winding Ridge, Bear Creek receives its considerable South Branch, which is also a transverse stream at this point. The South Branch has worked directly back through Winding Ridge and the first Pocono ridge which it reached, then has extended its headwaters in every direction backwards to Elder, to Hoyes and to Accident, draining the weak central area of the dome by means of a set of deep and rather narrow valleys sunk below the general levels of the Hampshire and Jennings hills. Remnants of an old floor at about

2500 feet may still be recognized on the hill tops about Accident and Hoyes.

There seems to have existed here, at a somewhat earlier geographic period, an inner lowland of roughly elliptical outline. It was characterized by very mature but not senile topographic forms, extending across the weak Hampshire and Jennings formations and into the narrow marginal subsequent valleys; and was everywhere doubly enclosed by the circumscribing hill-ranges due to the Pocono and the Pottsville sandstones. The whole made up a topographic combination resulting from the unroofing of the Accident-Hoyes stratigraphic dome and would seem to have resembled, in a rough way, the general appearance of an ancient amphitheater.

Deep Creek, in the lower part of its course, occupies a purely consequent position, draining the eastern limb of the southern end of the Youghiogheny syncline. It here occupies a gorge 200 feet in depth and of very limited width. From a point four miles below the mouth of its affluent Marsh Creek, up to the State Dam the valley is slighter shallower and is partly occupied by a broad flat terrace or a marsh. Marsh Run, the first tributary to Deep Creek, is at present a small stream occupying a broad, deep and level-floored valley, located transversely upon the south flank of the Accident dome. Its size is apparently too small for the valley it now occupies. Its headwaters lie within the Pottsville rim of the dome and upon the southern slopes of the inner Pocono ridge just north of McHenry. One small branch on the east heads against the extremity of Bear Creek, being separated from the latter valley only by a low broad saddle at an elevation of 2540 feet. On the west a somewhat longer branch seems to have recently intercepted the headwaters of Hoyes Run and diverted its upper waters into Marsh Run. Two miles above Marsh Run, Deep Creek receives the waters of Cherry Creek coming down from the uplands of the Meadow Mountain basin, and one mile to the eastward the subsequent stream Meadow Mountain Run empties into Deep Creek.

At the State Dam, Deep Creek cuts through Hoop Pole Ridge and spreads out to the east a number of weak streams to collect what waters they can from the low rolling country to the north of Oakland and Mountain Lake Park. From its uttermost sources down to the mouth of Marsh Run the channel of Deep Creek meanders over marshy flood-plains of varying widths which are situated in moist low meadow lands called Glades. In the case of Deep Creek it seems probable that its marshy character between the State Dam and the mouth of Marsh Run is due, in part, to the considerable amounts of detritus brought in by Meadow Mountain Run, Cherry Creek and Marsh Run, while the general volume of the whole group of streams has of recent times been steadily decreasing before the encroachments of Bear Creek, Castleman river and Savage river. However, the considerable portion of the Savage river anticlinal valley still drained by Deep Creek, its strikingly inconsequent and transverse location across the nose of the Negro-Meadow mountain canoe and the present disproportionate size of its upper valley, all indicate that this stream has been an important factor in the development of the Savage and the Youghiogheny valleys. Just what part it has played and what changes it has undergone have not been ascertained.

General Summary.

In reviewing the general topographic features of Garrett county as a whole its surface is found to fall naturally into three different groups of forms, viz.: the mountain crests, ridges and hill-tops of the highest levels, the wide, elongated and originally rather evenly floored valleys of an intermediate elevation, and the narrower steep-sided gorges which existing streams have cut below the average valley levels.

To the first group of features belong the crests of Great Backbone and Big Savage mountains, the Meadow Mountain-Roman Nose range, Negro Mountain, the Winding Ridge range and numbers of hills to the northwest of the Winding Ridge range as well as the crests of the Snaggy Mountain range in the southwest. All these crests are found to be remarkably even, quite accordant in elevation and reaching to an average altitude of 3000 feet. The even crest-lines, the gradual increase or decrease in elevation of the same, and the fact that, when neighboring regions are studied, similarly accordant elevations maintained by rocks of different hardness are found, these considerations have led to the conclusion that the existing crests are but remnants of an old peneplain of subaërial origin. This former surface extended, it is supposed, almost uniformly across areas of strong and of weak rocks; but only remnants on the resistant rocks have endured to the present time, forming the even crests of the highest ridges.

The ancient peneplain referred to would have been produced by the rivers of the whole area thus reduced, and in reducing the area the agents of denudation must have planed down or removed all structural elevations, such as domes and anticlinal arches, to the same general level. Thus it was during this earliest period that the Deer Park anticline and the Cranesville and Accident domes were unroofed. At the close of this cycle of denudation there could not have been much contrast between the valleys and their divides. A reëlevation of the whole area gave the streams another opportunity to reduce their valleys and divides. They had become located, in great measure, on the yielding rocks of the area before the close of the preceding cycle; now they went to work on these rocks and seem to have had time to reduce them to new lowlands resembling the earlier peneplain in character of surface, but limited in extent to the bands of weaker rock. This set of new lowlands, valley lowlands as they have been called, are still well preserved in the second group of topographic forms, namely, the set of even-floored valleys lying at an average elevation of about 2750 feet, which includes the Potomac, the Youghiogheny-Savage, the Castleman valley and the Accident amphitheater.

Sufficient time was also given for numbers of streams to cut through Savage, Meadow and Negro mountains, forming water-gaps, most of which soon became wind-gaps through perfected stream-adjustments, but the masses of these ranges were not very much reduced before another and a comparatively recent revival of stream activities set most of the streams to work on the carving out of the deep, narrow gorges which they now occupy. This most recent revival has been varied at times with terrace-producing incidents, but these latter are of very transient importance in the whole life history of the streams.

Among the drainage features of the county the lower course of the Youghiogheny, the Castleman, the North Branch of the Potomac and Georges Creek are all found in apparently consequent positions. This is probably to be explained by the fact that the synclines which they occupy are all composed of yielding shales lying above the unyielding Pottsville sandstone, and that in each case this whole combination was originally depressed below the lowest level to which the county was reduced by subaërial denudation. Thus at the close of the earliest topographic cycle, remnants of whose peneplain have already been described, these constructional troughs contained yielding strata at the surface and were therefore very favorable locations for streams at that time. Since then the neighboring unroofed anticlines have come to be further developed and lowered by subsequent streams of newer growth, while the earliest subsequent but synclinal streams have also been able to reduce their yielding rocks without being much hampered by the deep-lying Pottsville.

Some changes in drainage have resulted from the later streamwork, as it has been shown to be probable that not only the headwaters of the Youghiogheny and the Savage rivers, but also the eastern tributaries of the Castleman, once occupied the long subsequent anticlinal valley between Big Savage and Meadow mountains. The mature character of the present sources of the Youghiogheny and the position of their shallow valleys at the 2700 to 2800 foot level indicate that they are a portion of the original second cycle drainage by which this level of the valley was produced. Adjustments have been accomplished and others seem to be in progress, among the lower eastern and central western tributaries of the Youghiogheny, in the regions about the cores of the two domes along the Hoyes-Accident axis, which were also unroofed during the earliest topographic cycle and were left exposed at its close.

One of the most important adjustments is the one in progress along the Savage-Youghiogheny divide. The divide is seen to have once stood along the Great Backbone-Big Savage crest but to be now pushed to the lower level of the anticlinal valley as the result of the successful attack by Savage river upon that crest. Indications have also been found that the divide is on its way to a new resting place upon the Meadow Mountain-Roman Nose range.

THE GEOLOGY OF GARRETT COUNTY

BY

GEORGE CURTIS MARTIN

Introductory.

The following pages contain a brief review of previous geological work in this region, and a complete bibliography of all geological publications relating to the subject. Following this is a short description of the materials composing the rocks of this region, and of the methods employed in classifying them. Especial attention is then paid to the *Stratigraphy* and *Areal Distribution* of the rocks which are considered as individual beds having definite positions one above the other and occurring in definite areas of outcrop at the surface of the earth. This discussion is followed by a detailed account of the *Structure*, which considers the relations of the rocks to each other in regard to their position as a part of the earth's crust. The results gained from the foregoing chapters are finally interpreted in a *Sedimentary Record of Garrett County*, which includes a description of such local phases of geological activity as have manifested themselves in this particular region, and an account of the course of events which have occurred here during known geological time.

Historical Review.

The period of geological investigation in Garrett county extends from the year 1824 to the present. The physiographic features of much of the region have long been known, as it was on the route of the Indian and early military trails from the Atlantic coast to the Ohio valley, and on the early surveyed railroad and canal routes between the East and the West. These physiographic features, although early known, have however, not been properly studied and understood until the present.

Most of the geological work, except that of a very general nature, which was done prior to the last eight years was confined to that narrow strip of territory which is contiguous to Allegany county and lies within the Georges Creek coal-basin.

These investigations may be grouped into the following classes:

Private Investigations:
- Exploratory work.
- Economic investigations.
- General observations.

Official Investigations:
- Surveys by the State.
- Surveys by the National Government.
- Surveys of the adjacent States.

PRIVATE INVESTIGATIONS.

Exploratory Work.—The earliest systematic investigations of the natural resources of this region were the surveys for the projected canal connecting the waters of the Potomac and Ohio rivers. In 1824 James Shriver published an account of these investigations, accompanied by a map showing the topographic and something of the geologic features of the region between Piedmont and Cranesville. Other publications on this subject were by Mercer in 1834, and by Merrill in 1874. The construction of the Baltimore and Ohio Railroad led to a vast amount of investigation, most of which, however, has never been made public. In 1838 a report on these surveys was published.

Some of the earliest observations on the geology of Garrett county were made by travellers who passed through the region and observed its geology in an incidental way or in a purely scientific spirit. The first of these was Sam. Whyllys Pomeroy, who in 1832 published a letter containing some rather fantastic descriptions of the scenery along the National Road. Other travellers were W. E. A. Aiken, who published in 1834, and Charles Lyell, in 1845. Lyell's descriptions are the most scientific and the best known, but his investigations were largely confined to the Georges Creek coal-basin and especially to that part of it which lies within Allegany county.

Private Economic Investigations.—A large amount of work has been done on the character and extent of the coal by mining companies, especially in the Georges Creek basin. Many of these reports have not been made public, but among those which have are the following:

A report by J. H. Alexander and P. T. Tyson was made in October, 1836, to the Georges Creek Coal and Iron Company. This report gives two maps of portions of the Georges Creek area, one columnar section known as the "Dug Hill Section," one structure section and various other details.

A report made by George W. Hughes during the same year, 1836, to the Maryland Mining Company gives the result of an examination of the coal measures and iron ore deposits belonging to that company. The paper includes various analyses and columnar sections.

In this year also James C. Booth studied the area and published the results in a short paper entitled "Report of the Examination and Survey of the Coal-fields and iron ores belonging to the Barton and New York Coal Company." The next year, 1837, further notes by Mr. Booth, as well as short reports by L. Howell and John Powell were published for the same company.

The following year, 1838, Benjamin Silliman made a brief study of the property of the Maryland Mining Company.

In 1852 reports were published by the Phoenix Mining and Manufacturing Company which included a "topography of the mineral regions" by Professor Forrest Sheppard and a report on the topography and structure of the coal-field by Professor C. U. Shepard.

Two years later, 1854, George W. Hughes, President and Engineer of the Hampshire Coal and Iron Company, published a report dealing especially with the lands controlled by his company.

General Observations.—There are many more general papers which often deal only incidentally with Garrett county. Among the more important of these are the following:

The Transactions of the Maryland Academy of Science and Literature for 1837 contains three important papers bearing in part on the geology of Garrett county. These are: an "Outline of the Physical Geography of Maryland," by J. T. Ducatel; "A Description of the Frostburg Coal Formation," by Philip T. Tyson; and "A descriptive Catalogue of the principal minerals of the State of Maryland," by Philip T. Tyson.

In the year 1841, H. D. Rogers discussed the origin of the Appalachian coal strata, and with his brother, W. B. Rogers, published an important paper "On the Physical Structure of the Appalachian Chain as Exemplifying the Laws which have Regulated the Elevation of Great Mountain Chains."

J. P. Lesley in 1856 published his "Manual of Coal and its Topography," which contains a very important discussion of the succession of the strata of the Coal Measures.

During the summer of 1868, Professor James T. Hodge, of Boston, studied the coal basin and made an extensive survey of the coal properties of the Georges Creek basin. In his report, published the following year, he gives much attention to property lines, but also discusses the coal region as a whole, including the drainage of the basin, access to the coal-bed, system of mining, area covered by the Big Vein and product of Big Vein coal to the acre. To the property-owner this has been a most valuable work, but the report is now almost wholly inaccessible. This report deals chiefly with that part of the basin in Allegany county.

In the year 1871, Philip T. Tyson published a section of the Carboniferous strata of the Georges Creek basin. James McFarlane's "Coal Regions of America," published in 1873, contains a description of the coal of Maryland, based upon Tyson's work.

In 1878, Professor J. J. Stevenson published two articles in the American Journal of Science on the geology of portions of Pennsylvania, Maryland and West Virginia. In one article particular mention is made of the terraces in Garrett and Allegany counties, and in this article the causes of the present physiographic features are discussed. The other article deals with the Upper Devonian rocks.

The year 1882 was one of particular interest in the development of a correct knowledge of the structural geology of the western part of Maryland. Among the important publications which appeared during this year was a paper by Howard Grant Jones and one by

Professor I. C. White. In Mr. Jones' paper a section west of Cumberland was given which was accompanied by a discussion of the correlation of the various rocks. Professor White later reviewed the work and rectified some of Mr. Jones' conclusions. Professor White's paper is the first publication showing conclusively the conformity and proper relations of the rock formations as found in the region around Westernport.

Professor J. J. Stevenson published in 1887 a discussion of the lower Carboniferous rocks of Pennsylvania, Maryland and the Virginias, in Volume xxxiv of the American Journal of Science.

In the same journal and in the same year, Professor I. C. White discussed the probable causes which have brought about the deposition of rounded boulders at high altitudes on the eastern side of the Alleghanies. Six years later he published an important discussion of the geological section along the Baltimore and Ohio Railroad which was prepared for one of the excursions of the International Geological Congress.

A description of the Georges Creek basin, by Thomas L. Osborne, published in 1893, contains a very important section of the Coal Measures, in which the coal seams are named and intervals given.

OFFICIAL INVESTIGATIONS.

Surveys by the State.—The first state geological survey of Maryland was provisionally organized in 1833; and in 1834 J. T. Ducatel, State Geologist, and J. H. Alexander, State Topographical Engineer, in a "Report on the Projected Survey of the State of Maryland, pursuant to a resolution of the General Assembly," gave general statements concerning the geology of the county. Mention is made of the Frostburg coal-field. Much of the information was taken from the collection of reports and letters of the engineers of the Chesapeake and Ohio Canal.

During the year 1836, the State Topographical Engineer, J. H. Alexander, directed the execution of a chain of triangles with a planetable survey over a part of the Georges Creek area. The work of this survey was accomplished at individual expense, but the results were generously offered for the use of the state survey.

The following year, 1837, J. T. Ducatel, the State Geologist, in his official report to the Governor of Maryland, included a description of the Frostburg coal-field in which the columnar section made for the Georges Creek Coal Company is given. In this report there is also given a carefully prepared hachured map of the entire area on which the various streams, towns and mines are located and named. Frostburg is given on the map as Frost Town, and the coal area is called after it. This is the source of the maps of the Georges Creek area most frequently seen.

During the year 1840, Ducatel made a study of the physical geography, geology and agricultural and mineral resources of Western Maryland. The results of his observations were published in the "Annual Report of the Geologist of Maryland, 1840." This is a paper of 46 pages, 30 pages of which are taken up with a study of the area now included in Garrett county. Mr. Ducatel's report was the first published document of any considerable length which reviewed with reasonable accuracy the geology of the entire county. It includes an account of the geology and physical geography with remarks on the actual agricultural condition, prospects and resources, as well as information concerning the mineral wealth of the county and the best means of developing it. Two columnar sections of the coal-fields, one structure section along the "Cumberland and National roads," and a topographical map of what is now Garrett, Allegany and Washington counties on the scale of 1:400,000 are given.

The same year, Mr. J. H. Alexander, in an official report to the Governor of Maryland, gave an account of the manufacture of iron. This has more to do with Allegany county than with Garrett, but an account is given of the old furnace at Friendsville.

In the year 1848 Dr. James Higgins was appointed State Agricultural Chemist. He continued in office until 1858 when he was succeeded by Mr. Philip T. Tyson, who held the position until it was abolished in 1862. The investigations of the State Agricultural Chemists dealt chiefly with the relations between soils and crops and included many analyses of soils and fertilizers. There is not much in these publications which relates to Garrett county, but the Fourth Annual Report of Dr. Higgins, published in 1854, contains a paper on Allegany county which then included what is now Garrett county. Mr. Tyson's report in 1860 contains much geological information, including a map of the entire state. This map, published on the scale of twelve miles to the inch, gives the only detailed representation of the geological formations of the county prior to the work of the U. S. Geological Survey. Upon the map is a structure section across the northern part of the county. His second report, published in 1862, treats quite fully of the geology and industrial resources of the state.

In the year 1862 Mr. Higgins published under state auspices "A Succinct Exposition of the Industrial Resources and Agricultural Advantages of the State of Maryland."

The Maryland Agricultural Experiment Station has issued several publications dealing with the agricultural resources of the state. Among these are a paper by Milton Whitney, published in 1893, on "The Soils of Maryland;" one by H. J. Patterson in 1900 on "The Occurrence and Composition of Lime in Maryland;" and one by F. P. Veitch in 1901 on "The Chemical Composition of Maryland Soils."

The Inspector of Mines, since the year 1879, has issued reports on the condition of the mines in Allegany and Garrett counties. These deal with the safety and healthfulness of the mines and do not contain any geological data.

In the year 1892, Professor W. B. Clark published in the Report of the Maryland State Weather Service a paper on "The Surface Configuration of Maryland." The following year he published in the next volume, papers on the Water Power and Climate of Maryland.

The following year (1893), a general summary of the geology of the state was published by Professors George H. Williams and William B. Clark of the Johns Hopkins University in the Maryland World's Fair Book, entitled "Maryland, its Resources, Industries and Institutions." In this report the geology of Western Maryland is discussed at considerable length. With this publication there is a geological map of the state in which the areal distribution of the various formations and the structure of the rocks of Garrett county are represented in much greater detail and accuracy than on any previous map.

The next year, 1894, Professor Clark published in the First Biennial Report of the Maryland State Weather Service a description of the "Climatology and Physical Features of Maryland."

The present Maryland Geological Survey was organized in the early part of the year 1896 and at the opening of the field season began work in various parts of the state. Since then several volumes have been published by the Survey under the direction of Professor William B. Clark, State Geologist. In Volume I a general preliminary discussion of the various geological features of the state is given, including much new and valuable information concerning the stratigraphic, physiographic, economic and structural features of Garrett county. Volume II includes a description of the various building stones and of the geologic maps of the state, with particular mention of Garrett county. Volume III treats especially of the highways of the state, their present conditions and the material at hand in each of the counties for road-construction.

In 1898 a report by L. A. Bauer was published on the Survey of the Boundary-line between Allegany and Garrett counties. This contains a map showing approximately the outcrop of the Pittsburg coal.

Volume I of the Maryland Weather Service, published in 1899, contains "A General Report on the Physiography of Maryland," by Cleveland Abbe, Jr.; and also much meteorological information relating to Garrett county.

In 1900 a report on "The Physical Features of Allegany County" was published by the Maryland Geological Survey. This was the first of a series of county reports which includes the present volume. It contains much valuable information which relates directly to the geology of Garrett county.

The same year Professor Charles S. Prosser published two papers entitled "Names for the Formations of the Ohio Coal-Measures" and "The Paleozoic Formations of Allegany County, Maryland." Both of these contain much information relating to the geology of Garrett county, which was obtained in his field-work as Chief of the Division of Appalachian Geology of the Maryland Geological Survey.

Volume IV of the Maryland Geological Survey contains a paper by Bailey Willis entitled "Paleozoic Appalachia, or the History of Maryland during Paleozoic Time," and a report by Heinrich Ries on the Clays of Maryland. Both of these contain much information concerning the rocks of Garrett county. The latter is especially rich in new and valuable descriptive matter.

In 1901 the Maryland Geological Survey published a report on Maryland and its Natural Resources as the official publication of the Maryland commissioners at the Pan-American Exposition and the South Carolina, Interstate and West India Exposition.

In the year 1902, W. B. Clark and G. C. Martin published a paper on the correlation of the Coal Measures of Maryland with those of the adjacent states. The equivalence of the formations of the Coal Measures and of their subdivisions with those of other regions is shown, and the local names which had hitherto been in use in this region are abandoned in favor of the older names.

Surveys by the National Government.—The National government has made many investigations on the geology of Maryland, some of which have been in Garrett county.

In his "Report of a Geological Reconnaissance made in 1835 from the seat of government by way of Green Bay and the Wisconsin territory on the Coteau du Prairie, an elevated ridge dividing the Missouri from the St. Peters river," G. W. Featherstonhaugh gives considerable geological information concerning Western Maryland. He traveled under the direction of the United States government and passed through the county while en route westward, evidently entering the county by the National Road. From Cumberland he went to Frostburg, thence down the Georges Creek valley to the Potomac, which he ascended beyond the mouth of Savage river, then returned along the Potomac to Cumberland. He speaks briefly of the Georges Creek coal area, holding that the coal-bearing strata were deposited after the movement which produced the folding to the east. His report includes an important section of the Coal Measures at the mouth of Savage river.

During the year 1891, Bulletin No. 65 of the United States Geological Survey was published. This is by Professor I. C. White on "The Stratigraphy of the Bituminous Coal Field of Pennsylvania, Ohio and West Virginia." Reference is made to the Coal Measures of Maryland, and the map which accompanies the bulletin includes the Cumberland-Georges Creek district. This bulletin is of the greatest importance for it contains a number of very accurate and detailed local sections, and established for the first time the identity of the coal seams and other members of the Carboniferous formations with those already named in Pennsylvania and elsewhere.

In the Fourteenth Annual Report of the United States Geological Survey, published three years later, 1894, Joseph D. Weeks, under the title of "The Potomac and Roaring Creek Coal Fields," describes at some length the Cumberland-Georges Creek district, and gives columnar sections of the same, which are copied from the paper previously mentioned.

In 1896, the Piedmont Folio, No. 28 of the Geologic Atlas of the United States, was published by the United States Geological Survey. The geological work was done by Messrs. N. H. Darton and Joseph Taff under the direction of Mr. Bailey Willis, and was begun in the autumn of 1894. The quadrangle covered by this folio includes a large area in the southern part of Garrett county, and the geology of the entire quadrangle is very similar to that of this county. Several of the formational names used in the folio have been adopted by the Maryland Geological Survey, and much of the discussion concerning the various geological features has been of great value in the later work.

The Hydrographic Division of the U. S. Geological Survey published in 1899 two papers which include accounts of stream-measurements in Garrett county.

The Twenty-second Annual Report of the U. S. Geological Survey, published in 1902, contains a paper by Mr. David White on the Bituminous Coal Fields of Maryland.

A large amount of statistical information has been collected and published by the National Government in the Census Reports and in the reports on the Mineral Resources of the United States. The latter have appeared as a regular annual series of publications by the U. S. Geological Survey from 1883 down to the present.

Surveys of the Adjacent States.—In the course of the work of the geological survey of Virginia many observations were made along the Potomac river which have a most direct bearing on the geology of Garrett county, and in his report for 1839, W. B. Rogers makes some observations which apply to the Maryland side of the river.

The first and second Pennsylvania surveys shed a vast amount of light on the geology of Garrett county and many of the Pennsylvania reports contain direct observations on the geology of this region. Among these are the final report of the first Pennsylvania survey, published in 1858 by H. D. Rogers; the Report of Progress in the Cambria and Somerset District, by F. and W. G. Platt in 1877; the Second Report of Progress in the Laboratory of the Survey, by A. A. McCreath in 1879; the Annual Report for 1885 by J. P. Lesley; and the Final Report by J. P. Lesley, published in 1892.

A report on the clay of New Jersey by George H. Cook, published by the Geological Survey of New Jersey in 1878, contains references to the Mount Savage fire-clay.

SUMMARY.

It may be seen from what has been written that the previous information concerning the geology of Garrett county has been gathered both by unofficial and by official means. The unofficial work includes exploratory surveys, private travels and private economic investigations. The official work includes that accomplished by the existing U. S. Geological Survey and the earlier exploratory survey of Featherstonhaugh: by the geological surveys of the adjacent states: and by the three state geological surveys; the first or Ducatel-Alexander survey, the second survey conducted by the state agricultural chemists, Higgins and Tyson, and the third or present Maryland Geological Survey.

The approximate areal distribution of the three larger geological divisions (the Devonian, the lower Carboniferous, and the upper Carboniferous or Coal Measures) and the general structure of the region, have long been known. The first step toward a more refined classification of the Coal Measures was made by Tyson who measured and published accurate detailed sections of the strata in the Georges Creek valley. The second Pennsylvania survey divided the Coal Measures in great detail and mapped the various formations here recognized. As a result of this work the equivalence of many of the members exposed in the Georges Creek valley with those described and named in Pennsylvania became partly understood. The work of Dr. I. C. White as published in the Proceedings of the American Philosophical Society for 1883, and in Bulletin 65 of the U. S. Geological Survey in 1891, first established the identity of the formations and members of the Carboniferous and Devonian of western Maryland with those of other regions. The first attempt at detailed geologic mapping in this region was made in 1894 by Darton and Taft, who mapped the southern part of Garrett county as part of the Piedmont quadrangle of the geologic atlas of the United States. The structure of the region was properly represented but unfortunately the standard and accepted classification of the Coal Measures was ignored. The report on the Geology of Allegany County, published in 1899, contains the first accurate delineation in this region of the generally accepted classification of both the Carboniferous and Devonian. The present report is the westward extension and finer elaboration of the scheme of geologic mapping and description which was pursued in the preparation of that report.

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STRATIGRAPHY.

INTRODUCTORY.

The rocks which form the surface of Garrett county are entirely of the class known as *sedimentary* or *clastic*—that is, they represent deposits of material derived from the destruction of older rocks and laid down by moving water. The details of this process will be described more fully in the chapter dealing with the geological history of Garrett county.

The rocks of Garrett county, like all rocks of sedimentary origin, are *stratified*—that is, they consist of distinct superimposed beds which differ from each other in composition, texture, and appearance. Some consist of pebbles cemented together, and are known as *conglomerate;* some consist of small grains of quartz sand and are known as *sandstone;* some consist of clay with more or less fine sand, and are known as *shale*[1] or *sandy shale* or *fire-clay;* some consist of lime

[1] The rock known as *slate* in this region is not a true slate but a shale. A true slate differs from a shale in mineralogical composition and in texture; it usually has a more glossy surface, is harder, splits into large thin

with varying amounts of the shells of former animals and clay, and are known as *limestone;* some consist principally of carbonaceous matter of vegetable origin, and are known as *coal.* All of the above mentioned rocks are firmly consolidated and retain their form and individuality against considerable force. Other rocks have the same composition as these but differ from them in being unconsolidated and hence are known by other names. An unconsolidated conglomerate is a *gravel;* an unconsolidated sandstone is a *sand;* an unconsolidated shale is a *loam* or *clay;* an unconsolidated limestone is a *lime-sand* or a *marl;* an unconsolidated coal is a *peat* or *lignite.* This latter class of rocks is not abundant or prominent in Garrett county but some representatives are found here, and all are very abundant and important in other regions.

These various types of rock sometimes grade into each other irregularly, but generally they are separated from each other sufficiently to allow of their recognition and of the representation of their areas upon a map. This has been done upon the map accompanying this report. A stratum of rock or a series of strata which differs enough from those adjoining it in composition, appearance, or age, to permit a discussion of its distribution or its representation upon a map is called a *formation,* and each formation is named after some locality where it is typically developed and where it was first studied and described.

The rocks which come to the surface of the earth in Garrett county have been divided into eleven formations. All formations are grouped according to their age into larger divisions known as *Systems.* Four of these systems are represented among the surface rocks of Garrett county, and the representatives of several others lie deeply buried below the surface formations. The whole sequence of strata lie not in horizontal position, but folded in a series of alternating basins ("synclines") and arches ("anticlines"). These folds have been

sheets suitable for roofing, and does not break into small irregular fragments or grind up into a fine mud or clay suitable for brick making as shale does. True slate never occurs with *bituminous* coal as shale does, but is found in association with *anthracite* coal and with granite, marble, and other rocks which are foreign to this region.

cut into by the action of streams and weather, so that in various parts of the county different strata are exposed at the surface. The character of this folding will be described in the chapter on *Structure.*

The rocks forming the known portion of the crust of the earth, at and below the surface of Garrett county, have been classified as follows:

TABLE OF GARRETT COUNTY FORMATIONS.

Cenozoic		
Quaternary		
Paleozoic		
Permian (?)		Dunkard
Carboniferous	Pennsylvanian or Coal Measures	Monongahela
		Conemaugh
		Allegheny
		Pottsville
	Mississippian	Mauch Chunk
		Greenbrier
		Pocono
Devonian		Hampshire
		Jennings

The youngest system is called the *Quaternary.* The Quaternary deposits of Garrett county are neither abundant nor well developed, and consist of a few areas of gravel, sand, loam and clay somewhat irregularly distributed chiefly along the principal streams. They are not important enough to be named as a formation or shown upon the map. The next older system represented in Garrett county is the *Permian.* This consists of a single formation known as the Dunkard. Underlying the Permian and next older than it is the *Carboniferous* system which here consists of seven formations, called the Monongahela, the Conemaugh, the Allegheny, the Pottsville, the Mauch Chunk, the Greenbrier, and the Pocono. These rest upon one another in the order named, the last being the oldest, and resting upon the next older system, which is known as the *Devonian.* The Devonian system contains two formations which occur at the surface in Garrett county. These are called the Hampshire and the Jennings. The base of the Jennings formation probably does not come to the surface anywhere in Garrett county.

No rocks older than the Jennings have been exposed and there are no record of them in deep wells or shafts, but from analogy and comparison with other regions it is certain that most, at least, of the older rocks exposed to the eastward in Allegany county and in the adjoining parts of Pennsylvania and West Virginia exist as continuous strata and retain their lithologic and faunal characteristics and thickness under this county. This supposition is confirmed by the fact that the strata have been found in this condition in the deep oil and gas wells to the westward in West Virginia and along the continuation of the oil and gas belt in Pennsylvania. The basal beds of the Jennings formation in Allegany county consist of thin-bedded black argillaceous shales. These beds must be very near the surface in portions of the Deer Park anticline. Underlying the Jennings formation in Allegany county is the Lower Devonian, consisting of the Romney formation which contains about 1600 feet of shales and thin-bedded sandstones, the Oriskany sandstone which is about 325 feet thick, and the Helderberg limestone which is about 800 feet thick. Under this is the Upper Silurian system which contains several formations aggregating about 2300 feet of sandstones, shales and limestones. These formations are described in detail in the report by Dr. C. C. O'Harra on "The Geology of Allegany County,"[1] and in an article by Professor C. S. Prosser on "The Paleozoic Formations of Allegany County."[2]

Underlying the Upper Silurian system is the Lower Silurian system which in Washington county consists of from 700 to 1000 feet of shales and sandstones underlain by an unknown thickness of limestone. In the gas-well at Cumberland the sandstones and shales had a thickness exceeding 1200 feet. This system is in turn underlain by the Cambrian system which in eastern Washington county contains about 9000 feet of limestone and sandstone. It is highly probable that the Lower Silurian and Cambrian formations are very much thinner under Garrett county than they are to the east where the

[1] Md. Geol. Survey, Allegany County, 1900, pp. 57-163.
[2] Jour. Geol., 1901, vol. ix, No. 5, pp. 409-429.

FIG. 1.—VALLEY OF BIG RUN.

FIG. 2.—VALLEY OF MONROE RUN.

DEVONIAN TOPOGRAPHY, NEW DRAINAGE.

above mentioned thicknesses were measured. In many cases this tendency of these formations to thin to the westward has actually been observed, and according to the known facts concerning the conditions of deposition of these formations they must be much thinner. Underlying the Cambrian is a vast series of crystalline rocks concerning whose thickness, origin and relationships little is known even where they are best exposed. Even the wildest speculation could not venture a suggestion as to what these rocks are like in that portion of the earth's crust underlying Garrett county. We know only that under the lowest sediments of the Cambrian there is a great series of crystalline rocks, corresponding approximately at least in age, to some of the gneisses of the Piedmont Plateau and of the mountains of New England and Canada, and that these grade downward into the great unknown interior of the earth of which our knowledge must always remain a blank.

That portion of the earth's crust underlying Garrett county consists then of a totally unknown complex of crystalline rocks at the base, overlain by an unknown but probably not very great thickness of sandstones and limestones (in part at least crystalline) of Cambrian and Lower Silurian age, then by not more than 2400 feet of sandstones, shales and limestones of Upper Silurian age, and then by about 2800 feet of limestone, sandstone and shale of Lower Devonian age. On these rest the Upper Devonian, Carboniferous and Permian formations which are described in the following pages.

THE DEVONIAN.

The Jennings Formation.

Areal Extent.—The Jennings formation outcrops in two areas in Garrett county and underlies all of the remainder of the county at various depths. The largest of these areas is along the crest of the Deer Park anticline in a belt about 35 miles long and from one to four miles wide. The center of this belt enters the state from Pennsylvania where the valley of Piney Run enters it and extends in a direction about S 40° W to a point three miles west of Frank-ville (Floyd); thence about S 60° W to a point about three miles north of Altamont; thence about S 40° W to the West Virginia line at a point about five miles north of Potomac Stone. Both the southeastern and the northwestern boundaries of this belt are too irregular for verbal description, depending on variations in topography and in strike and dip. The narrowest portions of this belt are in the valley of the Savage river and its tributaries where the hills are so high that the overlying formation extends far toward the axis of the anticline. The widest portions are toward the southern end of the belt where the hills are lower and where the dip is steeper, thus bringing almost the whole thickness of the formation to the surface.

The other area is in the center of the Accident anticline, and occupies an irregular oval, about one mile long and three-fourths of a mile wide, the center of which is about two miles west of Accident.

Lithologic Description.—This formation consists predominantly of a series of beds of shales and sandstones of yellowish gray, drab, olive, and brown color. The total thickness is not certainly shown in Garrett county. In the vicinity of Gortner and Sunnyside a thickness of about 3500 feet is exposed without bringing the base in sight. The thickness in Allegany county has been estimated at from 3500 to 5000 feet. To the west in various parts of West Virginia a thickness of about 3300 feet has been found in the oil and gas wells. The basal beds in Allegany county are black argillaceous shales. These have not been observed in Garrett county, but it is uncertain whether they are absent or are nowhere brought to the surface. Above these beds in Allegany county and where the lowest parts of the formation have been seen in Garrett county are a series of alternating yellow and light olive green sandy shales and thin gray sandstones with some fossiliferous bands, the sandstones and the fossiliferous beds becoming more predominant toward the top. Still higher is a very constant fossiliferous shaly sandstone bearing a typical Chemung fauna. Immediately above this is a bed of conglomerate of doubtful thickness. The entire thickness of this conglomerate has not been observed in this county, but the size and abundance of the derived boulders indicate at least ten feet and probably much more.

About one and one-half miles above Corrigansville in Allegany county a thickness of thirty-five feet has been observed. This conglomerate consists of a mass of pebbles of white milky vitreous quartz with occasional pebbles of jasper, in a dark gritty ferruginous cement. The pebbles are characteristically flat and lenticular in shape. The joints always cut across the pebbles and are frequently coated with drusy quartz. The rock always breaks straight across the pebbles in a direction at right angles to the bedding. Boulders of this conglomerate are found along a more or less distinct line of hills parallel to and about half a mile from the outer and upper contact of the formation. They are especially abundant where the National Road crosses the Jennings belt and between Oakland and Sunnyside, and have also been observed near the center of the Jennings area to the west of Accident. Fossils occur sparingly in the conglomerate. The overlying beds consist of a series about 650 feet thick of brown and yellowish-brown sandstone with some shale. Fossils have been noted in them.

Taxonomy.—The black shales at the base of the formation represent the Genesee shales of New York. The overlying bluish, olive, and dark gray shales and flaggy sandstones represent the Portage formation of New York and carry the Naples fauna which invaded the Devonian sea from the west. The yellowish and gray fossiliferous sandstones and the flat-pebble conglomerate are the equivalent of the Chemung sandstone, while the conglomerate itself suggests very strongly the Lackawaxen conglomerate of Pennsylvania. The reddish or brown sandstones carry the expiring Chemung fauna and have been regarded as transition beds toward the overlying Hampshire or Catskill (which they are in lithologic character) and as the basal beds of the Hampshire formation. They are here placed where the faunal evidence very distinctly places them, as the equivalent of the highest Chemung.

The Hampshire Formation.

Areal Extent.—The Hampshire formation, resting as it does upon the Jennings formation with apparent conformity, flanks the eastern area of that formation on either side and surrounds the western area. There are thus three large separate areas of Hampshire in the county, and five small detached ones. These are as easily recognized in nature as they are on the map, for the soil derived from this formation is brick-red in color and contrasts sharply with the yellow soils of the underlying Jennings[1] and the overlying Pocono.

The more easterly of these areas extend for the entire length of the county along either side of the belt of Jennings already described. The outer boundaries of these belts follow parallel and very close to the crests of two ridges or lines of hills which are upheld by the more resistant rocks of the Pocono formation. These belts vary in width from half a mile to two miles.

The third area of Hampshire entirely surrounds the small area of Jennings already described as lying to the west of Accident. The outer boundary of this area is likewise defined by an encircling line of hills which are capped by the overlying Pocono. This area has a length of about nine and one-half miles and a width from the Jennings to the Pocono of about two and one-half miles on the eastern side and about one-half mile on the western. The average width of the area from the eastern to the western Pocono boundary is a little more than three miles.

North of this area are five small detached ones.

Lithologic Description.—The Hampshire formation consists of a series of shales and sandstones which are red or green in color. Various shades of red predominate. The derived soil is always brick-red. The basal beds are argillaceous shales with a few thin interbedded sandstones. The middle beds consist of alternating argillaceous shales, sandy shales, and flaggy sandstones. The upper beds contain more massive sandstones with some conglomeritic sandstone and occasional beds of argillaceous shales. Toward the southern end of the most eastern area (south of the Baltimore and Ohio railroad) the sandstones in the upper part of the formation become very mas-

[1] Even the reddish brown beds at the top of the Jennings, although they are lithologically not unlike some of the sandstones of the Hampshire, give the yellow Jennings soil rather than the red soil of the Hampshire.

FIG. 1.—HOOP POLE RIDGE, NORTH OF OAKLAND.

FIG. 2.—POCONO SANDSTONE, NEAR SWANTON.

POCONO FORMATION.

sive and form a line of high knobs which here overshadows the line of the Pocono outcrop. The sandstones of this formation are characteristically micaceous, and are frequently cross-bedded. The thickness of the formation varies from 1800 to 2200 feet in the eastern part of the county, but decreases toward the west. In the western area the thickness is about 1200 or 1400 feet. The thickness cannot anywhere be accurately measured because there is no place where a direct vertical measurement can be made, and the uncertainty of the dip (because of cross-bedding) makes any estimate liable to an error of several hundred feet.

Taxonomy.—This formation occupies a position in Maryland between the highest beds carrying the marine Chemung fauna and the lowest Carboniferous beds. It is the equivalent of a part at least of the Catskill beds of New York and Pennsylvania. The Catskill of that area is a lithologic unit which is synchronous wholly or in part with the Chemung and with the lowest Carboniferous. The Hampshire formation of Maryland is a lithologic unit which is physically identical with the Catskill. As above stated it is younger than the highest Chemung and older than the lowest Carboniferous *of this region.* Whether it may be synchronous with any beds of Chemung or of Pocono age of *other* regions, and *how much* of the Catskill it may represent cannot be determined until more work has been done in the intermediate region to the north of the Maryland line. I. C. White, J. J. Stevenson, and others who have studied these deposits in western Maryland and immediately adjacent districts regard the Hampshire as the practical equivalent of the Catskill. Dr. White thinks that the name Catskill should be used for these deposits in Maryland, since their "horizon, lithology, fossils and stratigraphic sequence are so plain in your state." He says further: "I have followed those green and red beds from the Catskill mountains entirely across Pennsylvania to the Maryland and West Virginia line." Professor Stevenson[1] in speaking of the same formation says that "the Catskill of Vanuxem—*the* Catskill—is present in and magnifi-

[1]The above quotations are from letters received from Dr. White and Professor Stevenson.

cently developed in Fulton county, Pennsylvania, on the Maryland line. It is present in Maryland and Virginia for I have followed it to New River in the latter state. You must have nearly 3000 feet of Vanuxem's Catskill in that portion of Maryland adjoining Fulton county, Pennsylvania. . . . 'Catskill' is of course only a local development of Upper Chemung. The condition began in New York even in the later Hamilton and spread southward slowly."

No fossils except possibly a few poorly preserved fish plates have been authentically recorded from the Hampshire of Maryland.

THE CARBONIFEROUS.

The Pocono Formation.

Areal Extent.—The Pocono formation outcrops in four areas in Garrett county. The most easterly extends across the longest dimension of the county from northeast to southwest, outcropping on the crest and eastern slope of the ridge which is parallel to and about two-thirds of a mile west of Savage and Backbone mountains, and which is known in its various parts as Little Savage Mountain, Fourmile Ridge, Elbow Mountain, and the Little Mountain. Between the Savage River gap and Swanton, and again to the southwest of Conway Hill the Pocono is apparently not as resistant as along the rest of this line of outcrop, for instead of forming a ridge it here outcrops along the western slope of Backbone Mountain. This area has a total length of about forty-six miles, and a width varying from one-eighth to one-half mile and averaging about a quarter of a mile.

The next area is on the western flank of the same anticline. It extends in a long narrow belt parallel to the last and about four and one-half miles northwest of it. The formation here outcrops along the crest and western slope of the ridge known in various parts as Red Ridge and Hoop Pole Ridge. This area has a length of about thirty-seven miles and a width of from one-fourth to three-fourths of a mile.

The third area encircles the dome of Devonian rocks at Accident. The inner edge of this belt is very irregular because of the small angle of dip and the irregularity of the topography. The outer edge enters the state from Pennsylvania about two-thirds of a mile west of the crest of Negro Mountain. It then extends in a southwesterly direction, parallel to and from one-half to two-thirds of a mile from the crest of that mountain, to McHenry. In this course it follows a very distinct line of drainage which consists of the headwaters of Puzzley Run for the first three and one-half miles, and the headwaters of Bear Creek for the remainder of the distance. From McHenry it extends in a west-northwesterly direction to a point about two miles east of Sang Run; and thence in a northerly and then northeasterly direction parallel to the crest of Winding Ridge. It reaches the Pennsylvania line about one-half mile east of Oakton.

The fourth area extends along the West Virginia line for about six miles south from Cranesville. The eastern boundaries are Pine Swamp, Whiteoak Spring Run, and the fork of Snowy Creek which flows along the western base of Snaggy Mountain.

Lithologic Description.—This formation consists of conglomerate and sandstone with some shale. The shaly beds are more predominant toward the base. Exposures of this formation in place are very infrequent, and no complete section of the formation has been obtained. The following section which was obtained in the railroad cut at Altamont shows in great detail the character of the lower beds in this part of the county.

Section of Lower Part of Pocono Formation at Altamont, Garrett County.

	Feet.
1. Gray sandstone	20
2. Gray, yellow, and dark shales	12
3. Sandstone	1
4. Yellow, gray and white, finegrained shales	5
5. Dark shales with marine invertebrates	12
6. Gray sandstone with interstratified shales	33
7. Green sandy shales	3
8. Massive yellow sandstone	15
9. Yellowish- and greenish-gray sandstone with cuboidal fracture and with interstratified thin brown shales and yellow sandy shales, which predominate at the base	60
10. Light blue shales	6
11. Yellow sandy shales	5
12. Brown micaceous sandstone (Hampshire)	
Total	172

Massive sandstones and conglomerates seem to make up the middle part of the formation, and are especially prominent in the western part of the county. The thickness of the conglomerates is not known. In the area around Accident they are very prominent and appear to constitute the greater part of the formation. In the more easterly areas conglomerate is almost lacking and fine grained gray sandstone is the prevailing rock.

Above the coarse sandstone and conglomerate of the middle part of the formation is a series of greenish somewhat shaly sandstone, which resembles certain rocks in the Hampshire and Mauch Chunk formations. The rocks are well exposed in the valley of Bear Creek.

Section Two and One-half Miles East of Friendsville, Garrett County.

	Feet.
1. Greenbrier limestone	
2. Thin-bedded green sandstone and concealed	120
3. Massive conglomerate and sandstone	15
4. Concealed	10
5. Thin-bedded green sandstone	5
Total	150

Taxonomy.—The Pocono formation is the eastern representative of part at least of the Waverly group of Ohio. Like the Waverly it carries a marine fauna. The fossils have not been studied carefully enough to determine whether or not the faunas are identical. It is the lithologic equivalent and the stratigraphic continuation of the Montgomery sandstone of Virginia.

The Greenbrier Formation.

Areal Extent.—The Greenbrier formation occurs at the surface in three entirely separate areas in Garrett county. One of these areas is so complicated in its boundaries that in describing the surface distribution it may be considered as made up of four connected areas, making a total of six Greenbrier areas in the county. The most easterly of these areas is situated parallel to and about one-half mile west of the crest of Savage and Backbone mountains. It enters the county from Pennsylvania one-half mile west of the northeast

FIG. 1.—EXPOSURE OF GREENBRIER LIMESTONE, SOUTHWEST OF OAKLAND.

FIG. 2.—NEARER VIEW OF THE SAME.

GREENBRIER FORMATION.

P. 92 B

corner of the county and extends in a southwesterly direction to the West Virginia line, one mile north of Potomac Stone. This belt is about forty-five miles long and from one-fourth to one-half mile wide. It occupies a valley between the Pottsville (Savage Mountain) and the Pocono (Little Savage Mountain) ridges. This valley is that drained at the north by the headwaters of Laurel Run and Savage river, and farther south by Little Savage River, Swamp Run, and Pine Swamp Run. Along the northern end of Backbone Mountain the line of outcrop is for a large part of the way up on the mountain-side, but further south it occupies a series of valleys like those along Savage Mountain but less pronounced.

The second area extends along the eastern side of Meadow Mountain in the valleys of Red Run and Meadow Mountain Run as far as the confluence of the latter with Deep Creek near Thayerville. Thence it extends in the same southwesterly direction, in a similar series of valleys between Hoop Pole Ridge and the ridge of Pottsville rocks to the west of it, to the West Virginia line at a point about seven miles southwest of Oakland. This series of valleys is drained by branches of Deep Creek and of Miller Run and by White Meadow Run and Rhine Creek. This belt is about thirty-seven miles long and from one-eighth to one-half of a mile wide.

The third area extends from a point near Thayerville on the one last described, down the valley of Deep Creek to the mouth of Marsh Run, thence up the valley of Marsh Run to McHenry, thence in a westerly direction for about one mile where it bifurcates. One prong extends down the valley of Hoyes Run for about one mile where it dips under the overlying formation. The other extends in a northwesterly direction through a valley to Sang Run. From here it extends up and down the valley of the Youghiogheny river to points one and one-half miles north and two and one-half miles south of Sang Run where it dips under the overlying formation.

The fourth area extends from a point on the one last described at McHenry, in a north-northeasterly direction in the valley parallel to and about one-half mile west of Negro Mountain as far as and across the Pennsylvania line. This belt is about fifteen miles long and one-eighth of a mile wide.

The fifth area extends from a point on the third one, about one mile east of Sang Run, in a northerly and northeasterly direction until it crosses the Pennsylvania line at Oakton. It occupies a sinuous line of valleys parallel to and about one-half mile east of the crest of Winding Ridge. This belt is about thirteen miles long and one-eighth of a mile wide.

The sixth area enters the county from West Virginia near Cranesville and extends south along the valley occupied by Pine Swamp and Muddy Creek as far as Browning Mill, and thence up the valley lying west of Snaggy Mountain for about four miles. Here it extends across the line into West Virginia.

Lithologic Description.—The Greenbrier formation consists of limestone, red and green shale, and calcareous sandstone. The following sections show the general character of the formation:

Section of Greenbrier Formation at Crabtree, Garrett County.[1]

	Feet.	Inches.	Feet.	Inches.
1. Green micaceous sandstone (Mauch Chunk)				
2. Argillaceous limestone	4	8		
3. Massive sandy limestone	13			
4. Red sandy limestone	2			
5. Gray limestone	3		65	2
6. Red calcareous shale	3	6		
7. Red sandy limestone	8			
8. Gray sandy limestone with red bands	21			
9. Gray limestone	10			
10. Red shale interstratified with thin bands of gray sandstone	80		88	
11. Pure white sandstone	8			
12. Gray limestone	27		27	
Total	180	2		

In the western part of Allegany county the formation is somewhat thicker as may be seen by the following very complete section:

[1] This section was measured by Mr. A. C. McLaughlin.

Section of Greenbrier Formation at Stony Run, Allegany County.[1]

	Feet.	Inches.	Feet.	Inches.
1. Heavy dark bluish gray fossiliferous limestone	4	6		
2. Argillaceous shale. Fossiliferous, especially in the upper part. Drab colored on fresh surface, but inclined to show as a dull red shale on account of its prominent ferruginous surface coating		8		
3. Massive bluish fossiliferous limestone..	7			
4. Concealed	10			
5. Massive bluish fossiliferous limestone..	1	6		
6. Massive bluish, highly fossiliferous limestone, weathers very irregularly	3	6		
7. Thinly bedded fossiliferous limestone with thin bands of olive-green fossiliferous shale	10	10	85	3
8. Concealed	9			
9. Reddish brown, much disintegrated sandstone		9		
10. Concealed	20			
11. Heavy, pinkish green, mottled, slightly fossiliferous limestone	2	6		
12. Concealed	11			
13. Red sandy shale with thin green layers near top and bottom	3			
14. Greenish red shaly arenaceous limestone	1			
15. Concealed	3			
16. Red sandy shale with a few thin poorly defined green argillaceous bands.....	32			
17. Concealed	6			
18. Red shaly sandstone	1	6		
19. Massive sandstone in streaks or layers of pink, green and white	6			
20. Red arenaceous shale	10		98	6
21. Red shaly sandstone	9			
22. Calcareous, pinkish gray sandstone	2	6		
23. Concealed	7			
24. Shaly sandstone	1	6		
25. Mostly concealed, some shaly sandstone showing	20			
26. Very arenaceous pinkish green limestone	26			
27. Concealed	5		46	
28. Bluish arenaceous limestone	7			
29. Concealed	8			
Total	229	9		

[1] C. C. O'Harra, Geology of Allegany County, p. 111.

From a study and comparison of these sections it will be seen that the Greenbrier consists of an upper calcareous member, 65 to 85 feet thick; a middle sandy and shaly member, 88 to 98 feet thick; and a lower calcareous member, 27 to 46 feet thick. This division into members appears to be constant in the region here studied. These members may be called the Upper Greenbrier, the Middle Greenbrier, and the Lower Greenbrier.

The Lower Greenbrier rests with apparent conformity upon the Pocono formation. There is a gradual lithologic transition from the upper beds of the Pocono into the calcareous sandstone and silicious limestone of the basal Greenbrier, and it is very difficult to draw an exact line between the formations. The lower member is well exposed in the valley of Bear Creek about two and one-half miles east of Friendsville.

SECTION ON BEAR CREEK, 2½ MILES EAST OF FRIENDSVILLE, GARRETT COUNTY.

	Feet.	Inches.
1. Red shale	11+	
2. Blue limestone	7	
3. Red limestone, becoming more silicious toward the bottom	23	6
4. Pocono sandstone		
Total	41	6

The Middle Greenbrier is nowhere very well exposed because it does not form good natural outcrops, and is not of sufficient economic value for good artificial exposures to be made in it. Lithologically it is very much like the Mauch Chunk formation, except that it contains some calcareous beds. The Stony Run section (p. 95) contains the most complete representation of the beds of this member that is known in Maryland.

The Upper Greenbrier consists more largely of limestone and contains the purest and most valuable limestone in the entire formation. Most of the limestone quarried in Garrett county is from this member. For this reason, and because it has a larger number of natural exposures this member is better known than either of the others. It is also far more fossiliferous than the underlying members.

SECTION ON BALTIMORE AND OHIO R. R., EAST OF CRABTREE, GARRETT COUNTY.

	Feet.
1. Gray sandstone (Mauch Chunk)	
2. Red shale	5
3. Red shale and limestone	16
4. Red limestone with corals	5
5. Concealed	10
6. Gray shaly and sandy limestone with occasional fossils	15
7. Massive reddish limestone	15
Total	66

SECTION TWO MILES SOUTHEAST OF FRIENDSVILLE, GARRETT COUNTY.

	Feet.	Inches.
1. Massive limestone	2	
2. Shaly limestone	3	
3. Massive limestone	5	
4. Shale		8
5. Limestone		9
6. Shale		7
7. Massive blue limestone	12	
Total	24	

Neither the top nor the bottom of this member is represented in the last section. In the following the top and perhaps the bottom is concealed. This contains an unusual amount of shale for this member.

SECTION ON WESTERN SLOPE OF SNAGGY MOUNTAIN, GARRETT COUNTY.[1]

	Feet.	Inches.
1. Decomposed limestone	4	
2. Massive fossiliferous limestone	20	
3. Concealed	7	
4. Broken limestone	2	
5. Green shale	3	
6. Green and red shale	3	6
7. Impure bluish-white limestone	1	6
8. Red shale	5	6
9. Bluish-white impure limestone	1	9
10. Red sandy shales	6	5
11. Bluish-white limestone, sparingly fossiliferous	4	3
Total	58	11

[1] Measured by Mr. A. C. McLaughlin.

Taxonomy.—The Greenbrier formation carries the fauna of the Genevieve limestone of the Mississippi valley. The lithologic and faunal character of the formation in the region adjoining Garrett county at the northwest has recently been discussed in detail by Stevenson.[1]

It is the equivalent of the Maxville limestone of Ohio and of the Greenbrier, Bangor, and Newman limestones of the southern Appalachians. Toward the south it thickens at the expense of the overlying Mauch Chunk (Pennington) shales until it attains in southern West Virginia, Kentucky, Tennessee, and Alabama, a thickness many times as great as that which it possesses in Maryland. Toward the north in Pennsylvania it thins rapidly. This change consists in an increase in the thickness and amount of shale in the middle member, a decrease in the thickness of the upper or pure limestone member, and an increase in the amount of sandy material in the lower member. The result is that the formation changes along the bedding and along the strike into a series of red and green shales and sandstones which in central and northeastern Pennsylvania constitute part of the Mauch Chunk formation.

The Mauch Chunk Formation.

Areal Extent.—There are six areas in which the Mauch Chunk formation outcrops in Garrett county.

The most easterly area is along the western slope of Savage and Backbone mountains. The eastern boundary of this belt is about one hundred yards west of the crest of the mountain. The width of the belt varies with the slope of the mountain-side, being greatest where the slope is least. Where Savage and Backbone mountains are separated by the gap through which the Savage river flows the Mauch Chunk belt swings eastward for about two miles. The length of this belt is about forty-seven miles, its width varies from one-eighth to one-third of a mile.

[1] Amer. Geol., vol. xxix, 1902, pp. 242-249.

The second area extends along the western flank of the anticline of which the first area is on the eastern side. It occupies a position on the eastern slope of Meadow Mountain for its entire length. At the southern end it swings around to the westward and joins the Negro Mountain area which will be later described. Across the valley of Deep Creek from this point, the belt is resumed in the same structural position as the Meadow Mountain belt, by a belt which is here connected with another belt which comes from the west where its distribution will be later described. From the Deep Creek gap southwestward this belt extends parallel to the Backbone Mountain belt and along tho eastern slope of the Halls Hill-Roman Nose ridge, until that ridge crosses the West Virginia line seven miles southwest of Oakland. This belt occupies a position on the eastern side of the latter ridge similar to that occupied by the formation on the western side of the Savage-Backbone ridge, but with its dip in the opposite direction. This belt is thirty-six miles long, and from one-eighth to one-half mile wide.

The third area extends along the western slope of Negro Mountain from Pennsylvania to the juncture of Meadow and Negro mountains at their southern extremity. At this point it joins the Meadow Mountain belt already described. It is about eighteen miles long and from one-eighth to three-fourths of a mile wide.

The fourth area is connected with the Halls Hill-Roman Nose belt at its northern end near Thayerville. From here it extends in a generally northwestern but extremely sinuous course along the northern slope of that group of Pottsville hills which forms the northern rim of the upper Youghiogheny syncline. It crosses the Youghiogheny river about one mile below Swallow Falls and then rises toward the north in the eastern front of that line of hills which forms the steep western bank of the river. Near Sang Run it attains its maximum elevation and then descends again and crosses the river about two miles south of Sang Run.

The fifth area flanks the Accident anticline on the west, and extends from the northwestern end of the area last described, in north-northeasterly direction, along the eastern slope of Winding Ridge. Its course is somewhat sinuous.

The sixth area, starting at a point about one mile west of Cranesville, extends in an easterly direction along the southern slopes of Feik Hill and Dog Ridge. At a point about one mile west of Sang Run it crosses Salt Block Run, and then swings back to the west and circles around the northern and western slopes of Whites Knob. From here it extends in a southerly direction along the western slope of the line of hills extending from Whites Knob to Lewis Knob. At this point it swings to the east down into the valley of Deep Creek, and thence extends westward and then southwestward along the western slope of Snaggy Mountain until, with that mountain, it crosses the West Virginia line.

Lithologic Description.—The Mauch Chunk formation consists of a series of thinly bedded green sandstones at the base, overlain by a great thickness of irregularly alternating red and green shales and green sandstones. These beds apparently contain no characteristic strata upon which any subdivision of the formation can be based. The sandstones are either green or dark red, and are micaceous, thinly bedded and cross-bedded. The shales are of various shades of red and green, and are sometimes arenaceous and sometimes argillaceous.

Taxonomy.—The Mauch Chunk formation of Maryland is the taxonomic equivalent of the upper part of the Mauch Chunk formation of the typical locality in the anthracite fields of northeastern Pennsylvania. The change which takes place in the formation in passing southwestward across Pennsylvania has been discussed above under the *Greenbrier formation* (p. 98). The formation is represented in the southern Appalachian region by the Pennington formation, which agrees in lithologic character with the Mauch Chunk. The upper part of the Bangor and Newman limestones of the southern Appalachian region is probably in part at least synchronous with the lower part of the Mauch Chunk of Maryland.

The Pottsville Formation.

Areal Extent.—The Pottsville formation outcrops in eight important areas in Garrett county. The most easterly of these extends along the crest of Savage Mountain. The western border of this

FIG. 1.—KNOB OF MAUCH CHUNK SHALES, WEST OF HOYES.

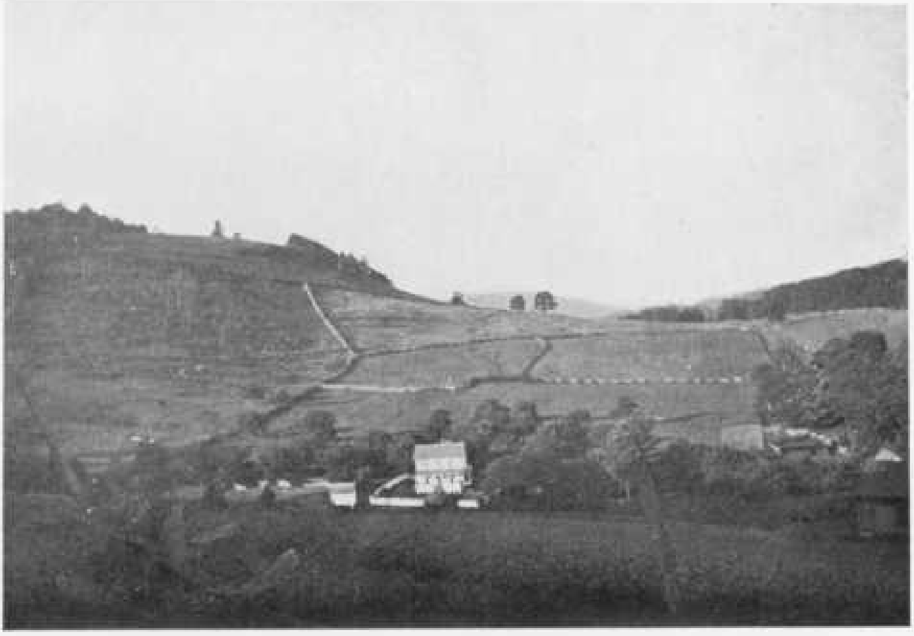


FIG. 2.—VALLEY IN MAUCH CHUNK SHALES, NEAR ELDER.

MAUCH CHUNK FORMATION.

area lies slightly (possibly 100 yards) to the west of the crest of the mountain. The eastern border lies at a distance varying from one-fourth to one-half mile east of it. This area follows the crest of the mountain from the Pennsylvania line to the Savage River gap. At this point the belt swings down to the eastward and from a point about one mile east of Crabtree to Bloomington forms the floor of the gap, also extending for some distance up the sides.

From this gap a second Pottsville belt extends to the southward along the crest of Backbone Mountain. This belt is very similar to that already described as extending along the Big Savage Mountain. The thickness, dip, and topographic form being the same in the two cases, the form of the belt of outcrop is also the same. This belt extends without break from the Savage river to the extreme southern corner of the county at Potomac Stone.

The lithologic character of the Pottsville makes it the most resistant formation in the entire Appalachian region. Consequently it forms mountain ridges. It may be stated as a law that where the Pottsville outcrops as a mountain ridge, the basal contact will lie not far from the crest of the mountains and on the side opposite to the direction of dip, while the upper contact will be marked by a line of headwater streams which come together in pairs at a series of points which usually mark the places of greatest width of the Pottsville. On Big Savage Mountain the contacts follow this law very closely,—more closely than elsewhere in Maryland.

A third belt of different character from those already described extends, with a few interruptions, up the Potomac valley from Bloomington almost to Bradshaw. The general course of the river is near the axis of the syncline, but as it meanders from side to side it alternately cuts into the Pottsville and flows back into the deeper parts of the syncline where the Pottsville is buried beneath younger rocks.

A fourth belt extends in a southwesterly direction along the crest and western flank of Meadow Mountain from the point where that mountain is crossed by the Pennsylvania line to the southern end of the mountain at the valley of Deep Creek. This belt is from one-half to three-fourths of a mile wide. The width of outcrop is greater here than in the more easterly areas because the dip here is less.

A fifth belt joins that of Meadow Mountain at the southern extremity of the latter and extends from there in a northerly direction along the crest and eastern flank of Negro Mountain to the Pennsylvania line. This has about the same width as that of the Meadow Mountain belt.

A sixth belt enters the state from West Virginia about seven miles southwest of Oakland and extends in a northeasterly direction along the crest and western flank of a broken ridge which has no general name, but of which Halls Hill and Roman Nose are parts, to the point already mentioned where Deep Creek has cut this ridge off from Meadow Mountain. Here the outcrop swings to the northwest and joins the belt next to be described. This belt has a width of from one-half to one mile.

The seventh belt enters the state from West Virginia where Snowy Creek and the Baltimore and Ohio Railroad enter it near Corinth and extends in a northerly and northeasterly direction along the crest and eastern flank of Snaggy Mountain to the point where Muddy Creek breaks through to the east at Browning Mill. Here it swings to the east, then bifurcates. One prong crosses the Youghiogheny valley at Swallow Falls and then swings to the northeast, joining the belt last described. The other extends northward along the western side of the Youghiogheny river and widens out in a region of low dips where it forms the crest of the group of high hills to the southwest of Sang Run, of which Lewis Knob, Whites Knob and River Hill are prominent peaks. This belt has a width of between three-fourths and one mile in the southern ridge part, but widens out in the northern prongs till it is in places several miles wide and so irregular in shape that it cannot be verbally described.

The eighth belt enters the state from West Virginia about one mile northwest of Cranesville and extends in an easterly direction along the crests and northern slopes of Feik Hill and Dog Ridge, then it is joined by the seventh belt from across the valley of Salt Block Run. From here it extends in an easterly and northeasterly direction into the valley of the Youghiogheny, which from near Sang Run to Krug is a Pottsville gorge. Thence it extends in a northeasterly direction along the crest and western slope of Winding Ridge to the Pennsylvania line just west of Oakton. This belt varies in width from three-fourths to one mile along the ridge, but has a width of about two miles where it crosses the Youghiogheny valley.

There are also several outliers in the Deep Creek valley, and between Hoyes Run and Sang Run. About two miles south of Friendsville is a detached area where the overlying formation has been stripped off.

Lithologic Description.—The Pottsville formation consists of a series of coarse and massive conglomerates, sandstones, shales, fireclay and coal. The general character of the formation is well shown in the following section which was measured in the Youghiogheny gorge at and below Swallow Falls.

Section of Pottsville Formation, Swallow Falls, Garrett County.

		Feet.	Inches.
1. Massive sandstone, Homewood		50	
2. Shale		6	
3. Fire-clay, Mount Savage	Flint fire-clay Plastic fire-clay	4	
4. Coal, Mount Savage	Coal ... 4″ Bone .. 8″ Coal ... 1′ 4″ Shale .. 2″ Coal ... 6″	3	
5. Shale		5	
6. Sandstone		5	
7. Coal, Lower Mercer			10
8. Conglomeritic sandstone, Upper Connoquenessing		75	
9. Black shale		2	
10. Coal, Quakertown		1	6
11. Shale			6
12. Concealed		8	
13. Massive conglomeritic sandstone, Lower Connoquenessing		75	
14. Concealed		60	
15. Shale		5	
16. Coal, Sharon	Coal ....5″ Shale ......6″ Coal ....5″	1	4
17. Shale			6
18. Sandstone		25	
Total		327	8

Farther east the thickness is somewhat greater as is shown by the following section:

SECTION OF THE POTTSVILLE FORMATION, ONE-HALF MILE EAST OF WESTERNPORT, ALLEGANY COUNTY.

	Feet.	Inches.
Allegheny shales		
1. Massive sandstone, Homewood	26	
2. Concealed, but with abundant fragments of flint fire-clay in the talus	64	
3. Massive sandstone	6	
4. Concealed	29	
5. Massive quartzose sandstone	20	
6. Sandstone	4	
7. Concealed	28	
8. Black shale	5	
9. Sandstone	1	
10. Dark shales	12	
11. Coal	1	
12. Dark gray shale	4	
13. Coal	1	6
14. Dark gray shale	4	
15. Sandstone	4	
16. Concealed	16	
17. Dark gray shales	10	
18. Sandstone	1	
19. Concealed	40	
20. Massive sandstone	20	
21. Shale	2	
22. Sandstone	10	
23. Black shales	25	
24. Coal		8
25. Black shale	4	
26. Sandstone	25	
27. Shale and sandstone	6	
28. Coal	1	3
29. Sandstone	4	
Mauch Chunk shales		
Total	374	5

It can readily be seen that these beds may be grouped into the following members which have been described and named by the geologists of the Pennsylvania surveys.

	Swallow Falls Section.	Westernport Section.
Homewood sandstone	1	1
Mercer group (coal, fire-clay and shale)	2–7	2
Connoquenessing sandstones	8–13	3–22
Sharon group (shale and coal)	14–18	23–29

The basal contact of the Pottsville formation has been seen at only one point in Garrett county, namely, in the railroad cut one mile west of Oakland and immediately east of the bridge over the Youghiogheny river. Here the following section is exposed:

SECTION ONE MILE WEST OF OAKLAND, GARRETT COUNTY.

	Feet.
Shaly sandstone	8
Massive sandstone	8
Limestone conglomerate	2
Red shale (Mauch Chunk)	20

This section is overlain by beds containing red shale but in all probability the limestone conglomerate represents the base of the Pottsville. This bed is a mass of rounded and somewhat angular pebbles of dark colored limestone set in an argillaceous cement. The origin of the pebbles is not known. The bed has not been elsewhere observed in Garrett county, but in western Allegany county it has been recorded from near Barrellville and east of Westernport. It has hitherto been considered as the uppermost member of the Mauch Chunk, but in view of its resemblance to a widespread basal conglomerate it may perhaps be well to place it in the Pottsville. As has already been noted (p. 104), the exposure of the contact between the Mauch Chunk and Pottsville one-half mile east of Westernport, Allegany county, shows the basal bed of the Pottsville as a fine-grained sandstone which rests upon the greenish shales of the Mauch Chunk with (local at least) discordance of bedding. This exposure fully establishes the fact that the Pottsville rests upon the Mauch Chunk, locally at least, with unconformity, but it also shows that the limestone conglomerate already referred to is either below the base of the Pottsville (as earlier writers have considered), or is here locally replaced by sandstone. The writer is inclined to accept the latter as the true explanation. This unconformity may explain the slight development or absence of the lowest Pottsville beds (the Sharon conglomerate, etc.) in this region. Throughout the northern Appalachian region it is here one bed and there another which forms the base of the Pottsville. Perhaps further study will show that the lower Carboniferous sea bottom was raised and eroded over this entire region before the Coal Measures were deposited, and that the subsequent subsidence was so slow and irregular that great thicknesses of Pottsville were accumulated in other regions while this was yet land.

If the Sharon conglomerate is represented in Maryland it is by the twenty-five feet of sandstone at the base of the Swallow Falls section and the four feet at the base of the Westernport section.

The Sharon coal-group of West Virginia is represented in Garrett county by a series of shales with one or two thin coal seams. These beds are about 60 feet thick at Westernport and of a doubtful thickness which does not exceed 60 feet at Swallow Falls. The correlation is based upon the stratigraphic position of the beds with reference to those above and below, and upon the fauna contained in the shales, which according to Mr. David White[1] is that of the Sharon coal.

Above the coal and shales of the Sharon group is a great thickness of sandstones and conglomerates which are the equivalent of the Connoquenessing sandstones of Lawrence county, Pennsylvania. It is clearly shown in the Swallow Falls gorge that here, as in Pennsylvania, the group is capable of a threefold subdivision. At the base is the lower Connoquenessing sandstone which is hard, white and conglomeritic, and has a thickness of about 75 feet. Above this is a small thickness of shale with a thin coal which is the equivalent of the Quakertown coal of eastern Ohio and western Pennsylvania. In Allegany county this coal[2] has split into two seams separated by four feet of shale. The shales associated with the Quakertown coal are overlain by another bed of very hard and massive white conglomeritic

[1] Verbal communication.

[2] Here it must be noted that in the report on Allegany County the so-called "Railroad seam" was given the name *Bloomington Coal* and was referred to a stratigraphic position closely corresponding to that of the Quakertown Coal. Careful study has shown that the "Railroad seam" does not belong in this position but is the equivalent in part of the Mount Savage coal and in part of the Clarion. The matter will be referred to at greater length under the description of those seams.

sandstone which has a thickness of about 75 feet. This is the equivalent of the upper Connoquenessing sandstone.

Resting with apparent conformability upon the upper Connoquenessing sandstone is a series of shales with some fire-clay and coal, which are both stratigraphically and paleontologically the equivalent of the Mercer group of Pennsylvania. The lithologic character of this group is well shown in the following section which was measured in the west bank of the Potomac one mile above Blaine.

SECTION ONE MILE ABOVE BLAINE, GARRETT COUNTY.

		Feet.	Inches.
Sandstone, Homewood		40	
Concealed		65	
Massive sandstone		5	
Shale		1	
Coal, Mt. Savage	Coal .. 4″; Shale .22″; Coal .. 3″	2	6
Fire-clay, Mt. Savage	Flint fire-clay....6′; Plastic fire-clay..8′	14	
Concealed		12	
Massive sandstone, Upper Connoquenessing		8	
Total		147	6

In the Savage Mountain Fire-clay mine the following section was measured:

SECTION AT SAVAGE MOUNTAIN FIRE-CLAY MINE.

		Feet.	Inches.
Sandstone, Homewood	Sandstone ..28′; Soft shale .. 1′; Sandstone .. 8′ 6″	37	6
Shale		1	
Coal, Mt. Savage	Coal .... 1′ 2″; Shale ...... 11″; Coal .... 2′	4	1
Shale		6	
Fire-clay, Mt. Savage		10	
Total		58	7

The following section was obtained from a bore-hole at Henry:

SECTION AT HENRY, GARRETT COUNTY.

		Feet.	Inches.
Homewood Sandstone 51 feet.	Sandstone	25	5
	Conglomerate	1	8½
	Sandstone	8	11½
	Shale and sandstone	1	4
	Sandstone and conglomerate	4	10
	Fine sandstone	9	1
Mercer Group 53 feet.	Shale	1	
	Sandstone	1	8
	Shale	1	1
	Sandstone	1	7
	Shale	6	2½
	Coal, Mount Savage or Upper Mercer	1	8
	Shale and bone	15	5½
	Sandstone and shale	2	7
	Shale	8	
	Coal	1	3
	Shale	3	2
	"Flint" — Lower Mercer Coal		2
	Shale	5	7
	Coal	1	2½
	Shale	2	7½
Upper Connoquenessing Sandstone 66 feet.	Sandstone with streaks of shale	18	½
	Hard sandstone	30	10½
	Hard sandstone with streaks of shale	17	9½
	Total	172	2½

These sections show the relationships of the members of the Mercer group to each other and to the underlying and overlying strata. The lower Mercer coal is usually absent in Maryland, having been reported only from Swallow Falls and from the Henry bore-hole. The Mount Savage coal,[1] which is identical with the Upper Mercer (where there are two Mercers) of Pennsylvania, is always present. The Mount Savage fire-clay lies immediately or a very short distance under it.

[1] This seam was called *Westernport* in *The Geology of Allegany County*, but further study has shown that the Mount Savage Coal undoubtedly belongs at this horizon, so that name having been used for many years in the Pennsylvania reports has priority.

FIG. 1.—CREST OF MEADOW MOUNTAIN.

FIG. 2.—MUDDY FALLS.

POTTSVILLE FORMATION.

At Swallow Falls conditions are abnormal, for there is no clay under the coal, while a fire-clay of exactly the same character as the Mount Savage clay overlies it. This state of affairs has not been recognized elsewhere.

The Mount Savage fire-clay is apparently one of the most constant members of the Coal Measures, even where its outcrop is concealed its presence being revealed by the occurrence of flint boulders in the soil.

The Mercer limestones which are very characteristic at this horizon in Pennsylvania have not been recognized in Maryland.

Resting conformably upon the shales at the top of the Mercer group is a very quartzose and massive sandstone, which is the equivalent of the Homewood sandstone of Pennsylvania. It was formerly called the Piedmont sandstone but its identity with the Homewood sandstone is now satisfactorily established. It differs from the Connoquenessing sandstone in being less conglomeritic, and from the overlying Allegheny sandstones in being more massive and quartzitic. The thickness varies from about 30 to almost 100 feet, and is usually over 60 feet.

Taxonomy.—The Pottsville formation of Maryland represents the upper part of the formation in its type locality in northeastern Pennsylvania. Two hypotheses have been suggested by Mr. David White[1] to account for the thinning of the Pottsville and the absence of its lower members in the bituminous coal-fields of western Pennsylvania, Maryland, and West Virginia. He says: "The existence of the older floras in the lower portions only of the very thick sections, or, in other words, the equivalence of the very thin sections to the upper portions only of the very thick sections, suggests alternative hypotheses in explanation of the conditions attending the sedimentation of the Pottsville formation. First, the lower portions of the very thick sections may be regarded as laid down in Mauch Chunk time and contemporaneous with the latest red shale or lower

[1] The Stratigraphic Succession of Fossil Floras of the Pottsville Formation in the Southern Anthracite Coal Field, Pennsylvania. Twentieth Annual Report, U. S. Geological Survey, pt. ii, p. 821.

Carboniferous sediments in other regions, in which case the basal boundary of the Pottsville in those regions may be diagonal in time without unconformity. The second hypothesis assumes a case of overlap, by which the upper and relatively thinner northern and western deposits were spread beyond the limits of the deeper eastern basins in which the thicker deposits were accumulated. In the latter case the unconformity may or may not extend throughout the field." While he regards the problem as still an open one, Mr. White is inclined to believe that the oldest Pottsville in the very thick sections rests upon the underlying Mauch Chunk *conformably*, and is contemporaneous with the highest Mauch Chunk of those regions where the Pottsville is thin; and that the Pottsville of the latter regions was deposited in an encroaching sea, and is hence *unconformable* upon the Mauch Chunk *by overlap*. The writer agrees with Mr. White that the Pottsville and Mauch Chunk of Maryland are separated by an unconformity. Whether this unconformity represents the whole of lower Pottsville (i. e. pre-Sharon) time, or whether part of that period is represented by the highest Mauch Chunk of this region, is a problem on which the rocks of this region have shed no light.

The uppermost beds of the Pottsville in this region (i. e. the Mount Savage coal and fire-clay, and the overlying sandstone) are to be most definitely correlated with the Mercer coal group and the Homewood sandstone which are found at the top of the Pottsville throughout the entire coal fields of Pennsylvania, eastern Ohio, and northern West Virginia. This means that Pottsville time ended almost simultaneously in all parts of the northern Appalachians. As far as is known the same is approximately true to the southward. The Pottsville formation is the equivalent of the Blackwater formation of Darton and Taft[1] which was named, described, and mapped in the southern part of Garrett county and the adjacent part of West Virginia, which are included in the Piedmont quadrangle of the Geologic Atlas of the United States. But as Pottsville is the older name, Blackwater must be considered a synonym.

[1] U. S. Geol. Survey, Geol. Atlas, folio 28.

The Allegheny Formation.

Areal Extent.—The Allegheny formation outcrops in seven large and important areas in Garrett county. The first of these extends in an almost straight line along the eastern slope of Savage Mountain from the Pennsylvania line to the valley of the Savage river at a point about two and one-half miles east of Crabtree. From here it extends along the north bank of the Savage river to the Allegany county line.

The second area extends in line with the first along the eastern slope of Backbone Mountain from the valley of the Savage river to the West Virginia line near Potomac Stone. In this as in the first area the rocks dip to the southeast.

The third area extends along the bank of the Potomac river from Bloomington to near Bayard. It extends for a greater or less distance up all the streams entering the Potomac in this interval, and connects with the area last described through the valleys of the Savage river, Laurel Run (below Windom), Folly Run, Elklick Run, Threefork Run, and Lostland Run. It extends far up Wolf Den Run and Laurel Run (near Schell) and almost connects with the area next to the west. From Bayard to Bradshaw and for a number of short distances between Bradshaw and Bloomington it forms the floor of the Potomac valley.

The fourth area extends along the western slope of Meadow Mountain from the Pennsylvania line to the juncture of Meadow and Negro mountains, thence along the eastern slope of Negro Mountain to the Pennsylvania line. It completely encircles the Castleman valley.

The fifth area, which is the largest in the state, covers the greater part of the region drained by the Youghiogheny river above Swallow Falls, lying between Snaggy Mountain on the west and the Roman Nose-Halls Hill ridge on the east. Several areas within this tract are covered by the overlying Conemaugh formation.

The sixth area extends along the western slope of Winding Ridge from the Pennsylvania line to Elder. About one and one-half miles below Krug it descends to the bottom of the Youghiogheny river, crosses that stream and extends along the western bank to a point about one mile south of the mouth of White Rock Run. Thence it extends westward up the valley of that stream to the West Virginia line.

The seventh area lies in the northwest corner of the county and is very irregular in outline. It occupies the entire valley of Feik Run, sends a long irregular prong across into the valley of the north branch of Buffalo Run, and extends southward along the West Virginia line to a point about six miles south of the northwest corner of the county.

There is a smaller area in the valley of Buffalo Run about three miles west of Friendsville; another still smaller about half-way between the last mentioned area and Friendsville; and three on the eastern bank of the Youghiogheny river between Krug and Sang Run.

Lithologic Description.—The Allegheny formation which consists of a series of sandstones, shales, coal seams, and limestones, overlies the Pottsville with apparent conformability. The following sections show the general character of the formation.

Section of Allegheny Formation. Bore-hole No. 1, Henry, Garrett County.

Mahoning Sandstone, etc.	Feet.	Inches.
1. Coal, Upper Freeport.. { Bony coal ..22″ / Coal ....40″ }	5	2
2. Shale	2	2½
3. Limestone		11½
4. Shale	7	6½
5. Sandstone with streaks of shale	10	3
6. Sandstone	13	3
7. Conglomerate	1	7½
8. Conglomeritic sandstone	5	6
9. Light gray sandy shale	13	3
10. Sandstone	17	5
11. Shale	2	
12. Shaly sandstone	21	3
13. Shale	15	1
14. Shaly sandstone	24	10
15. Bone		2
16. Shale	3	
17. Sandstone	1	10

		Feet.	Inches.
18. Shale		1	1
19. Limestone		1	
20. Shale		16	3
21. Black shale with streaks of bone		1	1
22. Shale		11	6½
23. Sandstone and shale		14	5½
24. Black shale		3	1½
25. Sandy shale		3	8
26. Sandstone		2	3½
27. Black shale		2	4
28. Coal, Middle and Lower Kittanning	Coal .. 2″ Shale . 1″ Coal ..33½″ Shale . 4½″ Bone . 7½″ Coal ..24' Shale . 1½″ Coal ..24″ Shale . 1″ Bone .. 2½″	8	5½
29. Shale		19	2½
30. Rough coal and shale ("split-six")		2	1½
31. Sandstone and black shale		4	4
32. Black shale		4	5
33. Shale and bone			7½
34. Shale		6	5
35. Limestone		2	8
36. Shale		12	8½
37. Hard flinty sandstone		13	
38. Conglomerate		7	4½
39. Sandstone		5	11
40. Shale and sandstone		22	11½
41. Sandstone		8	4½
42. Shale		1	2
43. Coal, Clarion	Coal with sulphur 11″ Shale ½″ Coal 6″ Sulphur 1″	1	6½
44. Shale		10	2
45. Coal, Brookville	Coal 17″ Shale 8½″ Bone 2½″ Shale and bone 5½″ Coal 8″	3	5½
46. Shale		4	7½
Homewood sandstone, etc.			
Total		341	8½

Another bore-hole (No. 5) about three miles from this gave the following section of the upper part of the formation:

SECTION, BORE-HOLE NO. 5, 1½ MILES N. W. OF BAYARD, GARRETT COUNTY.

	Feet.	Inches.
Mahoning sandstone, etc.		
1. Coal, Upper Freeport { Bony coal, ...20″; Coal ....41″ }	5	1
2. Shale	19	4
3. Sandstone	6	
4. Hard conglomeritic sandstone	7	6
5. Sandstone	13	
6. Shale	11	
7. Bony coal, Lower Freeport	2	
8. Hard dark sandstone	22	6
9. Shale	16	6
10. Limestone	16	6
11. Shale	3	6
12. Shale and sandstone	11	
13. Shale	13	
14. Black shale mixed with coal, Upper Kittanning	3	
15. Blue shale	7	
16. Shale and sandstone	10	
17. Sandstone	13	
18. Shale	3	4
19. Coal, Middle and Lower Kittanning { Bone .... 9″; Coal and bone ...11″; Coal ....12″; Shale ....12″; Coal ....30″; Shale .... 1″; Coal ....19″ }	7	10
20. Shale	14	10
Total	200	8

The following section was measured by Dr. I. C. White[1] at the Maple Swamp water-tank, one and one-half miles above Harrison.

[1] Bull. U. S. Geol. Survey, No. 65, p. 127.

SECTION OF ALLEGHENY FORMATION, ONE AND ONE-HALF MILES ABOVE HARRISON.

		Feet.	Inches.
1. Coal, Upper Freeport	Coal ....0′ 5″ Bone and slate.1′ 4″ Coal ....2′ 6″	4	3
2. Concealed		60	
3. Coal, Lower Freeport		1	2
4. Concealed		55	
5. Coal, Upper Kittanning		1	
6. Concealed and slate		45	
7. Coal, Lower Kittanning	Coal ....3′ 0″ Slate ....2′ 0″ Coal ....1′ 5″	6	5
8. Concealed, and sandstone		85	
9. Coal, Clarion		2	6
10. Shales, and concealed		45	
11. Massive sandstone, top of No. XII.....			
Total		305	4

On the east side of the Potomac at Harrison is the following section:

SECTION OF ALLEGHENY FORMATION AT HARRISON.

		Feet.	Inches.
1. Coal, Upper Freeport ..	Coal ....15″ Shale ..... 1″ Coal .... 6″ Shale ..... 6″ Coal ....36″	5	4
2. Concealed		134	
3. Black shale		3	
4. Coal, Upper Kittanning		3	7
5. Concealed		37	
6. Sandstone		5	
7. Coal, Middle and Lower Kittanning	Coal .....24″ Shale .... 9″–12″ Coal ..... 6″ Shale .... 6″ Coal .....28″	6	4
8. Concealed		20	
9. Massive sandstone		45	
10. Concealed		15	
11. Coal, Clarion		2	4
12. Concealed		35	
Total		311	7

SECTION OF ALLEGHENY FORMATION IN BORE-HOLE AT JENNINGS MILL, GARRETT COUNTY.[1]

		Feet.	Inches.
1. Coal, Upper Freeport .	Coal .... 0′ 2″ Bone .... 0′ 3″ Black shale .10′ 10″ Coal .... 2′ 2″	13	5
2. Shale		4	
3. Shaly sandstone		9	
4. Gray shale		35	5
5. Brecciated fire-clay			8
6. Gray shale		12	
7. Coal			2
8. Gray shale		11	7
9. Black shale			9
10. Coal, Lower Freeport		1	2
11. Black shale		1	
12. Gray shale		18	9
13. Sandy shale		15	
14. Coarse sandstone		12	
15. Gray shale		1	
16. Coarse sandstone		3	
17. Black shale		8	10
18. Coal, Middle and Lower Kittanning	Coal ....1′ 4″ Black shale ..3′ Gray shale ..2′ 4″ Coal .... 10″ Gray shale ..5′ 3″ Coal ....1′ 10″	14	1
19. Gray shale		8	6
20. Coarse sandstone		10	
21. Coarse crossbedded sandstone		20	
22. Coarse sandstone		11	
23. Shaly sandstone		10	
24. Gray shale		6	6
25. Sandy shale		7	
26. Dark gray and black shale		7	
27. Coal, Clarion			8
28. Gray shale		4	
29. Gray sandy shale		5	
30. Black shale		5	
31. Coal, Brookville (?)		1	
Total		257	6

[1] This section extends from a depth of 193 feet to 451 feet. The record of the overlying beds is given on p. 128.

SECTION OF ALLEGHENY FORMATION, FOUR MILES NORTHWEST OF OAKLAND, GARRETT COUNTY.

		Feet.	Inches.
Mahoning sandstone			
1. Concealed		40 ±	
2. Coal, Lower Freeport.	Bone 4″; Shale 1″; Bone 4″; Shale 1″; Coal 3″; Bone 4″; Coal 12″; Bone 3″	2	8
3. Concealed		80 ±	
4. Sandstone		15	
5. Shale and shaly sandstone		5	
6. Coarse sandstone		26	
7. Gray sandstone		3	9
8. Gray shale		2	
9. Oolitic shale		2	
10. Shale		3	7
11. Oolite			6
12. Shale		4	8
13. Coal, Middle and Lower Kittanning	Coal 16″; Coal and bone 7″; Shale 6″; Coal 16″	3	9
14. Gray shale		13	4
15. Calcareous rock		1	2
16. Black shale		3	11
17. Coal, "Split-six"	Shale and bone 8″; Coal 11″	1	7
18. Gray shale		1	2
19. Black shale		10	
20. Gray shale		19	6
21. Hard gray sandstone		4	9
22. Green shale		1	6
23. Red shale		12	7
24. Red and green shale		2	
25. Green sandy shale		16	
26. Dark green and brown shale		6	
27. Alternating shales and sandstones		18	3
28. Fossiliferous limestone, Ferriferous.		1	2
29. Alternating shales and sandstones		17	
30. Coal, Clarion			5
31. Plastic fire-clay		1	8
32. Flint fire-clay		1	
33. Plastic fire-clay		1	8
34. Shale		3	
Total		326	7

[1] The upper 122 feet of this section was obtained from surface measurements, while the lower part is the record of a bore-hole on Herrington Manor, 4 miles northwest of Oakland.

The individual beds making up the Allegheny formation have been classified as follows:

Freeport Group	Upper Freeport coal Lower Freeport coal
Kittanning Group	Upper Kittanning coal Middle Kittanning coal Lower Kittanning coal
Clarion Group	Ferriferous limestone Clarion sandstone Clarion coal Brookville coal

As far as is known the shales which form the base of the Allegheny formation lie conformably upon the underlying formation. Near the base of the formation and not separated by more than a few feet from the top of the Pottsville there is sometimes found a coal-seam which is the equivalent of the Brookville[1] coal of Pennsylvania. As in other regions this coal is here very irregular and uncertain in its occurrence. It has been observed at only one locality in Garrett county, namely, in the bore-hole at Henry where it is less than five feet above the base of the formation.

The Clarion[2] coal is one of the most persistent and characteristic members of the Coal Measures in this region. Its position varies from 15 to 45 feet above the top of the Pottsville. It usually contains about 2½ feet of coal. A mass of sandy shales about 10 feet thick which contains very abundant nodules of siderite overlies the Clarion coal. At places these are abundant enough to suggest the possibility of profitable mining.

These shales are usually overlain by a thick and massive sandstone which in appearance suggests the underlying Homewood sandstone and is known as the Clarion sandstone. It can be readily distinguished, however, by the presence of siderite concretions instead of flint nodules in the underlying shales.

[1] In the report on the Geology of Allegany County, this was called the Bluebaugh coal. It is now known to be the same as the Brookville coal, so, that name having priority, is here used.

[2] This seam was called, in the report on the Geology of Allegany county and elsewhere, the Parker coal. Clarion is the older name and must therefore be used.

A bed of limestone known in Pennsylvania as the Ferriferous limestone is separated from the Clarion sandstone by a series of shales. This is well exposed about one-half mile north of Stoyer and also in the bed of the run just above the bridge at the Preston Lumber Company's mine about two miles southwest of Crellin. About one mile west of this locality, just across the West Virginia line, the stone has been quarried near Van Werth's coal mine. About three and one-half miles north of Gorman the stone is exposed in one of the branches of Glade Run. At all of these localities the rock is clearly of fresh-water origin and contains no fossils except ostracods. In the Herrington Manor bore-hole the Ferriferous limestone was found with a thickness of 14 inches. Here it is of the marine type, which is the usual type in the region to the north and west in Pennsylvania and Ohio, and contains abundant brachiopods.

The strata immediately above the Ferriferous limestone are soft argillaceous shales. At the point where the limestone is exposed near Stoyer the shale has a thickness of scarcely more than one foot and is overlain by coal. The section at this point is as follows:

SECTION AT STOYER, GARRETT COUNTY.

		Feet.	Inches.
Shale			
Coal, Middle Kittanning	Coal .. 4″ Bone .. 1″ Coal .. 9″ Bone ..12″ Coal ..18″	3	8
Shale		8	4
Coal, Lower Kittanning	Coal .. 5″ Bone .. 1″ Coal .. 5″ Bone .. 1½″ Coal .. 4″ Bone ..12″ Coal ..23″	4	4
Shale		1	
Limestone, Ferriferous		1+	
Total		18	4

The shale above the limestone is the base of the Kittanning group and the two seams of coal represent the Middle and Lower Kittanning coal of Pennsylvania. In Maryland and the adjacent parts of West Virginia, and especially in the Potomac basin, these seams are usually so near together that they constitute practically one seam and can be mined together. In this condition they have been called the "Davis seam."

In the southern end of the Georges Creek basin the section of the lower part of the Allegheny formation is as follows:

SECTION AT MERRILL'S MINE, LUKE, ALLEGANY COUNTY.

		Feet.	Inches.
1. Coal smut (Upper Kittanning)			6
2. Thin bedded sandstone with iron nodules		11	
3. Fire-clay		4	6
4. Shale		3	
5. Sandstone		28	
6. Shale		7	
7. Coal, "Six-foot"	Coal 8″ Bone 6″ Coal 20″ Shale 1″ Coal 28″	5	3
8. Concealed, shales and sandstones		27	6
9. Coal, "Split-six"		4	
10. Concealed		37	
11. Fire-clay		7	
12. Greenish sandy shales		17	
13. Sandstone and sandy shales		44	
14. Coal, Clarion		1	10
15. Arenaceous shales		14	9
16. Sandstone, Homewood			
Total		212	4

If the seam which is locally known as the "six-foot" is the exact equivalent of the Davis seam of the Potomac basin, then the "split-six" cannot be correlated with any seam hitherto named in other areas. On the other hand the "six-foot" of this region may be considered as the equivalent of the upper ply of the Davis or the Middle Kittanning, and then the "split-six" can be readily correlated with the Lower Kittanning. This view is supported by the fact that usually where the "split-six" is present the overlying seam is thin

FIG. 1.—CLARION SANDSTONE, NEAR WINDOM.

FIG. 2.—CLARION SANDSTONE, NEAR CHAFFEE.

ALLEGHENY FORMATION.

and has no thick middle shale, while where the Davis seam has its typical development with great thickness of coal separated by a thick middle shale, the "split-six" is absent. The only observed exception to this is in bore-hole No. 1 at Henry where two feet of "Rough coal and slate" was recorded twenty feet under the Davis seam. In spite of this it may seem satisfactory to correlate the Davis seam with the Middle and Lower Kittanning, the "six-foot" with the Middle Kittanning and the "split-six" with the Lower Kittanning. The "Rough coal and slate" in the bore-hole would then have to be left as a local sporadic seam which can neither be correlated nor locally named.

The "split-six" seam occurs at an interval varying from 65 to 115 feet above the Clarion coal, and a short distance above the Ferriferous limestone. In its normal position with reference to the next higher coal, it has been seen at only one locality in Garrett county, which is on the south bank of White Rock Run. Here it is 24 feet below the Lower Kittanning. In the vicinity of Westernport this interval is somewhat greater (28 feet). The Middle and Lower Kittanning coals, in the greater part of the Potomac basin, are separated by less than one foot of shale, and constitute one workable seam. In the Upper Youghiogheny basin the intervening shale is usually about three feet in thickness. In the Lower Youghiogheny basin it varies from one to ten feet. In the Castleman basin the Kittanning group (and in fact the entire Allegheny formation) is known only from the bore-hole at Jennings Mill. Here the Kittanning coals are all thin and occur within a total interval of about 15 feet.

In the Georges Creek and Potomac basins this coal is locally known as the "Six-foot," "Five-foot," or Davis coal. It was called by the last name in the report on the Geology of Allegany County, but is now known to be the equivalent of either the Lower or the Lower and Middle Kittanning. In the Castleman basin it is known only in the bore-hole at Jennings Mill and at the mine owned by Mr. Joel Bender at the southern end of the basin. Here it has been incorrectly correlated with the "Beachey" coal which it closely resembles.

It has been given no other local name in this basin. In the Upper Youghiogheny basin it is locally called the "Corinth coal" or "Four-foot." In the lower Youghiogheny basin it is locally known as the "White Rock seam," and sometimes as the "Four-foot."

A massive cross-bedded sandstone about 25 feet in thickness is separated from the top of this coal by an interval of usually only a few inches of shale. This sandstone is characterized by the presence of abundant brownish mica flakes.

The Upper Kittanning coal occurs at an interval varying from 35 to 65 feet above the top of the Middle Kittanning coal. The intervening strata are sandstones and shales, the former predominating, and of them the massive micaceous cross-bedded sandstone above described being the most conspicuous. This coal is far less persistent than the Middle and Lower Kittanning. Frequently it is absent or represented by black shale or a few coaly streaks. The best development of it is in the section above described at Harrison (p. 115) where it has a thickness of 43 inches.

The strata between the Upper Kittanning coal and the top of the Allegheny formation constitute the Freeport group. The lithologic characteristics of the members of this group are well shown in the section of bore-hole No. 5 at Henry (p. 114) and also in the following:

SECTION AT PIEDMONT, WEST VIRGINIA.[1]

		Feet.
1. Coal, Upper Freeport..	Coal .... 2′ Shale and bone ... 1′ Coal .... 2′	5
2. Concealed		10
3. Shale, bluish		10
4. Coal, Lower Freeport		2
5. Fire-clay		2
6. Concealed		10
7. Sandstone, hard		2
8. Sandstone, shaly		5
9. Shales, sandstone and concealed		55
10. Coal, Upper Kittanning		
Total		101

[1] I. C. White, Bull. U. S. Geol. Survey, No. 65, p. 126.

SECTION AT BARNUM, GARRETT COUNTY.

		Feet.	Inches.
Mahoning sandstone			
1. Coal, Upper Freeport	Bone .... 3″ Coal ....1′ 7″ Shale .... ½″ Coal .... 3″	2	1½
2. Concealed		30	
3. Flaggy sandstone		3	
4. Concealed		4	
5. Sandstone		4	
6. Concealed		20	
7. Massive sandstone		26	
8. Concealed		24	
9. Flaggy sandstone		8	
Coal tracing, probably Upper Kittanning			
Total		121	1½

The Freeport group where completely developed contains the following members:

Upper Freeport coal Upper Freeport limestone Bolivar fire-clay Upper Freeport sandstone Middle Freeport coal Lower Freeport coal Lower Freeport limestone Lower Freeport sandstone	Freeport group

The individual beds of this group are not usually very well exposed in this region. The Lower Freeport sandstone is apparently present, but is less conspicuous than another sandstone which is immediately under the Upper Kittanning coal. The Lower Freeport limestone is apparently represented by the one foot of limestone in bore-hole No. 1 at Henry (19 of section as given on p. 113), and by the sixteen and one-half feet in bore-hole No. 5 at Henry (10 of the section as given on p. 114.) It has not been seen at the surface.

The Lower Freeport coal is often represented by a thin seam but it is not at all persistent.

The Middle Freeport coal is not present in Garrett county.

A short distance under the Upper Freeport coal is a coarse sandstone, frequently conglomeritic, which at Henry has a thickness of about twenty feet, and which represents the Upper Freeport sandstone.

The Upper Freeport coal is practically always present at the very top of the Allegheny formation. The areas in which it is entirely absent are extremely local and infrequent. This seam has a very characteristic section of which that at Harrison (p. 115) is an excellent example. So characteristic is this complexity of structure, or division into benches by layers of shale that Dr. I. C. White[1] says:

"One of the main features which characterizes this bed is its complexity, since it is always separated into two or more benches by divisions of slate. This complexity of structure is illustrated at the type locality, and so far as the writer knows it is never entirely absent anywhere in the Appalachian field, whenever the bed is thick enough to mine. These parting slates vary in number and thickness in different regions, so that there is nothing characteristic about them over the whole field, but yet in any particular district or coal basin their number and position in the bed are quite regular."

This complexity of structure is apparently not quite as characteristic in Garrett county as it is in other regions, for sometimes the shale partings are quite absent. But this is decidedly the exception, and the complexity of structure may be regarded as characteristic.

In the Georges Creek basin this seam is known as the "Four-foot" and sometimes as the "Three-foot." In the Potomac basin it is called the "Three-foot" or "Thomas." In the Upper Youghiogheny basin it has no local name. In the Lower Youghiogheny basin it is sometimes called the "sand rock vein," but that name has also been applied to other seams in the region. In the Castleman basin it has not been opened and consequently has no local name. It will be described more fully in the chapter on *Mineral Resources*.

Taxonomy.—The Allegheny formation was named and described in 1840 by H. D. Rogers,[2] then state geologist of Pennsylvania, from its typical development along the Allegheny river. Under

[1] Bull. U. S. Geol. Survey, No. 65, p. 148.
[2] 4th Ann. Rept., Pa. Geol. Survey, p. 177.

this name, and as the "Lower Productive Coal Measures" it was studied and mapped in great detail by the Second Geological Survey of Pennsylvania. The several areas in Garrett county are the continuation of the areas mapped by the Pennsylvania surveys. The correlation[1] is based not only on this lithologic continuity but on the similarity of local sections and identity of sequence of the members.

The formation has been traced westward into Ohio by the Ohio Geological Survey, and southward into West Virginia. In these states it has been called the "Lower Productive Measures." It constitutes the Savage formation and the lower part of the Bayard formation of Darton and Taft, and was thus mapped by them[2] in the southern part of Garrett county.

The Conemaugh Formation.

Areal Extent.—The Conemaugh formation outcrops in twenty-four separate areas in Garrett county. These may be grouped into five distinct and separate regions, each of which contains one or more detached areas of the Conemaugh formation.

The first of these regions is situated in the Georges Creek valley and extends from a line parallel to the crest of Savage Mountain and about one mile east of it to the Allegany county boundary. In part of this region the Conemaugh is buried under younger formations whose areal extent will be described later.

The second region is in the Potomac valley and contains eight detached areas of greatly differing size. The first of these is situated on the ridge between Savage river and the stream about two miles south of it which is known as Laurel Run. The second area is on the ridge between Laurel Run and Folly Run. The third is between Folly Run and Elklick Run. The fourth is between Elklick Run and Threefork Run. The fifth is on the hill between the two central prongs of Threefork Run. The sixth is between Threefork Run and the north fork of Lostland Run. This area is almost cut in two by Wolf Den Run. The seventh area is between the two forks of

[1] Bull. Geol. Soc. Amer., vol. xiii, 1902, pp. 215-232.
[2] U. S. Geol. Survey, Geol. Atlas, folio 28.

Lostland Run. The eighth area extends from the valley of Lostland Run to the southern corner of the county, and from a line parallel to the crest of Backbone Mountain and about one mile east of it, to or almost to the Potomac river. The northern end of this area is almost detached by Trout Run, and again by Laurel Run. Above Bayard the Potomac flows over the rocks of this formation.

The third region is in the Castleman valley and consists of a single oblong area fourteen miles long, and from three to four miles wide.

The fourth region is in the upper part of the Youghiogheny valley above Deep and Muddy creeks, and contains twelve small detached areas. The largest of these extends from the valley of Deep Creek on the north to Miller Run on the south and lies on the east side of the Youghiogheny river except at its southern extremity. The next largest area extends along the north side of the Baltimore and Ohio Railroad from a point about one mile west of the Youghiogheny river to a point about one mile east of Hutton where it crosses the railroad and covers a small tract on the south side. The third in areal extent lies on the west side of the Youghiogheny river opposite the first-mentioned, extending from near the mouth of Herrington Run to a point about one mile above Swallow Falls. There are nine smaller areas situated near these three.

The fifth region is in the lower part of the Youghiogheny valley below White Rock Run. It includes two areas, a large and a small one. The larger one covers the greater part of the area north of the valley of White Rock Run and west of the Youghiogheny river (except the valley of Feik Run in the northwest corner of the county) and extends east of the Youghiogheny from a point one and one-half miles above Friendsville to the Pennsylvania line. The eastern boundary of this area is roughly parallel to the crest of Winding Ridge and about one and three-fourth miles west of it from Friendsville to the Pennsylvania line. Just west of the mouth of White Rock Run is a detached oval area about one mile long and half a mile wide.

Lithologic Description.—The Conemaugh formation consists of a very complex series of sandstones, shales, limestones, and coal seams, whose total thickness varies from 575 to 720 feet. The usual thickness is about 600 feet. The following sections are typical of the formation.

SECTION OF CONEMAUGH FORMATION AT BARTON, ALLEGANY COUNTY.[1]

	Feet.	Inches.
1. Coal, Pittsburg		
2. Concealed, shale toward the base	41	
3. Gray shales	8	
4. Concealed	18	6
5. Black bituminous shale	2	
6. Yellowish shales with iron-band markings	26	9
7. Concealed, with sandstone near base.	29	
8. Arenaceous shales and thin bedded sandstones	8	
9. Concealed	10	6
10. Coal, Franklin: Coal ..... 9″ Shale .... 2″ Coal ...... 3″ Bituminous shales ..12″ Coal ...... 8″ Shale .....24″ Coal .....24″+	6	10
11. Ferruginous shales	4	3
12. Concealed	26	9
13. Dark gray shales	20	9
14. Coarse sandy shales	10	6
15. Massive gray cross-bedded sandstone.	9	9
16. Concealed	94	9
17. Brownish-gray massive sandstone ...	7	9
18. Concealed	84	6
19. Coal, Bakerstown.......: Bone .... 4″ Coal ....28″ Coal and shale .. 4″	3	
20. Concealed	77	
21. Sandy shale	15	
22. Coal, Masontown	1	7
23. Sandy shale	3	5
24. Shale	12	
25. Sandstone	28	
26. Shale	8	
27. Sandstone	33	6
28. Shale	3	6
29. Coal, Upper Freeport		
Total	594	7

[1] 1 to 20 of this section was measured at Swanton plane, and 21 to 29 obtained from the American Coal Co's. bore-hole at Barton.

SECTION OF CONEMAUGH FORMATION NEAR BLAINE, GARRETT COUNTY.[1]

		Feet.	Inches.
1. Coal, Pittsburg			
2. Concealed		180 ±	
3. Sandstone		3	
4. Concealed		108	
5. Sandstone		2	
6. Concealed		60	
7. Sandy shales		4	
8. Coal, Bakerstown	Coal ....1′ 2″; Shale ... 1″; Coal .... 5″; Bone ... 4″	2	
9. Concealed		26	
10. Shale		6	
11. Coal	Coal .... 4″; Shale ......1′ 6″; Coal .... 3″	2	1
12. Concealed		36	
13. Black shales		10	
14. Fossiliferous disintegrated limestone, Lower Cambridge			8
15. Black shales		8	
16. Coal, Masontown	Coal ..1′ 2″; Bone .. 1″; Coal .. 6″	1	9
17. Concealed		110	
18. Flaggy sandstone		7	
19. Sandy shales		5	
20. Coal, Upper Freeport			
Total		571 ±	6

SECTION OF CONEMAUGH FORMATION IN CASTLEMAN VALLEY, GARRETT COUNTY.[2]

	Feet.	Inches.
1. Probable position of Pittsburg coal.		
2. Strata eroded to top of hill	15 ±	
3. Shale	8	
4. Sandstone	6	
5. Shale	26	
6. Coal		6

[1] Nos. 1-6 measured on hillside below (W. of) Elkgarden; Nos. 7-20, one mile north of Blaine.

[2] Nos. 1 to 23, measured on north end of Ridgleys Hill; 24 to 34, in railroad cut one mile south of the National Road; 35 to 60, from a bore-hole at Jennings Mill.

	Feet.	Inches.
7. Shale	4	6
8. Concealed	36	
9. Yellow shale	5	
10. Concealed	12	
11. Sandy shales	6	
12. Sandstone	1	
13. Black shale	17	
14. Coal		11
15. Shale	2	
16. Limestone	3	
17. Concealed	134	
18. Sandstone	41	
19. Black fissile shale	10	
20. Limestone Ames .... { Black limestone . 9″ / Shaly fossiliferous limestone .....39″ }	4	
21. Coal, Friendsville	1	9
22. Gray shaly limestone	4	
23. Concealed	72	
24. Sandy shale	40	
25. Coal, Maynardier { Coal, bony ..24″ / Shale .... 3″ / Coal ....11″ }	3	2
26. Shale		2
27. Limestone		3
28. Shale		6
29. Limestone	1	
30. Shale	11	
31. Limestone		8
32. Black shale	26	
33. Coal, Bakerstown	2	4
34. Gray shale	7	6
35. Concealed	39	
36. Green shale	8	2
37. Red shale	4	2
38. Green shale	4	9
39. Red shale	13	4
40. Green shale	1	2
41. Red shale	2	8
42. Gray shale	7	
43. Gray shaly sandstone	8	
44. Gray sandstone	11	6
45. Dark shale		3
46. Gray sandstone	3	
47. Black shale	4	
48. Fossiliferous limestone, Lower Cambridge	3	
49. Black shale	7	7

		Feet.	Inches.
50. Coal, Masontown	Coal ..1′ 4″; Bone .. 3″	1	7
51. Black shale		1	
52. Gray shale		20	3
53. Green shale		5	4
54. Gray shale		4	9
55. Green shale		4	10
56. Gray shale		3	2
57. Fine grained greenish-gray sandstone		24	
58. Gray shale		2	
59. Fine grained shaly sandstone		17	
60. Coarse sandstone		9	
61. Greenish and grayish shale		6	1
Total		718	10

Section of Conemaugh Formation, One-half Mile Northwest of Friendsville, Garrett County.

		Feet.	Inches.
1. Probable position of Pittsburg coal.			
2. Strata removed by erosion		10 ±	
3. Concealed		62	
4. Coal, Little Pittsburg	Coal .. 6″; Shale . 2″; Coal ..1′ 5″; Shale . 1″; Coal ..1′ 6″	3	8
5. Limestone		1 ±	
6. Concealed		6	
7. Flaggy sandstone		26	
8. Concealed, and massive conglomeritic sandstone		50	
9. Fine grained sandstone		8	
10. Shale		2	
11. Limestone, Clarksburg	Limestone ..2′ 6″; Shale ......1′; Limestone ..3′ 6″	7	
12. Shale		1	
13. Concealed		15	
14. Shale		5	
15. Concealed		18	
16. Sandstone and shale		15	
17. Fine-bedded sandstone		21	
18. Massive conglomerate		9	
19. Shaly, cross-bedded sandstone		18	
20. Coal, Elklick			6

	Feet.	Inches.
21. Gray calcareous shale	3	
22. Massive sandstone	20	
23. Shaly limestone and fossiliferous shale, Ames limestone	10	
24. Coal, Friendsville	1	3
25. Yellow shale	5	
26. Fine-grained cross-bedded sandstone	30	
27. Gray shale	1	
28. Concealed	31	
29. Sandy fossiliferous shales	4	
30. Yellow shales and concealed	15	
31. Black shale	2	
32. Coal, Bakerstown	1	6
33. Shale and sandstone	36	
34. Red shale	2	
35. Limestone	2	
36. Red and green shales	7	
37. Sandy shales	10	
38. Limestone	1	
39. Sandy shales	27	
40. Black fossiliferous shales	5	
41. Limestone, Lower Cambridge		6
42. Black shale	5	
43. Coal, Masontown	1	9
44. Concealed	80	
45. Black shale with coal smut on top	6	
46. Coal, Mahoning { Bone .7" Shale .6" Coal ..9" }	1	10
47. Black shale	10	
48. Sandstone		4
49. Shale	4	
50. Concealed	25±	
51. Approximate position of Upper Freeport Coal		
Total	635	4

The characteristic members of the Conemaugh formation are as follows:

Lower Pittsburg limestone.
Little Pittsburg coal.
Connellsville sandstone.
Little Clarksburg or Franklin coal.
Clarksburg limestone.
Morgantown sandstone.

Elklick coal.
Ames limestone.
Friendsville or "Crinoidal" coal.
Saltsburg sandstone.
Bakerstown coal.
Upper Cambridge limestone.
Buffalo sandstone.
Lower Cambridge limestone.
Mahoning coal.
Upper Mahoning sandstone.
Mahoning coal.
Mahoning limestone.
Lower Mahoning sandstone.

The Mahoning sandstone does not show as prominently in sections in Garrett county as it has been reported as doing in other regions. But even here it is a very important rock because of the influence that it has upon the topography. It has been the direct means of preserving large areas of the Upper Freeport coal from erosion and is of great value as an aid in locating the position of that coal.

This rock has exerted the most striking influence upon the topography in the Castleman basin, where there is within the outer rim of Pottsville conglomerate an inner rim of Mahoning sandstone. This rim is best shown on the eastern side of the basin where it includes Chestnut Ridge, Salt Block Mountain and Maynardier Ridge. In the Lower Youghiogheny basin it forms the spurs of Winding Ridge which come down to Friendsville on either side of Bear Creek. The rock is well exposed in the bed of Bear Creek immediately above the covered bridge at Friendsville and on the road from Friendsville to Elder. In the northwest corner of the county it holds up a very prominent ridge of which Sickle Hill and Division Ridge are parts and outcrops in the beds of Buffalo Run and Laurel Run. It holds up a number of prominent knobs in the southern end of the basin. From a short distance above Friendsville to below Selbysport and perhaps as far as the Pennsylvania line the Youghiogheny river is flowing along the upper surface of this rock, and to this fact is due the flatness of the valley bottom. In the Upper Youghiogheny basin this is the surface rock over wide areas, especially along the line of the Baltimore and Ohio railroad between Hutton and Offutt's sawmill, and on either side of Herrington Creek. The western bank of the Youghiogheny between the mouth of Chisholm Run and Miller Run is capped for long distances by this rock. There is an excellent exposures on the east bank of the river about one mile above Oak Shoals. In the Potomac and Georges Creek basins the rock is less prominent but nevertheless holds up a number of hills along its western outcrop and forms numerous bluffs in the valley of the Potomac.

The Mahoning sandstone is usually complex, consisting of two prominent sandstones with a shale interval between them. This shale interval usually contains a thin coal and sometimes a limestone. The following section was obtained from a drill-hole near Fairfax, West Virginia.[1]

SECTION IN DRILL-HOLE NEAR FAIRFAX, W. VA.

		Feet.
Upper Mahoning	Sandstone, massive	25
	Concealed	9
	Sandstone, soft	1
	Clay, yellow	6
	Sandstone	20
	Limestone, Mahoning	20
Lower Mahoning	Soft shale	1
	Hard shale	9
	Soft shale	1
	Slate, light blue	10
	Slate, dark	19
	Sandstone	2
	Coal, Upper Freeport	
	Total	103

This is the only record of the occurrence of the Mahoning limestone in this region, but the Johnstown iron ore which frequently replaces it in Pennsylvania has been observed in the Castleman valley. The position of the Mahoning coal is well shown in the following section:

[1] I. C. White, Bull. U. S. Geol. Survey, No. 85, p. 82.

SECTION OF BORE-HOLE ON LAUREL RUN NEAR DOBBIN, GARRETT COUNTY.

			Feet.	Inches.
1. Strata from surface			242	4
2. Upper Mahoning	Gray sandstone	7′ 5″	18	1
	Shale	10′ 8″		
3. Coal, Mahoning	Shale and bone	7″	1	1
	Coal	6″		
4. Lower Mahoning	Shale	1′ 2″	62	
	Shale and sandstone	55′ 9″		
	Sandstone	3′ 1″		
	Shale and sandstone	2′		

The Mahoning coal is frequently present in the Potomac basin. In the Lower Youghiogheny basin it is thicker and more persistent than elsewhere in Garrett county and has been mined for local use.

Of the two divisions of the sandstone the lower is the more prominent and is practically always present, while the upper is frequently absent or replaced by shale.

The strata immediately overlying the Mahoning sandstone, or the shale which replaces the upper Mahoning, consist of from 15 to 25 feet of very argillaceous shales.

The Masontown coal which overlies these shales is one of the most persistent and characteristic strata in the entire Coal Measures. It has been observed at various localities in each coal basin except in the Upper Youghiogheny basin, where it has been almost entirely removed by erosion.

Overlying the Masontown coal is a bed of fissile black shale from 5 to 8 feet thick which is in turn overlain by the lower Cambridge limestone. This limestone is of distinctly marine origin and is filled with marine fossils. It varies in thickness from 6 inches to 3 feet. Considering the extreme thinness of this stratum, its persistence is remarkable. In not a single instance has the position of this bed and of the underlying Masontown coal been exposed without both the limestone and the coal being present. Above the limestone is a series of black shales which carry the same marine fauna. These become more sandy above and finally grade into a fairly persistent and massive sandstone which is the equivalent of the Buffalo sandstone described by Professor White from Butler county, Pa.[1]

[1] Second Geol. Survey, Pa., Q, p. 33.

Above the Buffalo sandstone is a succession of strata which have as yet been seen only in the river-bluff north of Friendsville and which are recorded as Nos. 34 to 38 of that section (see p. 131). The lowest of these strata is a very hard limestone one foot in thickness and carrying marine fossils. This is overlain by ten feet of sandy shales, which are in turn succeeded by seven feet of argillaceous shales which are green toward the base but become red toward the top. Above these red shales is a stratum two feet thick of limestone with marine fossils. This limestone weathers deeply but irregularly to a yellow ocherous mass, but is hard and almost black where fresh. This is overlain by another bed of red shales at least two feet in thickness. These two limestones with the seventeen feet of shales probably represent the Upper Cambridge limestone. In the bore-hole at Jennings Mill this interval is represented by a series of alternating red and green shales.

These beds are succeeded by about 35 feet of shales and sandstones, the latter predominating. Then comes a coal seam of great persistence and considerable value. This is the Bakerstown coal of Pennsylvania, or, as it was called in *The Geology of Allegany County*, the Barton coal.[1] One mile north of Blaine a very thin seam has been opened thirty-two feet below the Bakerstown. This has not been seen elsewhere.

In the Potomac and Georges Creek valleys the Bakerstown coal is locally known as the "Four-foot" and sometimes as the "Three-foot." In the Castleman basin it is locally known as the "Honeycomb." There is another seam in the Castleman basin which is locally known as the "Beachey seam" or "Four-foot," which may be a local development of the "Honeycomb" or Bakerstown, or may belong as much as sixty feet below that seam. It is however more than eighty feet above the Masontown coal. The various possibilities in regard to the actual local position of this coal will be discussed in the chapter dealing with *Mineral Resources*. In regard

[1] This is not the Barton coal of Professor Stevenson as described in Report KK of the Pennsylvania Geological Survey (pp. 67, 68).

to its correlation it may be said that if it is not a local phase of the Bakerstown it has no equivalent in the other coal-basins of Maryland. In the Salisbury basin of Pennsylvania, of which the Castleman basin is the southern continuation, there are three coal-seams between the Bakerstown and the Masontown[1] which have no recognized equivalent elsewhere. The "Beachey" seam is probably one of these, but there is no positive evidence as to which it is. It is here named the *Grantsville coal,* from its typical development near the town of that name. It is mined by Aaron Beachey about one mile west of Grantsville.

The strata immediately overlying the Bakerstown coal are well exposed in the Castleman valley in the railroad cut one mile south of the National Road. This section is part (Nos. 24 to 34) of the complete Conemaugh section given on p. 129. The coal seam 40 feet above the Bakerstown and the limestones underlying it have not been recognized in Maryland outside of this basin, but the coal at least appears to be very constant within the basin. The name *Maynardier coal* is here given it from its development at the west end of Maynardier Ridge. Neither the coal nor the limestone can be correlated with any members of the Conemaugh hitherto described from other regions. In other basins this interval is generally concealed or only poorly exposed.

In the river-bluff northwest of Friendsville there are good exposures of a fine-grained cross-bedded sandstone about 30 feet thick which occupies the interval of from 50 to 80 feet above the Bakerstown coal. This is apparently the equivalent of the Saltsburg sandstone, described by Professor Stevenson,[2] from Saltsburg, Indiana county, Pa.

The Saltsburg sandstone is overlain by a bed of shale, never more than ten feet thick, above which is the thin but very characteristic and persistent Friendsville coal.

The *Friendsville coal,* here called by that name for the first time,

[1] I. C. White, Bull. U. S. Geol. Survey, No. 65, p. 76.
[2] 2nd Geol. Survey, Pa., KKK, p. 22.

FIG. 1.—VALLEY OF GLADE RUN.

FIG. 2.—VIEW NEAR FRIENDSVILLE.

CONEMAUGH FORMATION.

is the equivalent of the "crinoidal" coal of the Pennsylvania reports and of "coal 8b" or the "crinoidal" coal of the Ohio reports. It has apparently never been given a locality name.[1] This seam is well developed in the vicinity of Friendsville, where it is exposed in the bank of the Youghiogheny river one-half mile north of the town at an elevation of 250 feet above the river, and opened at several small mines west and southwest of the town. It has been mined at many places in the Castleman valley where it is locally known as the "Fossil" coal. About one mile west of Mount Savage, Allegany county, it has been opened and mined where it has a thickness of 28 inches. A mine near this was visited in 1842 by Charles Lyell, who listed the fossils in its roof.

The Ames or "crinoidal" limestone immediately overlies the Friendsville coal. This limestone apparently is always either present or is represented by a bed of calcareous shale. Both the limestone and the shale carry abundant marine fossils. The relations of the coal and limestone are well shown in the following sections:

Section at David Herring's Mine, One Mile Southwest of Friendsville, Garrett County.

	Feet.
Black and gray shales	6
Fossiliferous calcareous shales	1
Fossiliferous limestone (Ames)	2
Coal (Friendsville)	1⅓

Section One-half Mile Northwest of Grantsville, Garrett County.

	Feet.
Massive sandstone	15
Concealed	41
Black shales	10
Fossiliferous limestone (Ames)	1
Coal (Friendsville)	1½
Limestone	4
Shale	1

[1] In Bulletin 65, U. S. Geological Survey (pp. 65, 91), Dr. I. C. White suggests that the Platt coal of the Somerset basin in Pennsylvania may be the equivalent of the "crinoidal" coal. This correlation does not seem to be sustained, and even if this seam is the "Platt," that name is objectionable as it is probably a personal rather than a locality name. Hence a new name is proposed.

The limestone below the coal is frequently present. It is No. 22 of the Castleman valley section (p. 129). The interval above the Ames limestone is not well exposed. In the bluff northwest of Friendsville there is a thin coal about 40 feet above the Ames limestone, and the interval between them consists principally of sandstones. This thin coal is probably the equivalent of the Elklick coal. In Garrett county it seems to be quite irregular in its occurrence and always very thin.

Immediately overlying the Elklick coal is a very massive, persistent and characteristic sandstone, which is the equivalent of the Morgantown sandstone of West Virginia. It is well exposed in an old quarry in the western outskirts of Grantsville, on numerous hills to the southwest along the axis of this syncline, in the bluffs of the Youghiogheny below Friendsville, on the higher hill-tops in the Potomac valley, and at numerous places in the Georges Creek valley. The thickness varies from 25 to 50 feet. Toward the base it is usually conglomeritic, but it becomes finer toward the top and finally grades into shale.

An important limestone, which is the equivalent of the Clarksburg limestone of West Virginia, occurs about 40 feet above the top of the Morgantown sandstone. The occurrence of this limestone in Allegany county (near Mount Savage) was described in *The Geology of Allegany County*, p. 119. It is well exposed in Mr. Rumbaugh's quarry one mile northwest of Friendsville; and is probably the limestone (No. 16) in the Castleman valley section (p. 129) which is exposed one-half mile northeast of Bevansville. This limestone, which usually has a thickness of about seven feet, differs from the Cambridge and Ames limestones in lacking the marine faunas, having no fossils except ostracods and fish. Its fauna and its lithologic character give it a very distinctive and characteristic appearance.

A coal-seam, which is known in the Georges Creek basin as the Franklin or "Dirty-nine-foot," and in West Virginia as the Little Clarksburg, overlies the Clarksburg limestone. This coal is very variable in thickness and quality, especially in Garrett county, and is occasionally absent.

The very massive conglomeritic Connellsville sandstone occurs a short distance above the Franklin coal. No sections have been observed which give the full thickness of the sandstone, but the marked influence upon the topography and the amount and character of the talus derived from it indicate a thickness of probably fifty feet. It is this sandstone which holds up the bench which is always below the Pittsburg coal. This bench and the immense amount of talus which surrounds it are very strikingly developed in the Georges Creek basin. The hill northwest of Shaw, from just below the top of the old gravity-plane to Mt. Zion Church, is capped by this sandstone, as is also the hill one mile northwest of Blaine and several other hills in the Potomac valley. The broad flat plateau between Crab Run and Niverton is held up by this sandstone, and the summit of Ridgley Hill is probably capped by it. In the Youghiogheny basin the great flat plateau which overlooks the valley on the western side of the river from Friendsville to the Pennsylvania line is determined by the presence of this sandstone which outcrops along the top of the bluff and whose talus conceals much of the underlying beds.

The Connellsville sandstone is overlain by a group of rocks of slight resistance, which consequently yield few good sections. The predominating rock is shale and accompanying the shale is at least one seam of coal and one of limestone. In some regions there are two of each. The relations of the strata are shown in the following sections:

Section One-half Mile Northwest of Gise, Garrett County.

	Feet.	Inches.
Sandy shale	10	
Shale	3	
Coal, Little Pittsburg { Coal ..12″ / Shale . 3″ / Coal ..12″ }	2	3
Shale	1	3
Limestone, Lower Pittsburg	3	
Concealed, mostly shale	20 ±	
Sandstone, Connellsville		
Total	39	6

SECTION NEAR FAIRFAX KNOB, WEST VIRGINIA.[1]

		Feet.	Inches.
1. Pittsburg coal			
2. Shales and concealed		85	
3. Coal, Little Pittsburg	Coal ..2′ 9″ Shale .0′ 6″ Coal ..0′ 6″	3	9
4. Shales		40	
5. Coal, Second Little Pittsburg	Coal, slaty .....0′ 10″ Coal ....1′ 5″ Slate ....1′ 0″ Coal ....1′ 0″	4	3
Total		133	

The strata from the upper Little Pittsburg coal to the top of the formation consist of shales and have a thickness varying from thirty-five to ninety feet.

TAXONOMY.—The Conemaugh formation is the same as the formation mapped by that name and as the "Lower Barren Coal Measures" by the Pennsylvania Geological Surveys. The correlation is based upon the continuity of the belts in the northern part of Garrett county with those mapped in the adjacent part of Pennsylvania, on the similarity of sequence of the individual beds with those of the type region on the Conemaugh river, and on the presence of identical faunas in the Ames and Cambridge limestones. The formation is clearly defined here, as in Pennsylvania, between the Upper Freeport coal below and the Pittsburg coal above.

The formation is identical with that mapped in Ohio and West Virginia as the "Lower Barren Measures." In both of these states as in the western part of Pennsylvania the faunas of the Ames and Cambridge limestones have been followed as horizon markers of the greatest value in correlation.

The Fairfax and the upper part of the Bayard formation of Darton and Taft are identical with this formation.

The Monongahela Formation.

AREAL EXTENT.—The Monongahela formation occupies twelve small areas in Garrett county. Eleven of these are in the Georges Creek basin, and five of them extend over into Allegany county.

[1] I. C. White, Bull. U. S. Geol. Survey, No. 65, p. 82.

The most northerly extends into the county from the east on the ridge between Staub Run and Midlothian for a distance of a few rods. The second is on the ridge between Staub Run and Wrights Run. The third is on the hill between Wrights Run and Koontz Run. These three are all part of the largest Monongahela area of Allegany county. The fourth is on Detmold Hill. The fifth is the Pekall area on the ridge between Laurel Run and Bartlett Run. The sixth is an oval knob about 650 feet in greatest diameter between the forks of Bartlett Run. The seventh is the Swanton area to the west of Barton. The eighth is the Phoenix area north of Franklin. The ninth is a small oval area about one-quarter of a mile west of the Phoenix area. The tenth is an oval slightly larger than the last and about one-half mile southwest of it. The eleventh is on Franklin Hill. The twelfth is in the Potomac basin, on the hill one and one-half miles northwest of Shaw. A thirteenth area lies in close proximity to the border of Garrett county on the summit of Fairfax Knob.

Lithologic Description.—The Monongahela formation consists of a series of sandstones, shales, limestones and coal-seams having a total thickness of about 260 feet. The following sections show the general character of the strata:

Section of Monongahela Formation at Koontz, near the Allegany County Boundary

		Feet.	Inches.
1. Coal, Waynesburg or Koontz	Coal ..3′ 4″ Shale .0′ 3″ Coal ..0′ 6″ Bone ..0′ 6″ Shale .1′ 8″ Coal ..2′ 0″	8	3
2. Concealed		106	
3. Coal, Upper Sewickley or Tyson		3	6
4. Concealed		107	
5. Shale		2	2
6. Coal, Pittsburg or Elkgarden	Coal, wild ...0′ 11″ Shale ....0′ 10″ Coal, top ....1′ 6″ Coal, breast .7′ 6″ Shale .... 1″ Coal .... 2″ Shale .... 1″ Coal, bottom .2′ 0″	13	1
Total		240	

Sections of this formation are so poor and incomplete that it will be necessary to quote, with slight modifications, the following Allegany county section in order to describe the formation in detail.

SECTION OF MONONGAHELA FORMATION IN PUMPING SHAFT, TWO MILES SOUTH OF FROSTBURG, ALLEGANY COUNTY.

	Feet.	Inches.
1. Coal, Waynesburg or Koontz	1	10
2. Concealed	20	
3. Limestone, Waynesburg	5	7
4. Silicious fire-clay	3	11
5. Sandstone		10
6. Shale	4	10
7. Sandstone	1	8
8. Shale	20	
9. Coal, Uniontown		5
10. Shale	5	8
11. Sandstone, Sewickley	14	2
12. Shale	38	
13. Coal, Upper Sewickley or Tyson (Coal ..0′ 10″; Shale .3′ 0″; Coal ..1′ 8″)	5	6
14. Shale	16	
15. Sandstone	4	
16. Shale	25	
17. Sandstone	1	
18. Coal, Lower Sewickley	2	6
19. Shale	18	
20. Sandstone		10
21. Shale	9	6
22. Limestone, Sewickley	5	6
23. Shale	7	8
24. Coal and shale, Redstone	7	4
25. Shale	18	9
26. Sandstone	1	2
27. Coal, Pittsburg or Elkgarden (Coal and shale ..3′ 7″; Coal ......9′ 6″)	13	1
Total	252	9

The Monongahela formation is conformable upon the underlying Conemaugh. The base of the formation is the floor of the Pittsburg coal. This dividing plane is everywhere present and everywhere easily recognized.

[1] C. C. O'Harra, Geology of Allegany County, p. 127.

The Pittsburg (or "Elkgarden," "Big Vein," or "Fourteen-foot," as it has been locally called in this region) is the thickest, most constant and best known coal not only in Garrett county but in the entire northern Appalachian field. Because of the shallowness of the other basins, and the amount of erosion, its occurrence in Garrett county is limited almost exclusively to the Georges Creek basin. In this and in the Potomac basin there is a geographic variation in the character of the seam. In the northern end of the basin both the coal and shale partings are thin, but toward the south the coal thickens, while the shales remain constant or decrease somewhat in thickness, until the maximum thickness of the coal is obtained in the central part of the Potomac basin. South of here the tendency was evidently for the shales to thicken enormously while the coal remained almost constant.

Above the roof coals of this seam is a stratum of shale which with the overlying strata is well illustrated in the following section:

SECTION TWO AND ONE-HALF MILES NORTHEAST OF GRANTSVILLE.
(ONE-EIGHTH MILE NORTH OF THE PENNSYLVANIA LINE).

	Feet.
1. Sandstone	2
2. Shale	12
3. Coal, Redstone	3
4. Shale	6
5. Limestone, Redstone	10
6. Shale	30
7. Coal, Pittsburg	9
Total	72

The Redstone limestone has not been recognized in the Georges Creek basin, but the Redstone coal appears to be quite generally present. A short distance above the Redstone is a thin limestone (the Sewickley limestone) which is the only representative of the great thickness of limestone in about this position in southwestern Pennsylvania. In western Allegany county there is a seam of coal about 30 feet above this limestone, which represents the Lower Sewickley coal. This seam has not been exposed in Garrett county but may be confidently expected there. About 45 feet above the Lower Sewickley coal and separated from it by shales and sandstones is the Upper Sewickley coal, or Tyson seam, as it has been called in Allegany county. A sandstone about 40 feet still higher is the representative of the Sewickley sandstone. A short distance above this there is found in western Allegany county the very thin representative of the Uniontown coal, but this has not been seen in Garrett county. About 30 feet higher is the Waynesburg limestone, which occupies a position about 30 feet below the upper member of the formation, or the Waynesburg coal. The Waynesburg coal is a very constant stratum, but its area in Garrett county is small and exposures of it are infrequent. It was called the "Koontz" coal in the report on the *Geology of Allegany County*. The roof of this coal marks the top of the Monongahela formation.

TAXONOMY.—The strata here mapped as the Monongahela formation are correlated with the formation which was long ago given that name and mapped in Pennsylvania. They have also been called in Pennsylvania, West Virginia and Ohio the "Upper Productive Coal Measures."

The Elkgarden formation of Darton and Taft is synonomous with the Monongahela formation.

THE PERMIAN.

The Dunkard Formation.

AREAL EXTENT.—The Dunkard formation occupies three small areas in Garrett county. These are all in the Georges Creek basin and are situated in close proximity to the Allegany line. The most northerly of these is on the summit of the hill north of Koontz. The next area is on the summit of Detmold Hill. This extends along the Allegany line for one and one-half miles and is about one-eighth mile in width. The third area is on Swanton Hill west of Barton.

LITHOLOGIC DESCRIPTION.—The Dunkard formation lies with apparent conformability upon the Monongahela. The areas are all so small, and are so near to the summits of gently rounded hills above the drainage lines that there are no good exposures. Consequently it is

FIG. 1.—TERRACES IN CASTLEMAN VALLEY, NEAR GRANTSVILLE.

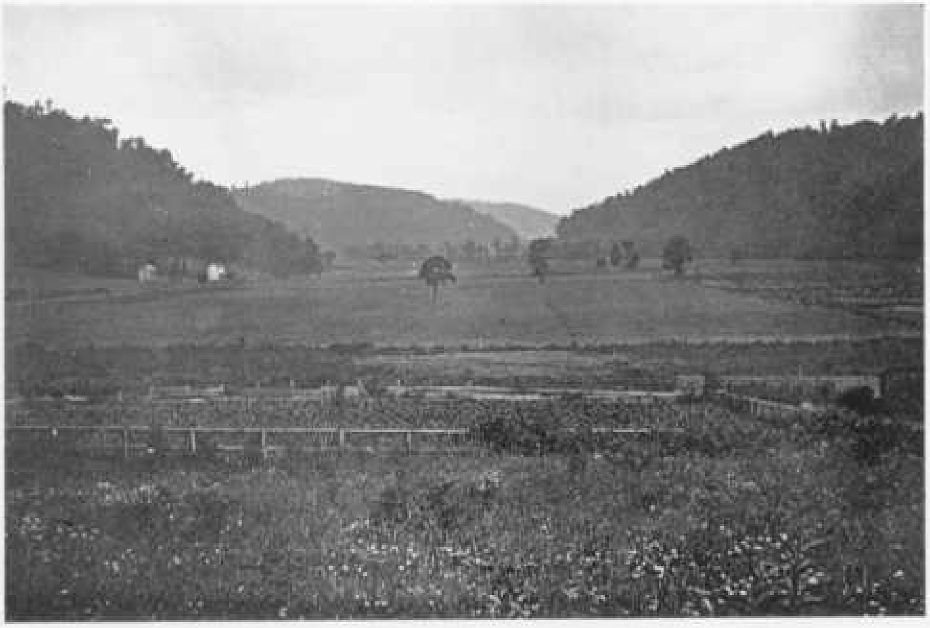


FIG. 2.—RIVER BOTTOM IN YOUGHIOGHENY VALLEY, NEAR SELBYSPORT.

QUATERNARY.

impossible to say anything definite about the strata, except that they are apparently shales or limestones which do not show through the soil. The Waynesburg sandstone which is almost always seen a short distance above the base of the formation in other regions, has not been recognized in Maryland. The thickness in Garrett county nowhere exceeds two hundred feet and is far less except on Swanton Hill. The strata as exposed in Garrett county are not at all distinct from the upper beds of the Monongahela formation, and the only reason for showing the Dunkard on the map is that these hills are high enough above the base of the Monongahela to include more than the normal thickness of that formation. In Allegany county the formation has a thickness of about four hundred feet, and in southwestern Pennsylvania more than one thousand feet, but in Garrett county all but the lowest beds have been removed by erosion.

Taxonomy.—This formation, as stated in the report on *The Geology of Allegany County* (p. 129), is classified as Permian in conformity with the results of study of the equivalent beds in West Virginia and Pennsylvania. Some doubt exists, however, regarding the age of the deposits, and further study of the fossils may show the Dunkard formation to be Carboniferous rather than Permian.

The strata preserved in Garrett county, like all (or almost all) of those in Allegany county, belong in the lower division of the Dunkard, i. e., the Washington County Group of the Pennsylvania geologists. The Dunkard formation was formerly called locally the Frostburg formation.

THE QUATERNARY.

The Paleozoic rocks of Garrett county everywhere, except where they are constantly being swept clean, are covered by a mantle of unconsolidated material of diverse character. The age of this mantle extends from the immediate present, back through a somewhat indefinite but not very long period in geological history. Excluding the soil which is still in process of formation and which is everywhere present, the age of the greater part of the unconsolidated material is Pleistocene.

From the point of origin, the surface deposits of Garrett county may be classified as follows:

Untransported products of agencies still at work = *the soil.*
Sediments (fluviatile) still being formed = *river-bottoms.*
Sediments produced by past conditions = *river-terraces.*
Untransported material produced under past conditions = the residual soil of *the Glades.*

THE GLADES.—The oldest and most constant and characteristic of the unconsolidated deposits of Garrett county consist of a thick mantle of residual clay and sand which is best developed in the regions of flat open marsh- and meadow-lands known as "Glades." The thickness and exact lithologic character of these deposits are not well known as there are no good sections, either natural or artificial.

The Glades are a series of base-levels which were either caused or preserved from subsequent destruction by the influence upon the topography and drainage of the Pottsville and Pocono ridges.

RIVER TERRACES.—Terraces are very prominent along some of the streams of Garrett county, but for the most part the streams are without any distinct and extensive system of terraces. There are benches on the sides of most of the valleys but these are formed by ledges of resistant rock, are not horizontal, and are not of constructive origin. However there are some terraces which are horizontal and constant in position and are composed of sedimentary material younger than the valley itself.

These terraces are best developed in the Castleman valley a few miles south of Grantsville. Here is at least one terrace which is distinctly of constructive origin. It lies at an elevation of about 2200 feet above tide or about 30 feet above the bottom of the valley. It is composed of well-stratified sand and sticky blue clay with a surface of loam. In the sand and clay are rounded quartz pebbles and rolled crusts of limonite. The thickness of the deposits exceeds twenty feet in places. This terrace extends along both sides of the valley from the mouth of Shade Run to and somewhat above the mouth of the North Fork.

A similar terrace exists, but is not quite as well developed, in the

Youghiogheny valley from Friendsville to the Pennsylvania line. This is at an elevation of about 1500 feet, and shows most distinctly at the mouths of the side valleys.

Similar terraces have been observed in the Potomac valley, but are not well developed there.

The origin of these terraces cannot at present be explained.

River Bottoms.—Most of the rivers, especially those which are not actively lowering their beds, have built flood-plains of varying width and character. Most of them are narrow and consist only of belts of coarse detritus extending from the edge of the channel to the base of the steep hillside. The Castleman river meanders for much of its course through a broad swampy flood-plain which is still in process of construction. The Youghiogheny river from near Friendsville to and beyond the Pennsylvania line is flowing through a broad flood-plain whose surface is of fine loam, and which is high enough above the river so that it might almost be regarded as a terrace. Many of the smaller streams are bordered by narrow flood-plains which are still in process of construction and change. The best developed of these are along the Savage river.

The most extensive and most recent of the Quaternary deposits, the soil, is fully described in a later part of this volume.

Structure.

INTRODUCTORY.

The rocks of Garrett county are entirely sedimentary and have been but little altered since they were deposited. Like most sedimentary rocks they were originally deposited in an almost horizontal position, but have been subsequently thrown into a series of folds.[1]

[1] The elevations of the folds are known as *anticlines*, and the depressions as *synclines*. The angle which any bed makes with a horizontal plane is called its *dip*, and the direction at right angles thereto along the bed is its *strike*. If a fold has equal dips on the opposite sides it is a *symmetrical fold*, while if the dips on the opposite sides are unequal it is an *unsymmetrical fold*. The line of greatest depression of a syncline, or of greatest elevation of an anticline, from one end of the fold to the opposite is the *axis of the fold*. The angle between a line drawn along the axis on the surface of any bed, and the horizontal is the *pitch* of the axis and of the fold. An anticline

Garrett county lies entirely within what has been designated by Willis as the *District of Open Folding* of the *Appalachian Province*[1] In this district the folds are broad and the dips relatively gentle, so that further folding would have been possible without squeezing the strata. This district has been further divided into the *Valley region* where the folds are sharp and very long and where the distinctive topographic features are "governed by structures seen in the sharp upward folds or anticlines of the narrow-crested ridges and in the wide undulating downward folds of the valleys;"[2] and the *Plateau region* which "is characterized by low folds of wide amplitude. In this province the structures and topographic types do not conform as they do in the valley region. Valleys follow both upon the anticlinal and synclinal axes, while the mountains remain between upon the dip of the strata or limb of the fold."[3] Garrett county lies entirely within and near the eastern edge of the "Plateau region."

There are parts of four synclines and three anticlines in Garrett county. Their location is shown on the accompanying map (Plate XIII), and they are described in the following pages.

THE GEORGES CREEK-POTOMAC SYNCLINE.

Position.

The easternmost structural feature of Garrett county is a broad rather deep synclinorium, only part of the western limb of which lies within Garrett County. It is named from the two streams which flow along the axis. The southern part of this fold was called by Darton and Taft[4] the "North Potomac Syncline" while the northern

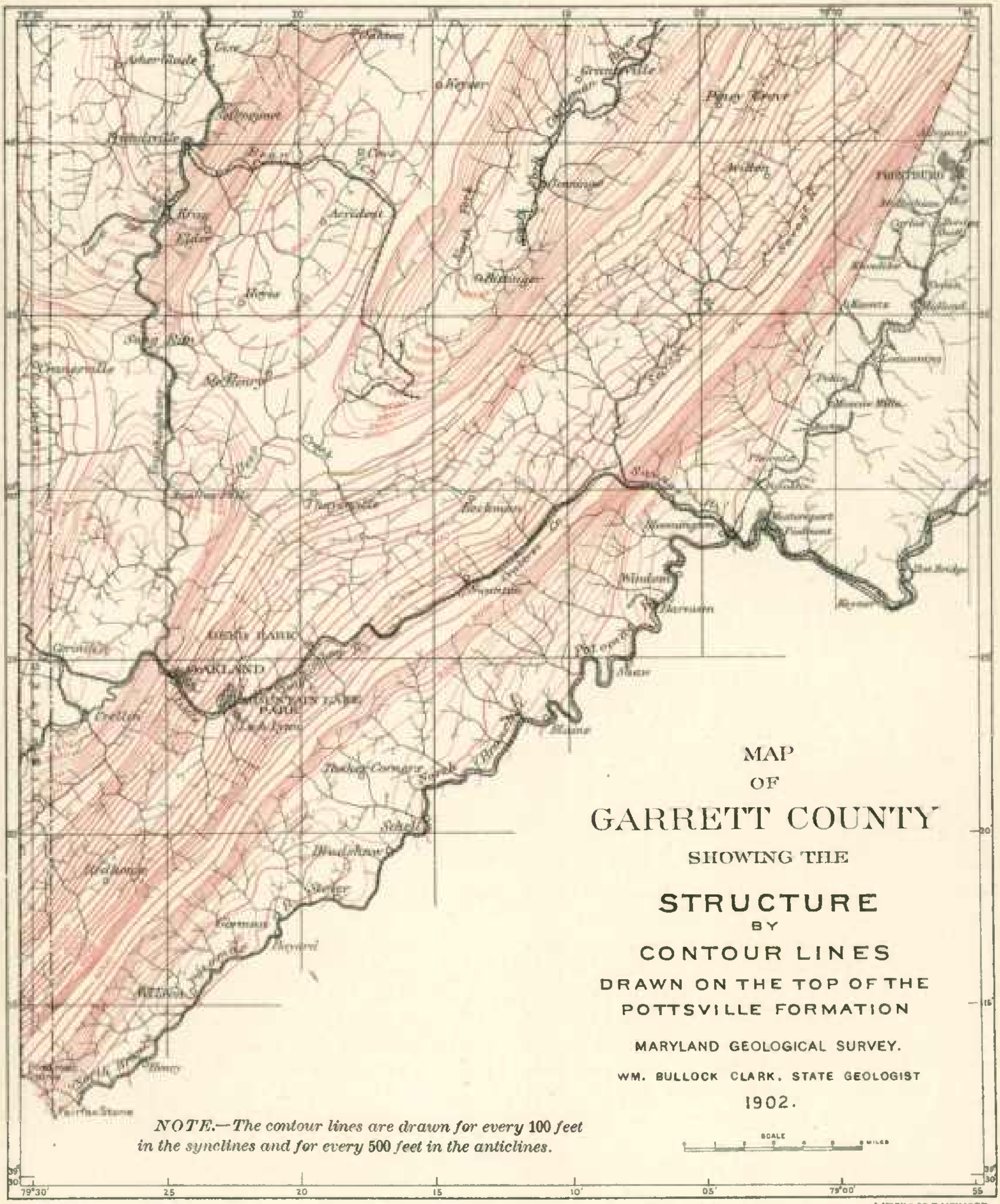
which has a long horizontal or almost horizontal axis which pitches down steeply at each end is called a *cigar-shaped anticline.* A syncline which has a long horizontal or almost horizontal axis which pitches up steeply at each end is called a *canoe-shaped syncline.* An anticline which has a steep pitch downward in opposite directions from a central point is called a *dome* or *domed anticline*, and the fold is known as a *quaquaversal fold.* A syncline which has a steep pitch upwards in opposite directions from a central point may be called a *spoon-shaped syncline.*

[1] The Mechanics of Appalachian Structure. 13th Ann. Rept. U. S. Geol. Survey, Pt. ii, p. 224.

[2] Darton and Taft. U. S. Geol. Survey, Geol. Atlas, folio 28, p. 4.

[3] Loc. cit., p. 5.

[4] Loc. cit., p. 5.



A. HOEN & CO. BALTIMORE

P. 148 B

part was called by O'Harra[1] the "Georges Creek Syncline." The further continuation of this fold into Pennsylvania has been called the "Wellersburg Syncline."

Inasmuch as a thorough knowledge of the general nature of this fold involves a discussion of the structure of the region adjoining Garrett county on the east, in Allegany county and in West Virginia, the descriptions of it by Darton and Taft and by O'Harra are quoted.

The region described by Darton and Taft includes the southern part of Garrett county and the adjoining part of West Virginia. They say:[2]

"The North Potomac synclinal fold is the first west of the valley region, and extends between the New Creek Mountain and Deer Park Valley anticlines. Rocks in the Allegany Front dip down steeply toward the north-northwest at 18° to 60°, but they rapidly change in dip to a few degrees, and pass across the valley of the North Branch of Potomac River almost horizontally. In Backbone Mountain the same rocks rise, dipping east-southeast 15° to 25°. This wide synclinal basin of the North Potomac inclines or pitches north-northeast nearly 45.7 feet per mile. It widens southward, and divides near the center of the Piedmont quadrilateral. One prong—the Stony River syncline—is in the valleys of Stony River and Red Creek, between the Allegany Front and Canaan Mountain. The other prong is a direct continuation of the North Potomac basin, and its axis passes almost through Fairfax Knob. This interruption and division of the North Potomac syncline is due to the Blackwater anticlinal fold. This anticline enters the area nearly in the southwest corner and extends northward approximately parallel to the Allegany Front. The Blackwater [Pottsville] sandstone and Greenbrier formation, which once closed in an arch over the Blackwater Valley, have been removed by erosion, and the wide valley between Canaan and Brown mountains now extends along the axis of the arch. The Blackwater anticline pitches northward, down into the North Potomac syncline, and is lost near the center of the basin. Structure sections

[1] Md. Geol. Survey, Allegany County, 1900, pp. 150–152.
[2] U. S. Geol. Survey, Geol. Atlas, folio 28, p. 5.

E. F. and G. H. illustrate the relations of these folds. Local disturbances of minor folding are indicated by dip of the rock in the Potomac Valley near Gorman and Stoyer, and in Stony River Valley above the falls on each side of the Blackwater anticline where it

FIG. 1.—Map of the North Potomac Syncline with contour lines showing the lay of the Lower Kittanning coal and its elevation above sea. (After Darton and Taft.)

dies out down the pitch, but they are too small to apparently affect the general structure or to be recognized in structure sections."

Above is a reproduction of part of the map of the Piedmont quadrangle by Darton and Taft, which accompanied the above description. The contours at intervals of 100 feet represent the lay of the Lower

Kittanning coal and its elevation above sea-level. It may be seen by comparing this figure with Plate XIII of this volume, on which 100 foot contours are drawn on the top of the Pottsville formation (about 100 feet lower), that the author differs somewhat from Darton and Taft as to the minor details of the folding. He agrees with them, however, as to the general character of the structure.

O'Harra described the Georges Creek Syncline of Allegany county as follows:—[1]

"The Georges Creek syncline is defined on the east by the Wills Mountain and Fort Hill anticlines already described. The western limit is west of Savage Mountain beyond the borders of Allegany county, hence need not receive further mention here. The full width of this syncline, of which only the eastern and central portions lie in Allegany county, remains approximately ten miles throughout its entire course across the state. This measurement, however, is not to be confused with the width of the high valley lying between Savage Mountain and Dans-Little Allegheny Mountain which occupies scarcely more than one-half of the synclinal fold. The axis of the syncline has been designated with considerable detail by means of the various mining operations in the coal basin. Its general direction is N. 28° to 30° E. passing through Franklin, Barton, Moscow and Lonaconing. It lies a little to the west of Westernport and passes through the immediate vicinity of Mount Savage.

"Steeply-dipping Silurian and Devonian strata occupy the eastern border of the syncline, but gradually growing less steep westward from Wills Mountain they disappear one by one beneath the high-lying Carboniferous strata of the coal basin.

"In the gap through which Jennings Run flows, where many of the strata, particularly those of the Hampshire formation, have an excellent exposure, the gradually decreasing inclination of the beds may be clearly seen. Numerous good exposures further south along Braddock Run and still further south in the Potomac gorge also aid materially in arriving at correct conclusions concerning the structure of this part of the county.

[1] Md. Geol. Survey, Allegany County, pp. 150-152.

"At the Jennings-Hampshire contact in the Jennings Run gap the dip is 68° W. At the Hampshire-Pocono contact the dip has gradually decreased to 28° W. At the Pocono-Greenbrier contact it is 17° W., while at the Mauch Chunk-Pottsville contact the dip is only 13° W. Further west the dip continues to gradually grow less.

"In the Potomac gorge and along Braddock Run the favorable places for observation cannot be concisely described but the measurements obtained correspond closely to those made along Jennings Run.

"These measurements were all obtained near the level of the streams mentioned, hence following the various formations upward to the positions which they occupy in the higher parts of the Alleghany Front the dip is found to increase slightly. Opportunities are not good for learning definitely how much this increase is, but it is known that the Pottsville dips from 16° W. to 22° W. where best exposed along the high crest of Dans-Little Allegheny Mountain.

"Outcrops of strata in Allegany county suitable for accurate measurement of the dip are rare west of the synclinal axis. Southward from the state line the Allegany-Garrett line gradually approaches the position of the synclinal axis, hence the western limb of the syncline is but poorly represented in Allegany county. It seems, however, that the steepness increases somewhat less rapidly west of the axis and the prevailing dip of the Pottsville in the northwest corner of the county is thought to be not greater than 12° E. to 15° E. . . .

"In much of the Georges Creek syncline this [the pitch] is not quite so apparent, but in the northern part of the county the upward pitch to the north becomes perceptible, and as a result the coal measures all come to the surface within some fifteen miles north of the state line."

The western edge of this syncline may be considered as located along the line of steepest dip where the surfaces of stratification change from an upward to a downward concavity. This line coincides approximately with the outcrop of the base of the Pottsville, with the 3200 foot contour drawn on the top of the Pottsville, and with the crest of the Great Backbone-Big Savage ridge. The course of the western edge of the fold is remarkably uniform, being about

N. 35° E, except for about four miles in a region east of Altamont where it is about N. 50° E. The syncline is continued to the northeastward into Pennsylvania, and southwestward into West Virginia.

The axis of the fold lies entirely east of Garrett county. It extends in Allegany county through Mount Savage, Frostburg, Borden Shaft, Lonaconing and Westernport. Thence it passes into West Virginia and lies somewhat east of the Potomac river from Piedmont to Elkgarden. Here, according to Darton and Taft, it divides, the eastern fork extending up the valley of Abram Creek. The western fork extends along and probably somewhat to the east of the Potomac river as far as the mouth of Stony river. Here another bifurcation takes place, one fork extending south into West Virginia, and the other crossing the Potomac river in a westerly direction to a point about two miles north of Gorman where it turns and runs southwest to the southern point of Garrett county slightly east of Fairfax Knob.

Attitude of the Strata.

The strike averages about N. 35° E. along the western edge of the fold. Toward the axis it becomes less regular and follows the directions shown by the contour lines on Plate XIII. The dip varies from 20° to 45° along the edge of the fold, averaging about 30°. Toward the center of the syncline it becomes steadily smaller and less regular. Along the Potomac river it is small but quite irregular in amount and direction, being prevailingly northwestward between Fairfax Knob and the mouth of Stony River and prevailingly southeastward from this point to Bloomington.

The pitch is very slight but apparently southwestward from Fairfax Knob to a point west of Henry. From here the axis pitches northeastward at the rate of about 40 feet per mile to the valley of Shields Run. Thence it pitches southwestward at a low, irregular angle as far as the mouth of Stony River. From here to Piedmont it pitches quite regularly to the northeastward at the rate of about 80 feet per mile. From this point northward the axis lies so far to the east of the boundary of Garrett county that the problem of pitch is of no concern in this report.

General Features.

The most striking features of the structure in this fold are the very uniform strike and dip along the western flank; the flattening of the center of the fold and steepening of the western flank in the valley of the Savage River; the development of a subordinate anticline with an axis extending in a N. W.-S. E. direction through Tasker Corners and the mouth of Stony River; and the presence of a subordinate spoon-shaped syncline west of and parallel to the Potomac above the mouth of Stony River.

The strata outcropping in this fold are those of the Mauch Chunk, Pottsville, Allegheny, Conemaugh, Monongahela and Dunkard formations.

THE DEER PARK ANTICLINE.

Position.

The Deer Park anticline bounds the Georges Creek-Potomac syncline on the west throughout its entire length. Its western edge may be somewhat arbitrarily placed at the outcrop of the base of the Pottsville formation along the crest of Meadow Mountain and the geologically continuous and similar ridge which extends from the valley of Deep Creek in a southwesterly direction to the Preston county (West Virginia) line. This coincides approximately with the 3200 foot contour drawn on top of the Pottsville formation. (Plate XIII.)

The axis extends S. 35° W. from the Pennsylvania line halfway between Big Savage and Meadow mountains through Avilton to Beckman. From here it extends S. 50° W. to a point about 2½ miles northwest of Altamont. Thence it resumes its former course of S. 35° W. passing through the eastern edge of Mountain Lake Park and a point midway between Sunnyside and Redhouse and crossing the West Virginia line 3¾ miles north of Great Backbone Mountain. In each of these courses the axis is very straight.

Attitude of the Strata.

The strike is very uniform throughout the entire fold. Except at a few points near the center of the fold it remains parallel to the axis.

The dip varies from 0° to 90°. A very noticeable feature in this anticline is the occurrence of very steep dips at no great distance from the axis. The steepest dips are in general on the west side of the axis. The average dip in the zone of greatest inclination is about 35°. The dip in general is greater toward the southern end of the fold.

The pitch from the Preston county (West Virginia) line to Middle Ridge is about 130 feet per mile northeastward. From this point to the Pennsylvania line it is about 160 feet per mile southwestward.

In the center of the fold there has been some faulting, but the displacement is apparently slight. In the fissures and fault planes are veins of calcite which contain small amounts of galena, sphalerite and pyrite.

General Features.

It may thus be seen that the anticline is more elevated and more steeply arched at the southern end. At the central depressed point the top of the arch is very flat. This depression is bounded on the west by a zone of steeply dipping rocks. This abruptly terminates the depression on the west so it does not affect the adjacent syncline. The steepest dips in the county are at this place where the rocks stand vertical.

The fold is a long, approximately straight, simple anticline, without subordinate folds.

The rocks involved in this fold which outcrop at the surface are those of the Jennings, Hampshire, Pocono, Greenbrier, and Mauch Chunk formations. The axis is in the outcrop of the Jennings formation throughout the entire length of the fold.

THE CASTLEMAN SYNCLINE.

Position.

The Castleman syncline adjoins the north end of the Deer Park syncline on the west. It occupies the area between the crests of Meadow and Negro mountains, the boundaries being approximately the outcrop of the base of the Pottsville formation on the crests of those mountains, or the position of the 3200 foot contour drawn on the top of the Pottsville formation. (Plate XIII.) The southern end of the syncline may be placed at Deep Creek which flows along a small low anticline which cuts off this syncline from the Upper Youghiogheny syncline to the southwest of it.

The axis of this fold extends from Niverton, Pennsylvania, through the eastern end of Grantsville and on to the Castleman river at a point one mile south of Grantsville. Thence it lies along the course of the Castleman as far as the forks of that stream. From here it extends to Bittinger, and then in a course of about S. 45° W. to the southern end of Meadow Mountain.

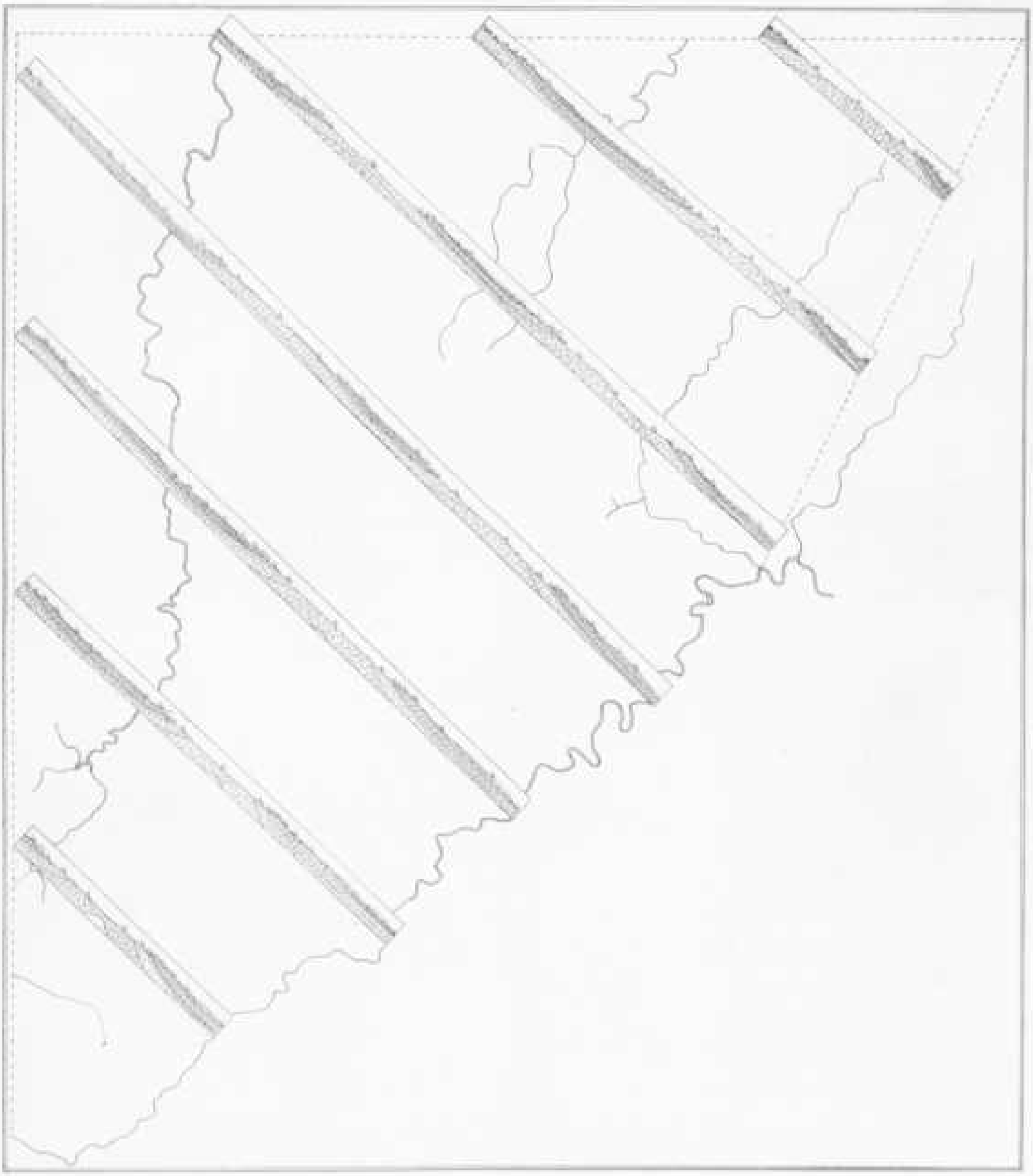
Attitude of the Strata.

The strike on the flanks of that part of the syncline southwest of Bevansville is in general parallel to the axis. Northeast of Bevansville it gradually diverges from the direction of the axis toward the east on the eastern limb of the fold and to the north on the western limb. In the region about four miles east of Accident there is a very pronounced divergence of the strike to a course almost east and west.

The dip is quite gentle and regular. It averages about 12° or 15° on the crests of Meadow and Negro Mountains and decreases rapidly and quite regularly toward the axis.

The axis pitches to the northeast at a rate of about 55 feet per mile from Niverton, Pa., to a point about 2½ miles southwest of Bittinger. From that point to the southern end of the syncline it pitches to the northeast at a rate of 200 feet per mile.

There is a fault in tho sandstones and shales of the Conemaugh formation in the west bank of the Castleman river just east of Grantsville. For a distance of about 100 feet along the roadside there can be seen a massive sandstone resting horizontally upon the upturned edges of steeply dipping shales. The dip of the shales is unusual for this region, the normal dip at this point being that of the almost horizontal sandstone. The disturbance is all the more remarkable for occurring in the center of a very open syncline where the strata are usually very slightly disturbed. The amount of displacement could



STRUCTURAL SECTIONS IN GARRETT COUNTY.

P 156 B

not be measured but the appearance at this one locality would seem to indicate that it might be considerable. There are however no indications of it in any other exposures.

General Features.

This is, as far as the portion in Garrett county is concerned, a typical canoe-shaped syncline. Subordinate folds and undulations of the axis are apparently lacking. It is a more simple fold than the Georges Creek-Potomac syncline or the synclines further west.

The strata involved in this fold and outcropping in it are those of the Mauch Chunk, Pottsville, Allegheny, Conemaugh and Monongahela formations. The last do not enter Garrett county but are exposed a few rods north of the Pennsylvania line.

THE UPPER YOUGHIOGHENY SYNCLINE.

Position.

The Upper Youghiogheny syncline adjoins the southern end of the Deer Park anticline on the west. Its western boundary is the outcrop of the base of the Pottsville formation along the crest of Snaggy Mountain. On the northeast it is separated from the Castleman syncline by the crest of the subordinate anticline referred to above. On the northwest it is separated from the Lower Youghiogheny syncline by a low anticline in the high hill south of Sang Run. On the north between the two low anticlines above mentioned is the Accident anticline of which they are both prongs.

The axis of this fold enters Garrett county from Preston county (West Virginia) along the line of the Preston R. R. Thence its course is N. 45° E. to the "Michler line." From this point it extends in a somewhat sinuous course to a point about ½ mile north of Skipnish where it bifurcates. The main axis runs east for about a mile and then turns northeast again and extends in that direction as far as the Youghiogheny river at a point about one-half mile above Oak Shoals. Here it turns north and follows roughly the course of the river as far as a point about one mile above Swallow Falls. Thence it extends in a northeasterly direction for about three miles where it is lost on the rim of the basin. The secondary axis extends from the point of bifurcation in a somewhat sinuous north-northeasterly and northerly course along the geographical center of the basin, passing through Brew Mahr Mill in the direction of Sang Run.

Attitude of the Strata.

The strike is very variable. Toward the edges of the basin it is parallel to the direction of the rim as described above. In the center of the basin it is very irregular following the courses of the contour lines on Plate XIII.

The dip seldom exceeds 12° or 15° on the flanks of the fold and decrease rapidly toward the axis. It is very variable in amount and direction especially in the center of the basin.

The pitch from the point where the axis crosses the West Virginia line to the point of bifurcation is about 120 feet per mile toward the northeast. From here the main axis undulates with a pitch of from 0 to 100 feet per mile until it reaches a lowest point at a place about two-thirds of a mile southeast of Swallow Falls. For a distance of about three miles northeastward from this point the axis has a pitch to the southwest of about 200 feet per mile. Then the pitch passes into the dip of the adjacent anticline. The secondary axis has a slight pitch toward the south for a distance of about two miles north from the point of bifurcation. Then it has a slight pitch toward the north as far as a deep point under the valley of Herrington Run. From this point to the crest of the anticline in the hill south of Sang Run the pitch of the axis is southward. It gradually increases from nothing in the valley of Herrington Run to a maximum of 200 feet per mile about one mile north of Brew Mahr Mill. From this point northward it gradually decreases in amount but continues its direction southward.

General Features.

The most noticeable structural features in connection with this fold are the unsymmetrical character; the shortness in proportion to the width; the strong pitch compared with the relatively gentle dip; the irregular strike and dip; the bifurcating axis; and the four subordinate spoon-shaped synclines. This syncline is of a different type from those described above. It is of the class typically developed in western Pennsylvania, which characterizes the interior of the *Plateau Region* of the *Appalachian District* of *Open Folding.*

The strata outcropping in this fold are those of the Mauch Chunk, Pottsville, Allegeny and Conemaugh formations.

THE ACCIDENT ANTICLINE.

Position.

The Accident anticline adjoins the Castleman syncline on the west and the Upper Youghiogheny syncline on the north. Its west ern boundary is the crest of Winding Ridge. This fold forks at the southern end; one prong extending southeastward through the valley of Deep Creek, connects with Deer Park anticline, the other extending southwestward, connects with the Cranesville anticline.

The axis extends in an almost straight line from a point on the Pennsylvania line S. 37° W. to a point one mile west of Accident. Thence it extends S. 26° W. for almost 4 miles where it becomes obscured toward the rim of the fold. A bifurcation takes place however; one axis passing southeastward through McHenry and the valley of Deep Creek, and the other southwestward through the high hill south of Sang Run toward the center of Pine Swamp.

Attitude of the Strata.

The strike is quite regular being roughly parallel to the rim of the fold, especially at points not far removed from the rim. The most marked exception to this is in the interior of the fold for a distance of about five miles northeast of Accident. Here the strike diverges from the direction of the axis southwesterly on the western limb of the fold, and southeasterly on the eastern limb.

The dip is quaquaversal except in the vicinity of the Pennsylvania line. The steepest dip is on the western limb of the fold about 2½ miles west of Accident where a maximum of 25° was observed in one exposure. It seldom exceeds 10° or 12° and is quite irregular.

It is possible that there has been faulting on the western limb of the fold in the region of steepest dip. The occurrence of abundant blocks of slickensided sandstone on the surface and an apparently abnormal thinness of the Hampshire formation suggest the presence of a fault to the west of Accident. Its actual occurrence, however, could not be established.

The axis pitches northeastward at a rate of about 160 feet per mile from the Pennsylvania line to a point about one mile west of Accident. From here south it pitches southwestward at a rate of 200 feet per mile for about three miles and then increases to a maximum of about 500 feet per mile toward the rim of the adjacent syncline.

General Features.

This fold is the southern end of a very long narrow arch which extends for many miles into Pennsylvania and is there known as the Negro Mountain anticline. Its most striking feature is the development of a great quaquaversal dome near the southern end, beyond which it pitches rapidly downward into the end of a syncline.

It is an anticline of a different type from those to the eastward, and is the counterpart of the syncline last described with which it characterizes the structure of this topographic and structural sub-province.

The strata involved at the surface are those of the Jennings, Hampshire, Pocono, Greenbrier and Mauch Chunk formations.

THE CRANESVILLE ANTICLINE.

Position.

The Cranesville anticline adjoins the Upper Youghiogheny syncline on the west. It is bounded on the north by Feik Hill and Dog Ridge, beyond which is the Lower Youghiogheny syncline. The western and southern limits of this fold as well as the greater part of its area, are in West Virginia.

The axis extends through the valley east of Nettle Ridge and the town of Cranesville in a southwesterly direction.

Attitude of the Strata.

The strike is quite regular in direction, keeping parallel to the edge of the fold on the contour lines shown on Plate XIII.

The dip as far as the Maryland end of this fold is concerned, seems to be quaquaversal. It is fairly regular, although of small amount, seldom exceeding 8° or 10° in the northern end of the fold, but increasing to a maximum of about 20° to the northwest of Corinth.

The pitch along that part of the axis which lies in Garrett county is about 500 feet per mile northeastward.

General Features.

The end of this fold which enters Garrett county resembles in its structure the southern end of the Accident anticline. As far as the facts concerning the Preston county (West Virginia) continuation of the fold are known to the author, the similarity is continued southwestward.

The surface rocks involved in the part of the fold which lies east of the Brown-Bauer line are those of the Pocono, Greenbrier, Mauch Chunk and Pottsville formations. Along the axis in West Virginia the Jennings and Hampshire formations are exposed.

THE LOWER YOUGHIOGHENY SYNCLINE.

Position.

The Lower Youghiogheny syncline adjoins the Accident anticline on the west, the Upper Youghiogheny syncline on the northwest and the Cranesville anticline on the northeast. It extends northward into Pennsylvania and westward into West Virginia. It is connected with the Upper Youghiogheny syncline across the low anticline connecting the Accident and Cranesville domes.

The axis follows a somewhat sinuous course near the eastern edge of the syncline. It crosses the Pennsylvania line about 1½ miles east of theYoughiogheny river and extends in a south-southwesterly direction. Crossing the Youghiogheny river about one mile below Selbysport, it continues on the west side of that stream and at an average distance of one-half mile from it, as far as the mouth of Trap

Run. Here it takes a southerly direction, the river winding back and forth across it as far as Sang Run. From this point it extends south into the high hill south and west of the river, and joins the western fork of the axis of the Upper Youghiogheny syncline.

Attitude of the Strata.

The strike on the eastern limb of the fold is very uniformly N. 35° E. as far south as a point two miles north of Sang Run. Between here and Sang Run there is great irregularity of strike. On the western limb of the fold the strike is in general north and south, except in the southern end of the fold, where it is northwest and southeast.

The dip is very regular on the eastern limb of the fold. The maximum angle is about 20°. On the western limb of the fold the dip is very irregular in amount and in direction. It seldom exceeds 5° or 8°. A low secondary anticline occurs in the northwest corner of the county on Sickle Hill and the ridge to the northward. The dip on the western flank of this is very slight. A very strong minor fold occurs at the mouth of Laurel Run and very near the axis of the syncline. This disturbance is evidently of slight extent.

The axis descends to the northward from the southern end of the basin to the Pennsylvania line. It pitches at an average rate of about 200 feet per mile above the mouth of Salt Block Run. From the mouth of Salt Block Run to the mouth of White Rock Run the pitch is about 330 feet per mile. From this point to Krug it is about 150 feet per mile. Here it increases again and maintains an average pitch of 260 feet per mile as far as Friendsville. The pitch is very slight below Friendsville but maintains its direction to the northeastward.

General Features.

This fold differs from the Georges Creek-Potomac and Castleman synclines in being very markedly unsymmetrical. Its most striking feature is the very strong regular dip on the eastern limb as compared with the weak irregular dip of the western limb. It should be noted that the pitch is greater than in any of the synclines described above.

This is due to the abrupt termination of the syncline at the south against the end of a steeply pitching anticline. This deflects the strike at almost a right angle, and the pitch practically passes into the dip of the southern limb.

The strata exposed are those of the Greenbrier, Mauch Chunk, Pottsville, Allegheny and Conemaugh formations.

CONCLUSIONS.

The rocks of Garrett county are unaltered sediments which have been thrown into a series of open, slightly unsymmetrical folds with axes trending toward the northeast and southwest. The region presents a structure which is similar to that of the adjacent regions on the northeast and southwest, but different from the adjacent regions on the southeast and northwest. With each of the latter it has certain points in common, being transitional between them. While on the whole it has within itself a marked individuality; yet too it has within itself certain divergent types which render it capable of division into structural sub-provinces.

The unit of structure is the fold. The anticline and the syncline are from one point of view complementary. Yet in describing a region which, like this, is composed of alternating anticlines and synclines, either might be ignored. Each syncline might be considered as extending from one anticlinal axis to the next; or each anticline, as from one synclinal axis to the next. The most rational and consistent way of dividing a region into anticlinal areas and synclinal areas would be to draw the line between the anticline and the syncline where the surface of any bed changes from an upward to a downward concavity. This would be along the line of greatest dip. There are two objections to this:—first, the difficulty of finding a fairly continuous and definite line of greatest dip; and second, the fact that in this region the anticlinal crests are very sharp so that such a division would throw almost all of the region into the synclinal areas. It has been found that the line of outcrop of the base of the Pottsville formation on the crests of the Pottsville ridges, the 3200 foot contour drawn on top of the Pottsville formation and the crests of the Pottsville ridges themselves, approximately coincide in all parts of the county, and in many regions coincide with the zones of steepest dip. Therefore the anticlines and synclines have been separated on these lines for the purposes of this discussion. The method has the merit of giving the divisions not only a structural but a topographic and geologic unity.

The major folds situated in part in Garrett county are seven; four of them being synclines, and three, anticlines. There is a long syncline (the Georges Creek-Potomac syncline) along the eastern boundary of the county. This is succeeded on the west by a long anticline (the Deer Park anticline) which extends from near the northeast to near the southwest corner of the county. West of this are two synclines (the Castleman syncline at the north and the Upper Youghiogheny syncline at the south) which are disconnected by a low uplift and are neither quite in line nor quite parallel. The axis of the latter is situated farther to the northwest, and its direction is nearer north and south, than the axis of the former. West of these two synclines are two anticlines (the Accident anticline at the north and the Cranesville anticline at the south) which like the synclines last described are also disconnected, and whose axes are both out of line and divergent. The discrepancy in the position and direction of the axes is similar to that of the axes of the above mentioned synclines, but is even greater in amount. Northwest of these anticlines is a syncline (the Lower Youghiogheny syncline). The Upper Youghiogheny syncline, from its position flanking the Deer Park anticline on the west, would seem to be more closely related to the Castleman than to the Lower Youghiogheny syncline. But it is structurally more closely related to the latter, as it is joined with it at a point on the axis 200 feet lower than with the former; and is a fold of the same broad unsymmetrical type.

Faults are small, infrequent and inconspicuous. They do not affect the areal distribution of the formations, or the general character of the structure.

The folds are in general unsymmetrical, the steepest dips being on the eastern limbs of the synclines and western limbs of the anticlines.

In other words the northwestward dips are steeper than the southeastward. This is in general true throughout the entire Appalachian province. The amount and the regularity of the dip decrease from the southeastern to the northwestern part of the county. The amount of pitch increases in the same direction. This regular change in the dip and pitch from the southeast to the northwest entirely changes the general character of the structure. The continuation of the change beyond the limits of the county in either direction makes Garrett county a transition zone between two radically different structural provinces. To the southeast and east is what has been designated the *Valley Region* of the *District of Open Folding* of the *Appalachian Province*, while to the northwest is the *Plateau Region* of the same district. The former is characterized by the canoe-shaped syncline and the cigar-shaped anticline. The latter is characterized by the spoon-shaped syncline and the domed anticline. The eastern edge of the Georges Creek-Potomac syncline forms the western boundary of the former region. The eastern edges of the Accident anticline and the Upper Youghiogheny syncline form the eastern boundary of the latter region. The intervening area, comprising in Maryland the Georges Creek-Potomac syncline, the Deer Park anticline, and the Castleman syncline, is transitional between them.

The Sedimentary Record in Garrett County.

EARLY PALEOZOIC PERIODS.

At the beginning of our record of geologic history large parts of what is now the continent of North America were covered by the sea. Land areas existed in what is now Canada and probably along a belt near the present Atlantic shore. These lands grew intermittently by elevation, and were worn away by the processes of erosion which are now attacking the land surfaces everywhere. The sea was fed by the waste of the eroded land, and shallowed and narrowed because of receiving these sediments.

The details of this early history are complex and varied. The uplift of the land was sometimes rapid and consequently large amounts of sediment were furnished to the sea within short periods.

At other times the land-surface stood near sea-level for long intervals, and then the sediment which reached the sea was fine in texture and small in volume. The land itself was sometimes submerged beneath the sea so that marine sediments were spread over the old land-surface. The sea-bottom was at other times raised above the water-level and the recently formed strata were eroded and redeposited.

There is no positive evidence as to what took place in what is now Garrett county during the early Paleozoic. It is probable that most of the time the region was submerged at a distance from shore.

THE DEVONIAN PERIOD.

The Early Devonian Epochs.

The rocks which were laid down early in the Devonian Period are not exposed in Garrett county. The character of the rocks in adjacent regions shows that the district was submerged and was receiving sediment from a neighboring land-mass.

This land was near base-level, forming a broad low plain from which little sediment was derived. The earliest Devonian sediments are consequently limestones. Gradually the continent rose, initiating erosion, and causing muddy sediments to reach the sea. The continent was, however, a lowland until the middle of the Devonian, when the record in Garrett county itself begins.[1]

The Jennings Epoch.

A very marked uplift of the land area east of the Devonian sea began in middle Devonian time. This resulted in the growth of a great highland area along the present shore of New England, New Jersey, Maryland, and Virginia. Erosion was very active in this region of uplift and a vast amount of sediment was furnished to the sea. This material was transported by powerful rivers without sorting, and was deposited in a series of deltas upon a subsiding sea-

[1] It is possible, as has been suggested in a paper published since the above was in type, that land areas existed in this region at times during the Silurian and Lower Devonian. (See Ulrich and Schuchert, Rept. N. Y. State Pal. for 1901, pp. 633–663.)

bottom. The beds thus formed now constitute the Jennings formation and are the oldest rocks exposed in Garrett county. The abundant marine fossils show that these rocks were formed in the open sea.

It is difficult to obtain a measure of the length of Jennings time. The thickness of strata accumulated is great, but the accumulation was rapid; and both the thickness of the rocks and the rapidity of the accumulation were local phenomena. In the southern Appalachians the same beds are represented by only a few feet of black shale. There the sediments were lacking and accumulation was slow.

Jennings time was not marked by any legible episodes. It was of monotonous uniformity, except when the minor details such as the shifting of deltas were concerned, and then it was of undecipherable complexity. The uplift and erosion of the highland, the rapid transportation of unsorted detritus to the ocean, and the deposition of the sediments upon the sinking sea-floor, were all uninterrupted.

Toward the end of Jennings time uplift failed to keep pace with erosion in some portions of the continent and these regions approached topographic maturity. A deep residual soil then began to accumulate. Other changes took place. The sea began to fill with sediment and a coastal plain formed. This grew westward by the filling of the sea, and eastward by the reduction of the land to an even plain over which rivers meandered and spread the coarser part of their burden.

The Hampshire Epoch.

Conditions little understood, which resulted in the formation of a great series of red and green shales and sandstones, in which marine fossils are usually absent, came into existence toward the close of the Devonian. These beds constitute the Hampshire formation, or as it has been called in Pennsylvania and New York, the Catskill formation.

The Catskill epoch is not to be considered as a fixed and definite time in geologic history, to which the age of certain formations can everywhere be referred. It represents rather a migrating set of conditions which began in eastern New York and northeastern Pennsylvania in middle Devonian time and continued there until after the beginning of the Carboniferous. In western New York and northwestern Pennsylvania it did not begin until the close of the Devonian. In Maryland and in the adjacent regions it began immediately after the Chemung as here recognized and ended before the deposition of the earliest known Carboniferous sediments. The Hampshire epoch is that part of geologic time during which Catskill conditions existed in Maryland and adjacent regions.

Hampshire time differed from Jennings time in this region in that red and green strata were deposited in waters which did not contain marine life. The conditions which brought about this change are very imperfectly understood. The known facts seem to be limited to the following:

In the first place the waters became unfavorable to marine life, as is indicated by the apparent absence of fossils. Furthermore, as far as known, the position of the shore did not change, for there is no evidence of an unconformity by overlap, such as would result from a marine transgression; or of the transfer of coastal-plain accumulations into the sea, such as would result from a marine recession. The volume of sediment was continued while its character changed, this change consisting in an increase in the amount of thoroughly oxidized material and in a decrease in the amount of fresh and unsorted material.

The conditions above cited might have come about as the result of the following causes. To begin with, the region bordering the coast having been reduced by subaërial erosion to a low-lying plain, over which all coarser river sediments were spread, only the finer sediments reached the sea. At the same time increased activity of erosion at a distance from the shore, due either to an elevation which did not affect the coast, or to increased precipitation, swelled the volume of the rivers, resulting in the transportation to the coastal plain of a large bulk of sediment of which only the more oxidized and finer portions reached the sea. The surface from which this material originally came was deeply disintegrated and was attacked rapidly by the strengthened streams. The result was a large accumulation of coarse material on the coastal plain, and a large influx of fresh water and of fine sediment into the sea. As a result either of the amount of this muddy material and fresh water which was poured into the sea, or of unknown changes in the sea itself, the marine life of the Devonian was destroyed. The waters which extended over the northern Appalachian region must have been shallow and cut off from the main ocean or they could not have been so profoundly affected. The Hampshire epoch was uniform in its conditions from beginning to end, and was probably of long duration.

THE CARBONIFEROUS PERIOD.

The change from the Devonian to the Carboniferous sediments in the region under discussion is of great lithologic abruptness. The surface is so sharp as never to be mistaken. Whether or not it is marked by an unconformity is a question which cannot at present be decided.

The Pocono Epoch.

According to Mr. Bailey Willis[1] the beginning of Carboniferous time was accompanied by a slight submergence and a tilting of the coastal plain toward the west. The red sediments which had been supplied to the sea during late Devonian time failed; either because the deep oxidized residual which had furnished them was exhausted or because transportation to the open sea was prevented by the submergence. At the same time the coarse and cleanly washed quartzose sediments which had been accumulating in the beaches and sand-flats of the Devonian coastal plain were delivered rapidly to the waters of the open sea and were spread as a broad sheet of conglomerate and sand. These beds form the Pocono sandstone. Some of the beaches and lagoons of earlier times were probably then entombed and preserved without destruction in the mass of partly transported and re-deposited material. This made the sediments of the Pocono of great complexity of character and discordance of bedding. The great and rapid variations in thickness of the formation find explanation in previous irregularities of the sea-bottom, in local differences in the amount of material at hand, and above all in the varying distance from shore.

[1] Paleozoic Appalachia; Md. Geol. Survey, vol. iv, p. 65.

Interbedded with the sandstone and conglomerate are beds of fine shale, some of which carry abundant marine fossils. These are probably the most shoreward representatives of the normal marine sediments which form the Waverly group in Ohio where they contain the remains of flourishing marine life.

Pocono time was marked by rapid submergence and the rapid delivery to the sea of the beach accumulations of previously washed and sorted material. The duration of Pocono time was probably not long.

The Greenbrier Epoch.

The beginning of Greenbrier time was marked by a sudden decrease in the amount of sedimentation. The waters of the Appalachian sea became clearer and deeper and little or no arenaceous sediments were deposited. These waters teemed with marine life, and by the agency of these organisms, aided perhaps by chemical precipitation, beds of limestone were laid down. The argillaceous character of most of the limestone, and the presence of interbedded strata of red shale indicate that land was near enough to furnish some detritus. The nature of this sediment shows that the land had a deeply disintegrated surface and that the shore-line was sufficiently embayed or beach-bound to prevent the coarser material from reaching the open sea. It was probable that the submergence which brought the deep clear ocean waters into the region converted the lower courses of the rivers into estuaries in which the coarser part of the land-waste was held.

The "siliceous limestone" or calcareous cross-bedded sandstone at the base of the Greenbrier records that stage of the submergence when the last of the pebbly beaches disappeared below the sea and clear marine waters first extended over them. The cross-bedding in this rock was the work of the undertow and tides on tops and sides of these already submerged beaches. They are a lithologic transition from the Pocono to the Greenbrier, but belong most positively to the age of the latter.

The absence of fossils in these beds is to be explained by the submergence and the accompanying eastward transfer of the shore-line having been too rapid for the fauna to accompany it.

Shortly after this first invasion of marine waters from the west, the ponded Pocono rivers succeeded in clearing their mouths of the marine waters and poured an accumulation of muddy sediment into the sea. Then were deposited the red and green shales and thin argillaceous limestones of the Middle Greenbrier. It is probable that these deposits record a halt in the subsidence.

The purer, more thickly-bedded limestones which predominate in the upper part of the Greenbrier formation are the record of a renewed and continued subsidence which lasted throughout the remainder of Greenbrier time. Marine conditions then existed for a long period and over a wide area. From time to time muddy sediment reached the sea but it did not interfere with life, for the limestones and shales are both fossiliferous.

The Mauch Chunk Epoch.

The beginning of the Mauch Chunk epoch was marked by the invasion of that part of the sea in which the present Mauch Chunk shales of Maryland were deposited by a great volume of muddy sediment similar to that which from time to time reached it during the Greenbrier epoch. The clear marine waters and the marine fauna were driven away and a great thickness of mud and sand was rapidly deposited. This was occasioned by an elevation of the continent sufficient to quicken erosion and to bring the region under discussion within the zone which could receive muddy sediments; but not enough to submerge the beaches or to deliver coarse unsorted material to the waves. The conditions of Catskill time were repeated. The already deeply weathered and oxidized soil was stripped off and carried to the sea but on the way the coarser material lagged behind and was accumulated in flood-plain and coastal-plain sediments which were not to receive their final deposition until the next epoch.

The Pottsville Epoch.

The beginning of Pottsville time was marked by the change from the deposition of fine oxidized sands and clays to that of much coarser and fresh sands and gravels. It was such a change as accompanies a submergence and seaward tilting of an old land surface. The coastal-plain accumulations were rapidly swept into the sea and redeposited without resorting.

The history of Pottsville time is complex, varying much within short intervals, not merely from time to time, but from place to place.

The lowest beds of the Pottsville in Maryland are much younger than those of the regions to the northeast and southwest. It is thus evident either that there was no sedimentation in Maryland during the earliest Pottsville time, or that any such sediments as ever existed have been eroded, or that the oldest Pottsville sediments of these other regions are contemporaneous with part of the Mauch Chunk. This question has been discussed by Mr. David White[1] who, while he regards the present evidence as inconclusive, is inclined toward the last explanation.

In the Maryland region the beginning of Pottsville time was marked by the deposition of a thin sandstone, following the cessation of the deposition of red sediments and possibly following a still later period of erosion.

The next episode was the invasion of fine lagoon and marsh sediments producing a succession of fine sandstones, shales, and coal seams. These beds carry the very distinctive Sharon flora and are hence to be correlated with the widespread Sharon coal-group. The existence of these beds implies an interval of quiescence of considerable duration which extended over a wide area.

The Connoquenessing sandstones indicate that Sharon time was followed by a tilting of the continent to the seaward which submerged the marsh deposits and spread over them not only part of the barrier beaches behind which they had accumulated but the sands and gravels which had been accumulating along the flood-plains of the rivers. About the middle of Connoquenessing time there was a short period of quiescence during which the Quakertown coal with its accompanying shales was spread in a great marsh which extended not only

[1] The Stratigraphic Succession of the Fossil Floras of the Pottsville Formation in the Southern Anthracite Coal Field, Pennsylvania. 20th Ann. Rept. U. S. Geol. Survey, part ii, pp. 749-928.

over the region under discussion but over the greater part of what is now western Pennsylvania, eastern Ohio, and northern West Virginia. But immediately after the deposition of the coal the conditions which existed during early Connoquenessing time were resumed and continued with great uniformity.

After the deposition of the Connoquenessing sandstone, the region which is now Garrett county again became a great coal marsh in which the Mercer coals and shales were laid down. This marsh extended over the whole of western Maryland and the larger part of western Pennsylvania, northern West Virginia and eastern Ohio. In its more minute details the history of the Mercer stage was complex. In some places as many as three coals were deposited, while in others there was only one. In some regions two limestones were deposited, but both of them are absent in Maryland.

Another great sandstone, the Homewood, was spread over the Mercer shales and coals. The deposition of this sandstone probably records a gradual subsidence during which the barrier-beach was driven landward burying the Mercer marshes. The culmination of this movement terminated Pottsville time.

The Allegheny Epoch.

Allegheny time began with the period of quiet which succeeded the submergence during which the Homewood sandstone was laid down. As soon as this submergence ceased the broad area of sand with its surface in the littoral zone was converted into a swamp in which was formed the Brookville coal. The formation of this coal was followed in some portions of the field by a very slight submergence which permitted the accumulation of mud. When this submergence ceased another swamp was formed in which the Clarion coal was formed. In those localities where there was little or no submergence during this interval the Brookville and Clarion coals are represented by a single seam. In such localities the coal represents *both* the Brookville and the Clarion. In some other localities one or the other may be and probably is absent, because that spot was the location of an island or a lake within the marsh. The Clarion sandstone which overlies the Clarion coal represents a crustal submergence of broad extent and considerable magnitude, which resulted in spreading the sands of the barrier-beach and of the flood-plains over the marsh accumulations. This was followed by a greater submergence which brought the entire district into the region of the accumulation of fine sediments. The shales which overlie the Clarion sandstone date from this time, as does also the "Ferriferous" limestone. It is evident that this submergence was greater toward the north and northwest, for the limestone carries a marine fauna only in Ohio, Pennsylvania and the northern part of Maryland and West Virginia, while in the southern part of West Virginia and in the adjacent part of Maryland it is of a fresh or brackish water type. As soon as the bed of shales in which the "Ferriferous" limestone is included was built up to the littoral zone, a marsh began to develop upon its surface and the Lower Kittanning coal was formed. The coal seam known as the "Split-six" records the development of a local marsh dating between the age of the "Ferriferous" limestone and that of the Lower Kittanning coal. The area of the Lower Kittanning marsh covered a region including what is now the bituminous coal fields of Pennsylvania, Maryland, West Virginia, Ohio and probably part of Kentucky. Large areas within this marsh became submerged enough for the Lower Kittanning coal to be covered by a few feet of mud. The Middle Kittanning coal was laid down upon this shale, or in the absence of the shale, directly upon the Lower Kittanning coal.

The Middle Kittanning coal was almost immediately submerged to the zone of the rapid accumulation of sand, and cross-bedded sands were spread over it. Upon this new surface local marshes immediately developed in which the upper Kittanning coal was formed.

The succeeding time interval was characterized by the rapid and somewhat irregular accumulation of sandstone and shale. The local variations are probably due to differences in source of supply and in stream action. Thero was probably a moderate submergence after the formation of the Upper Kittanning coal attended by uplift and increased erosion in the interior. The local occurrence of the Lower

Freeport limestone in this interval suggests local deeps or quiet places along shore which land detritus did not reach.

The Lower Freeport coal records the next period of widespread tranquillity. The marsh in which this coal was formed does not appear to have been as uniform and unbroken as the Kittanning marshes.

The deposits which cover the Lower Freeport coal are in some places shale and in others sandstone. This indicates variations in amount of submergence, local differences in supply, or both.

The variable succession of events during which these shales and sandstones were laid down was followed by greater quiet. During this interval only fine sediments were accumulated. These consist in some places of limestone, in others of iron carbonate, and in others of fire-clay. The Lower Freeport limestone and the Bolivar fire-clay date from this time.

Then came an invasion of rank vegetation, and the Upper Freeport coal was formed. The Upper Freeport marsh was one of great extent and uniformity. According to Professor I. C. White[1] this coal is more regular and persistent in Pennsylvania than elsewhere, although it is workable over large areas in West Virginia and Ohio. The destruction and burial of the vegetation in this marsh ended Allegheny time.

The Conemaugh Epoch.

Conemaugh time began with a general and widespread submergence which spread the previously formed beach accumulations over the Upper Freeport coal, and formed the Mahoning sandstone. This marine trangression was of wide extent and must have been of long duration. During its progress the Upper Freeport marsh was being driven eastward so that the Upper Freeport coal of the most eastern basins of Maryland, West Virginia and Pennsylvania is contemporaneous with part at least of the Mahoning sandstone of Ohio. During the middle of Mahoning time there were developed in parts of this region small marshes in which the Mahoning coal was formed.

[1] Bull. 65, U. S. Geol. Survey, p. 147.

During the formation of this coal the submergence must have ceased long enough for the land detritus to be built into a beach. The predominance of shale over sandstone at the horizon of the Upper Mahoning sandstone in this region indicates that the supply of material in the barrier-beach was not very great or else that the streams had filled their channels with debris to such an extent that they were carrying a large amount of unsorted material to the coast.

Mahoning time ended with the deposition of the last sand. The submergence had reached such a point at this time that only very fine material was reaching the sea. As soon as sedimentation caught up with this submergence a marsh of very broad extent was spread over the newly made flats and the Masontown coal was formed. The Masontown marsh covered all of Maryland west of Cumberland, most of southwestern Pennsylvania, all of eastern Ohio, the greater part of West Virginia and part of Kentucky. That conditions were extremely uniform over the greater part of this area is shown by the almost entire absence of variation in the character of this coal. The marsh was so large that the vegetation grew for the most part in clear water and consequently the coal is remarkably free from impurities.

The barrier behind which the Masontown marsh existed was low and contained a small amount of sand compared with the area of the marsh. Consequently when the submergence which terminated the formation of the coal took place, the overlying bed was not formed from the sand of the barrier-beach driven inland by the waves. But marsh and beach together were submerged under the waters of the open sea and the first covering which the coal received was of shale. As soon as from five to eight feet of shale was deposited the marine life which had been living farther from shore colonized this newly-made sea-floor, and flourished there. In this way the Lower Cambridge limestone was spread as a broad continuous sheet at a very uniform distance of about six feet above the Masontown coal. Then there was a continental elevation which increased the amount of sediment, rendering the conditions more and more unfavorable for marine life until as the deposits became a sand, the fauna entirely disappeared. The Buffalo sandstone was then rapidly laid down. This sandstone was evidently derived from a partly sorted mass of sand, which during the formation of the Lower Cambridge limestone, had been deposited on a coastal plain which lay to the eastward of that part of the Carboniferous sea in which the limestone was deposited. Still farther to the east lay a low continent whose surface was being deeply disintegrated by aerial agencies.

The next step in the history of the sediments was the submergence of the continental mass, probably accompanied by a seaward tilting. This brought the last of the coastal-plain sands below the reach of the waves, admitted the marine waters to the Maryland region, and delivered the red residual soil of the old land surface to the sea. The result was the deposition of a series of red and gray shales and marine fossiliferous limestones. The Upper Cambridge limestone, represented in Maryland by two limestone bands 17 feet apart, belongs here. The red shales carry some marine fossils.

The sea was gradually being driven back by the growth of the land and soon the shore was transferred westward beyond the Maryland region. Then a great marsh was spread as far west as the Monongahela river, and in it the Bakerstown coal was formed.

Over the Bakerstown coal the rivers spread a deposit of cross-bedded sand which is now known as the Saltsburg sandstone. As this sand was extended seaward the land sank until the coarser deposits failed to reach the coast, and a deposit of shale was laid down along the shore. A coastal plain was thus built up of fine material, the coarser land-debris being held back in the estuaries and on the flood-plains of the overburdened streams. The coastal plain then was brought to sea-level, a barrier beach was formed around its outer edge, and a great marsh was enclosed within. The Friendsville coal was formed in this marsh. The extent of this marsh was practically the same as that of the marsh in which the Masontown coal was formed. The history of the Masontown marsh was repeated. The entire coast,—barrier beaches, marsh, and estuaries were submerged below the open sea, thus cutting off the supply of terrestrial debris from this region and admitting a marine fauna, by the agency of which the marine Ames limestone was formed. It must be noted that in this case the invasion of the marine fauna was so rapid that the limestone rests directly on the coal.

This submergence was of short duration. The land mass was elevated, bringing muddy sediments into the region under discussion, and the marine fauna was driven to the west. The elevation of the sea-floor and the sedimentation from rivers resulted in a deposit of muddy and sandy material over the continental shelf. Soon these deposits reached the ocean level, and a marsh was inclosed in which the Elklick coal was formed. This coal is thin and very variable in Maryland, but whether this is due to the conditions of its formation or to its subsequent erosion is not known. It seems probable that the elevation which rendered the formation of the coal possible continued to some extent during and after its formation, and that thus not only was the surface of the coal somewhat eroded but the shore was transferred far to the westward, and the continent sufficiently raised so that stream action was greatly accelerated. This elevation terminated the marine history of the region.

It is also probable that from this time on differential uplift played a greater and greater part. The warping of the crust increased the elevation more rapidly in the interior than on the coast and barriers due to differential uplift kept back the sea. The thick deposits of sand and gravel which were then laid down form the Morgantown sandstone, the base of which records the break either between the middle and upper Carboniferous[1] or between the Carboniferous and Permian.[2]

It seems probable that when the Morgantown sandstone was deposited the Appalachian gulf ceased forever to be marine. This was due in part to the decrease in area of the gulf especially at the northeast end, in part to the general shallowing of the gulf throughout, and in part to the fact that the repeated seaward tiltings had increased the gradient of the westward-flowing stream, reducing at the same time that of those flowing to the east, and had thus diverted a large amount of drainage from the Atlantic into the gulf.

[1] I. C. White, Bull. 65, U. S. Geol. Survey, pp. 19, 70.

[2] I. C. White, Amer. Geol., vol. xxi, p. 51.

The Morgantown sandstone is the product of a great elevation which transferred the previously accumulated coastal-plain deposits into the sea, eroding and then burying the marine and coastal-marsh deposits which had been formed in the time just passed. This elevation was in large part differential, and the land areas were elevated more than the sea and coast. As far as the coast was concerned the elevation did not continue long. In fact it is highly probable that after a very short time the coast began to be submerged. Due in part to this reverse movement which may have involved to some extent the whole land-mass, and in part to the fact that erosion was counteracting the effect of elevation, the sediments gradually became finer. The upper part of the Morgantown sandstone grades into a sandy shale.

The red and green shales which frequently overlie the Morgantown sandstone record an epoch in which a large part of the land lay near base-level and only the finer sediments reached the sea. Toward the latter part of this epoch a fresh water limestone (the Clarksburg limestone) was laid down. The next step was the development of a very extensive coal marsh in which the Franklin coal was formed.

The Connellsville sandstone records another seaward tilting which spread the sand and gravel, which had failed to reach the sea during the preceding time, over the finer deposits.

Connellsville time was followed by a submergence and an epoch of quiet in which little sand and no gravel passed the shore line. Fine sands alternated with clays and limy muds. Several coal marshes were developed but these were of local extent. The epoch was marked by gentle and somewhat irregular submergence and slow sedimentation. Finally the bottom of the greater part of the gulf was brought near water level and the Conemaugh epoch ended.

The Monongahela Epoch.

Monongahela time began with the growth of vegetation on the even surface which was formed in the Appalachian gulf in the closing days of Conemaugh time. This was the Pittsburg marsh and in it was formed the Pittsburg coal. The Pittsburg marsh was of long duration, and conditions were of remarkable uniformity in the various parts of it. Such changes as took place, for example the interruption of vegetable growth by the deposition of mud, likewise extended over broad areas. The epoch of the Pittsburg coal was interrupted by a very gentle and widespread submergence without tilting, which brought the marsh below the waters so that it was covered by fine mud. That the land areas shared in this submergence is shown by the fact that coarse material is not included in this covering. The waters soon became deep and clear enough for a deposit of limestone (Redstone limestone) to form. The formation of this limestone brought the sea-bottom again to the surface of the water and a marsh developed in which the Redstone coal was formed. The next step was another gradual submergence which involved land and sea areas alike, and resulted in the deposition of more shale and limestone. This limestone (Sewickley) is somewhat irregular in extent and occasionally grades laterally into the shale. The water was not everywhere deep enough, or far enough removed from the mouths of rivers for limestone to form.

After the formation of the limestone the land rose and a coal marsh formed and migrated westward along the receding shore. In this marsh the Sewickley coal was formed. The presence in some regions of two Sewickley coals separated by an interval of shale indicates that the Sewickley marsh was locally submerged, and that the last stages of the marsh were spread in some regions directly over its old surface, and in others over the muds which had there buried the older part of the marsh. The Maryland region was one of the latter type.

After the formation of the upper Sewickley coal the sea-bottom sank with evidently some differential movement. The submergence was probably greater in the region which is now western Pennsylvania and Ohio than in West Virginia and Maryland. In Maryland and West Virginia shale and sandstone were deposited, while in Ohio and western Pennsylvania the deposits were of limestone and shale. Immediately after the deposition of the main mass of limestone or of sandstone, a coal marsh was locally developed and in it the Uniontown coal was formed. Submergence followed this, and a deposit of shale and sandstone was laid down. Then the waters became deeper and the Waynesburg limestone was formed. Subsequently the waters became extremely shallow and a marsh was developed, in which the Waynesburg coal was formed. The final interruption of vegetable growth and burial of this swamp ended Monongahela time, and with it the Carboniferous.

THE PERMIAN PERIOD.

The Dunkard Epoch.

Dunkard time began with the gentle submergence which buried the Waynesburg marsh. The events of this epoch in Maryland are not well known because the rocks are not well exposed. It was evidently a time of gentle and continuous submergence, and of slow sedimentation in fresh or brackish water.

There is no record preserved, in the Maryland rocks, of the last half of the Dunkard epoch. Sedimentation probably continued in this region until the Appalachian gulf was finally filled. This ended the Paleozoic sedimentary record in this part of the world.

THE MESOZOIC AND CENOZOIC ERAS.

The Pre-Quaternary Periods.

Garrett county like the rest of the Appalachian region was a land area during the entire Mesozoic and Cenozoic time. It received no sediment, but was a region subject to uplift, folding, and erosion. There is no chronologic record of the process of folding to which these rocks have been subjected. The present structure shows the final result of the folding without any historical details. The folding took place at no great depth below the surface and was not accompanied by any sudden or violent movement. It may have occurred at one or at several periods.

The uplift and erosion find expression only in the topographic form. Such details of this process as have been made out have been discussed in the chapter on *Physiography*.

The Quaternary.

Quaternary time in Garrett county was a period of erosion accompanied by the local and temporary deposition of sediments along the water courses and behind barriers of resistant rock. The minor details of this history were complex and no adequate record of them has been preserved.

The history is one of continued erosion retarded here and there by the shifting barriers of sandstone and conglomerate ledges across the streams. Behind these barriers small deposits of sand and clay accumulated. Probably at no time in the Quaternary did conditions over the region as a whole differ much from those existing at present.

THE MINERAL RESOURCES OF GARRETT COUNTY

BY

GEORGE CURTIS MARTIN.

INTRODUCTORY.

The economic mineral resources of Garrett county are largely confined to those areas which are underlain by Carboniferous rocks. As these rocks cover more than half of the county, and as the Carboniferous areas are distributed quite uniformly in the various sections, it is certain that all parts of the county will be benefited by a development of the mineral industries. All of these industries are as yet in a very youthful stage of development. Coal is now the chief product and the supply is such that it will probably continue to be the most important product until it is finally exhausted. Deposits of fire-clay have been found which are extremely promising, and it is not unlikely that this and other important clay and cement industries will be developed in the future. The supply of limestone is inexhaustible, but it has as yet been drawn upon only for local use. The rocks of this region contain deposits of iron ore similar to those which in neighboring regions have been of great value in the past, and the time may come when the deposits of this county can be worked with profit. Some of the sandstones and limestones can be used as building-stone and as road-metal.

Between the areas of Carboniferous rocks with their rich mineral resources are Devonian areas which, though poorer in mineral resources, contain rocks which by disintegration have formed a rich soil. These regions will be benefited by the development of the mining regions, because of the market which it will give for agricultural products; while the mining regions will in turn be benefited by being surrounded by rich and prosperous farming regions.

The areal distribution, sequence, and structure of the rocks have already been described in the preceding pages. The valuable minerals contained in these formations will now be described,—each in the order of its present importance.

Coal.

GEOGRAPHIC OCCURRENCE.

The coal of Garrett county is confined to the synclines, or as they are called when they contain coal seams, "*coal basins.*" The synclines of Garrett county are all *coal basins.* There are five of these coal basins lying partly in Garrett county. The *Georges Creek basin* lies in the northeastern part of the county to the east of the Savage Mountain. The most important part of this basin lies to the eastward of Garrett county and has already been described in the publications of this survey.[1] The *Potomac basin* lies in the southern and southeastern part of the county, to the east and south of Backbone Mountain. The Potomac river flows near the axis of this basin, so only half of it is within Maryland. This basin is structurally the continuation of the Georges Creek basin. The *Castleman basin* lies in the north-central part of the county, between Meadow and Negro mountains. It is the continuation of the Salisbury basin of Pennsylvania. The *Lower Youghiogheny basin* lies in the northwest part of the county, to the west of Winding Ridge and to the north of Dog Ridge. It is the continuation of the Confluence basin of Pennsylvania. The *Upper Youghiogheny basin* lies in the west-central part of the county, between Snaggy Mountain and a ridge which is the continuation of Meadow Mountain, parts of which are here called Roman Nose and Halls Hill.

Stratigraphic Occurrence.

The coal seams occur in the Pottsville, Allegheny, Conemaugh, and Monongahela formations, which collectively are called the Coal Measures.

[1] Md. Geol. Survey, Allegany County.

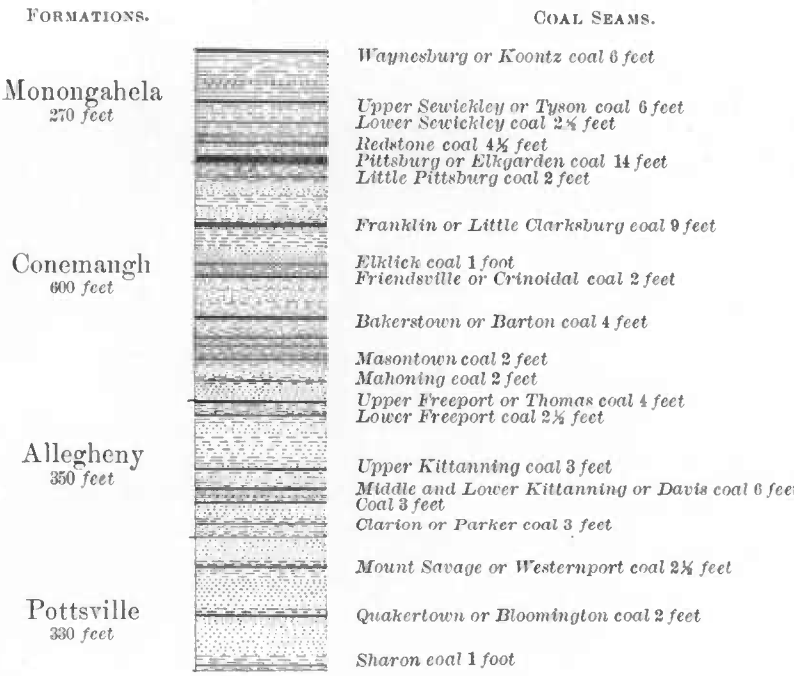


FIG. 2—Section showing position of coal seams.

The Pottsville Coals.

The coal seams of the Pottsville formation are of far less importance in Maryland than those of the overlying formations, or of the Pottsville formation itself in the regions to the south of Maryland. At present no Pottsville coal is mined in the state, but further prospecting and different conditions of the market may make some of the seams of commercial importance in the future.

THE SHARON COAL.—This seam which is the representative of the important New River and Pocahontas coals of Virginia and West Virginia has by far the greatest areal extent of any coal in Maryland, but is known to be of workable thickness at only a few points. It occurs only a few feet above the base of the formation and is very persistent in its position. It is exposed in the railroad cut about a mile north of Swallow Falls where it has a thickness of a little more than one foot. In the western part of Allegany county it is exposed

TABLE SHOWING THE CORRELATION OF THE COAL SEAMS.

Formation	Name adopted.	Local Usage. Georges Creek Basin.	Local Usage. Potomac Basin.	Local Usage. Castleman Basin.	Local Usage. Upper Youghiogheny Basin.	Local Usage. Lower Youghiogheny Basin.	Allegany Report (O'Harra), 1900. Md. Geol. Survey.	Piedmont Folio (Darton and Taft), 1896, U. S. Geol. Survey.	Pennsylvania Survey.	Miscellaneous.
Monongahela Formation.	Waynesburg	Waynesburg	Absent	Absent	Absent	Absent	Koontz or Waynesburg.		Waynesburg	
	Uniontown	No local name.	Absent	Absent	Absent	Absent	Not recognized		Uniontown	
	Upper Sewickley	Tyson or Gas	Tyson or Gas	Absent	Absent	Absent	Tyson or Sewickley.	Gas	Upper Sewickley	Meigs Creek.[1]
	Lower Sewickley	No local name.	No local name.	Absent	Absent	Absent	Not named		Lower Sewickley	
	Redstone	No local name.	No local name.	No local name.	Absent	Absent	Redstone		Redstone	
	Pittsburg	Big Vein or Fourteen-foot.	Big Vein or Fourteen-foot.	Nine-foot or Pittsburg.	Absent	Absent	Elkgarden or Pittsburg.	Elkgarden	Pittsburg	
Conemaugh Formation.	Little Pittsburg	Michael's	No local name.	No local name.	Absent	No local name	Not named		Little Pittsburg	
	Franklin	Dirty-nine-foot.	Dirty-nine-foot.	No local name.	Absent	No local name	Franklin or Little Clarksburg.	Dirty-nine-foot.	Not named	Little Clarksburg.[2]
	Elklick	No local name.	No local name.	No local name.	Absent	No local name	Not recognized		Elklick or Barton.	
	Friendsville	No local name.	Twenty-two inch.	Fossil	Absent	No local name	Not recognized		Crinoidal or Platt?	
	Maynardier	Not seen	Not seen.	Slate Seam	Absent	Not seen	Not recognized		Equivalent not known.	
	Bakerstown	Three-foot or Four-foot.	Four-foot or Three-foot.	Honeycomb	No local name.	No local name	Barton or Bakerstown.	Four-foot	Bakerstown	
	Grantsville	Not seen	Not seen	Beachey	Not seen	Not seen	Not recognized		Probably Coleman or Philson.	
	Masontown	No local name.	No local name.	No local name.	Not seen	No local name	Not recognized		Masontown	
	Mahoning	No local name.	No local name.	No local name.	No local name.	No local name	Not recognized		Mahoning	
Allegheny Formation.	Upper Freeport	Three-foot or Four-foot.	Three-foot or Four-foot.	No local name.	Sandrock Seam.	Sandrock Seam or Four-foot.	Thomas or Upper Freeport.	Thomas Bayard or Three-foot.	Upper Freeport or Seam E.	
	Lower Freeport	No local name.	No local name.	No local name.	No local name.	Not seen	Not named		Lower Freeport or Seam D.	
	Upper Kittanning.	No local name.	No local name.	No local name.	No local name.	Not seen	Not named		Upper Kittanning or Seam C'.	
	Middle and Lower Kittanning	Six-foot	Six-foot or Five-foot.	Bender	Corinth or Four-foot.	White Rock or Four-foot.	Davis or Lower and Middle Kittanning.	Davis or Six-foot.	Middle and Lower Kittanning or Seams C and B.	
	"Split-six"	Split-six	No local name.	Not seen	No local name.	No local name	Split six	Blue-ball	Equivalent not known.	
	Clarion	Railroad Seam.	Railroad Seam (in part).	No local name.	No local name.	No local name	Parker or Clarion.		Clarion or Seam A'.	
	Brookville	Bluebaugh	Bluebaugh	No local name.	Not seen	Not seen	Bluebaugh or Brookville.		Brookville or Seam A.	
Pottsville Formation.	Mount Savage	Mount Savage or Fire-clay.	Railroad Seam (in part).	No local name.	No local name.	No local name	Westernport or Mount Savage.		Upper Mercer or Mount Savage.	
	Quakertown	No local name.	No local name.	Not seen	No local name.	Not seen	Bloomington (in part).		Quakertown	
	Sharon	No local name.	No local name.	Not seen	No local name.	Not seen	Not recognized		Sharon	

NOTE.—The coal seams, like the geological formations, are named from the localities where they are typically developed. It is an accepted rule that a seam must ultimately be called by the oldest geographical name applied to it in print. Before the coal seams of Maryland were definitely known to be the continuation of the seams which had been described and named in Pennsylvania and West Virginia and Ohio, local names were applied to them in the publications of this and other organizations. These were intended at the time only as provisional names, which would be abandoned if found to be synonymous with older names, or permanently retained for such seams as had not hitherto been named. Most of the seams in Garrett county have proved to be identical with seams which had been previously named in other regions, so the temporary, local names for them have been abandoned and the older names used. The grounds for this correlation are given in an article by Clark and Martin in the Bulletin of the Geological Society of America for 1902.[3] Most of the seams have also been popularly known by several names which are not geographical and have not been used in print. There is usually a distinct name for each region where the seam is mined. The relation of all the local names used in Garrett county to the accepted names used in other regions and to those here adopted is shown in the table above.

[1] Ohio Geol. Survey, vol. vii, p. 288.

[2] I. C. White, Bull. 65, U. S. Geol. Survey, p. 88.

[3] W. B. Clark and G. C. Martin, Correlation of the Coal Measures of Maryland, Bull. Geol. Soc. America, vol. xiii, pp. 215–232, pls. 29–39, 1902.

by the roadside half a mile east of Westernport. Here the stratigraphic position is well shown, the base of the Pottsville being well exposed four feet below the coal which is here divided into two seams by about thirty feet of sandstone and shale. The lower and thicker member is only fifteen inches thick. About two and one-half miles north of Oakland on the road to Swallow Falls is an abandoned drift where this seam was once worked for local use. The coal is not now exposed, but is locally reputed to have a thickness of between three and four feet and to be of satisfactory quality. There is a considerable area in the vicinity which could be worked by drift and a large area which could be worked by slope or shaft, should further investigation show that the seam has a sufficient thickness and quality over a large enough area. A few miles to the northwest near the West Virginia line and on the opposite flank of this basin the same seam has been reported by Dr. I. C. White[1] as having a thickness of about three feet and being quite soft and pure and of the coking type of the New River coals. The seam has not been exposed in the Lower Youghiogheny or Castleman basins.

THE QUAKERTOWN[2] COAL.—This seam occurs about 140 feet above the Sharon coal and has been exposed at only one place in Garrett county, namely, in the gorge below Swallow Falls where it has a thickness of about 18 inches. The only other place in Maryland where it has been seen is in Allegany county where it is exposed about half a mile below Westernport on the plane of the Cumberland and Westernport Coal Company.

SECTION OF THE QUAKERTOWN COAL NEAR WESTERNPORT, ALLEGANY COUNTY.

	Feet.
Coal	1
Shale	4
Coal	1½

It is not probable that this seam will ever prove to have any economic value in Garrett county.

[1] Bull. U. S. Geol. Survey, No. 65, p. 202.

[2] The Bloomington coal of the Report on the Geology of Allegany County is in part synonymous with the Quakertown coal. The question has been discussed in the chapter on Stratigraphy. (See p. 106.)

THE MOUNT SAVAGE (WESTERNPORT) COAL.—This seam occurs from 120 to 150 feet above the Quakertown coal and from 25 to 75 feet below the top of the formation. It has been seen in all of the basins except the Castleman, and is very prominent in the Potomac basin, but is not at present mined anywhere in Garrett county. Both the thickness and the quality of the seam vary much within short distances, and it is doubtful if the seam can ever be profitably mined except possibly in connection with the fire-clay which is usually associated with it. The following section was measured at the Savage Mountain fire-clay mine near Frostburg:

SECTION OF MOUNT SAVAGE COAL NEAR FROSTBURG, ALLEGANY COUNTY.

	Feet.	Inches.
Sandstone		
Shale	1	0
Coal	1	2½
Shale		11
Coal	2	0
Shale and Fire-clay	12	

In the average development of this seam it contains about 3 feet of coal with almost 1 foot of shale near the middle. Although the quality of this coal is not good, yet it is the most promising coal in the Pottsville of Garrett county. It is the same as the Westernport coal of the Allegany county report.

The Allegheny Coals.

By far the greater part of the coal of Garrett county is in the Allegheny formation. Considering the great areal extent of this formation and the number of workable seams which it contains, there seems no doubt that the coal industry of Garrett county will some time exceed in importance that of Allegany county. This however will not be until the Pittsburg coal of Allegany county is exhausted.

THE BROOKVILLE (BLUEBAUGH) COAL.—This seam occurs only a few feet above the base of the formation. It is very irregular in its occurrence both in this region and in other regions. It is known at only one locality in Garrett county, namely, at Henry where it was encountered in a bore-hole, in which it had the following section:

SECTION OF BROOKVILLE COAL AT HENRY, GARRETT COUNTY.

	Feet.	Inches.
Shale roof		
Bone		1½
Coal	1	3½
Shale		8½
Bone		2½
Shale		5½
Coal		8
Shale floor		
Total	3	5½

This is the same as the Bluebaugh coal of the Allegany county report.

THE CLARION (PARKER) COAL.—This seam occurs between 15 and 45 feet above the base of the Allegheny formation and is one of the most persistent of the small seams. It usually contains about 30 inches of coal with a thin shale about 10 inches above the floor. Frequently the seam thickens locally to 4 feet or more, but is then broken up by shale. It was described under the name of the Parker coal in the report on Allegany county.

The Clarion seam usually has a characteristic roof of shale with carbonate of iron nodules, which is overlain by a massive sandstone. It has frequently been confused with the Mount Savage coal, but can be readily distinguished from the latter by being associated with iron ore rather than with flint fire-clay. The presence of this seam in the Castleman and Youghiogheny basins has not been definitely established, but in the Potomac basin it seems to be never absent.

SECTION OF CLARION COAL AT CHAFFEE, GARRETT COUNTY.

	Feet.	Inches.
Coal		6
Bone and shale		6
Shale		1-10
Coal	2	2
Shale		2
Bone		6
Total	4	8

THE "SPLIT-SIX" COAL.—This coal occurs from 60 to 120 feet above the base of the formation and about 50 feet above the Clarion coal. It is not well developed in Garrett county. At the White Rock mine $2\frac{1}{2}$ miles N. N. W. of Sang Run it has been opened 24 feet below the Lower Kittanning and shows the following section:

SECTION OF "SPLIT-SIX" COAL $2\frac{1}{2}$ MILES N. N. W. OF SANG RUN, GARRETT COUNTY.

	Feet.	Inches.
Black shale		
Coal	1	3
Shale		3
Coal	1	
Shale		1
Coal		11
Total	3	6

It is interesting to compare this with the following section at Franklin, Allegany county, where the seam is 28 feet below the Lower Kittanning:

SECTION OF "SPLIT-SIX" COAL, FRANKLIN, ALLEGANY COUNTY.

	Feet.	Inches.
Coal	1	
Shale		11
Coal		11
Shale		1
Coal	1	5
Total	4	4

This coal is frequently absent, having been seen at only a few points. Because of this, and because of its poor quality, it cannot be considered as having any economic value.

THE LOWER (AND MIDDLE?) KITTANNING (DAVIS OR SIX-FOOT) COAL.—This seam occurs between 90 and 150 feet above the base of the formation, about 80 feet above the Clarion coal, and about 28 feet above the "Split-six" when that seam is present. It really consists of two coals separated by a band of shale from a few inches to ten feet in thickness. This seam may be considered either as representing the Lower Kittanning, or both the Lower and the Middle Kittanning. When this middle shale is thin, as is the case in a large part of the Potomac valley, this seam is of great value.

SECTION OF LOWER KITTANNING COAL AT HENRY, GARRETT COUNTY.

	Feet.	Inches.
Coal	2	6
Shale	1	
Coal	2	
Shale		1
Coal	1	8
Shale		1
Coal	1	
Total	8	4

SECTION OF LOWER KITTANNING COAL ONE MILE SOUTH OF CRELLIN, GARRETT COUNTY.

	Feet.	Inches.
Coal		6–12
Shale		1–12
Coal	2	11
Bone		6
Coal		6
Shale	2	11
Coal		7
Bone		1
Coal		10
Coal or bone	1	6
Total	10	5

SECTION OF LOWER KITTANNING COAL 3½ MILES WEST OF FRIENDSVILLE, GARRETT COUNTY.

	Feet.	Inches.
Coal	1	2
Bone		2
Coal		4
Shale		1
Bone		9
Shale	1	8
Coal		8
Shale		¼
Coal		4
Bone		7
Coal		4
Total	6	1¼

Where the "Split-six" is present the Lower Kittanning does not usually have as great a thickness as elsewhere. The following sections are typical of its development under these circumstances:

SECTION OF LOWER KITTANNING COAL NEAR FRANKLIN, ALLEGANY COUNTY.

	Feet.	Inches.
Coal	1	
Bone		6
Coal	1	6
Shale		1
Coal	2	5
Total	5	6

SECTION OF LOWER KITTANNING COAL AT THE WHITE ROCK MINE, 2½ MILES N. N. W. OF SANG RUN, GARRETT COUNTY.

	Feet.	Inches.
Coal	2	3
Shale	1	
Coal		6
Shale		1
Coal	1	8
Total	5	6

The Lower Kittanning is by far the most persistent and valuable seam below the Pittsburg. There are, to be sure, some areas in which it is worthless or perhaps almost absent, but these are few and small. Probably there is not a square mile within its area of outcrop where part at least is not workable. Where it is valueless the trouble is not as much in the absence of coal as in the fact that the shale and bone partings have locally thickened so as to make the labor of mining too great.

But unfortunately this seam seems subject more than any other to one set of conditions which has caused a great amount of trouble, expense and discouragement. In almost every large mine in this seam there have been encountered what are known as "faults." These are not true faults in the sense in which the name is generally used. They may perhaps be considered overthrusts of small displacement. There has been slight movement along the bedding which is restricted almost entirely to the surface, either of the floor or roof of the seam, or of one surface of the most prominent shale parting. The coal has thus been squeezed and thrown into a series of undulating rolls which destroy the normal uniformity of thickness. In many cases the coal on one or both sides of the most prominent shale parting is squeezed out entirely. Apparently the shales within the seam are never cut off by this movement. In fact they are usually thicker where the coal is absent. This is probably a cause rather than a result of the movement; or more strictly speaking, it is probably the cause of the localization or local intensification of the movement. The cause of the movement itself is not known. It may be that in the general folding to which the region has been subjected, this seam being the thickest deeply buried coal, as the softest stratum, took up the differential movement. Variations either in the thickness of the coal or of the interbedded shales would determine the points at which this movement along the bedding would be resolved into directions which would result in cutting off the coal. An alternative hypothesis for the cause of the original movement can be based upon a consideration of the conditions which existed during the deposition of the Coal Measures. During Pottsville time conditions were less stable and uniform than during any other portion of the Carboniferous and perhaps than of the entire Paleozoic. The Pottsville conglomerates record rapid and wide changes of shore-line and profound differential crustal movements. These conditions probably were preceded by, and certainly resulted in, an extremely uneven sea-bottom. During early Allegheny time conditions were hardly less intense. It is certain that beyond the great coastal marshes which from time to time or continuously bordered early Carboniferous Appalachia lay a sea in which there were great deeps and an uneven bottom which formed an unstable foundation for the deposits which were later spread over it. After the Kittanning marshes had spread over their hundreds of square miles and had lasted for their centuries, tumultuous and disturbed conditions again held sway. Above the thin shale which overlies the Middle Kittanning coal is the thick, cross-bedded Lower Freeport sandstone. Between its irregular foundation and the uneven and changing weight of this great sandstone the coal would in its soft condition be especially liable to disturbances which could not but result in greatly modifying its thickness and uniformity. Indeed it is not unlikely that then as now submarine slips took place on the irregular sea-bottom. If this did happen as there is every reason to suppose it might, there is far less difficulty in explaining the presence of the "faults" than in explaining their infrequency and minuteness. Considering the conditions which we know to have existed, there is no reason to look later than the close of the Allegheny or even than the middle of the Allegheny for the cause of the irregularities of the coal.

The writer has attempted to give to each of these alternative hypotheses its maximum value. While he considers either set of causes sufficient to have brought about the disturbance, he is inclined to assign it to the latter, because it is certain that that cause was present and was sufficient to have produced the movement. The fact that the younger seams have apparently not been similarly disturbed in any such degree indicates that the cause existed and passed away prior to their formation.

To return to the economic side of the subject. The "faults" (judging from past experience) may be expected in almost any mine in the Georges Creek Potomac basin, and have been encountered in the Upper Youghiogheny basin. In most cases the coal will be found again within 100 feet by following along the bedding and across the strike. In one case the coal has been absent for 500 feet but was then found with full thickness. In the majority of cases the coal has been found in considerably less than 100 feet. These "faults" *do not cut the bedding* except *within the seam,* so it is absolutely useless to look for the coal anywhere except along the bedding. At present it is not possible to tell where these "faults" will be found or what their extent will be, but these problems can probably be solved in the future. When a few more mines have been opened it will probably be possible after platting all the known "faults" on a map, and determining their relation to the variation in thickness of the sandstones, to show also the probable extension of the "faults," where they must be expected and where and how they can be most economically avoided.

THE UPPER KITTANNING COAL.—This seam occurs at an interval varying from 35 to 65 feet above the top of the Lower Kittanning coal. Frequently it is represented by only a few inches of coal, or is entirely absent. The only place where it is known to be workable is in the vicinity of Harrison, where sections measured on the West Virginia side of the river showed thicknesses of 42 and 43 inches of clean coal at two openings about one-fourth of a mile apart. It is not known how large an area contains any such thickness of coal.

THE LOWER FREEPORT COAL.—This seam occurs at an interval of from 55 to 80 feet above the Upper Kittanning coal, and from 100 to 145 feet above the Lower Kittanning coal. It is somewhat variable and uncertain in its occurrence.

The following section was measured one-half mile west of Crellin:

SECTION OF LOWER FREEPORT COAL, ONE-HALF MILE WEST OF CRELLIN, GARRETT COUNTY.

	Feet.	Inches.
Coal		2
Bone		2
Coal		5
Bone		2
Coal	1	6
Total	2	5

The following section was measured at L. F. Tasker's mine,[1] one and one-half miles southeast of Swanton:

SECTION OF LOWER FREEPORT COAL, 1½ MILES S. E. OF SWANTON, GARRETT COUNTY.

	Feet.	Inches.
Coal	2	6
Shale	0	1
Coal	1	0
Total	3	7

THE UPPER FREEPORT (THOMAS OR THREE-FOOT) COAL.—This seam occurs at an interval of from 20 to 60 feet above the Lower Freeport and from 165 to 210 feet above the Lower Kittanning. It is generally present in all of the coal basins of the county, and is usually workable.

[1] It is possible that this section is of the Upper Kittanning rather than the Lower Freeport.

In the Georges Creek basin it is known as the "Three-foot" or more frequently but less correctly[1] as the "Four-foot." At Morrisons, about one mile east of the county line, it is now mined and has the following section:

SECTION OF UPPER FREEPORT COAL, MORRISONS, ALLEGANY COUNTY.

	Feet.	Inches.
Black shale		3
Bony coal		4
Bone		7
Coal		6
Bone		2
Coal	2	2
Total	4	

In the Potomac basin it underlies a large area and is locally known as the "Three-foot" or "Thomas" seam. In the northern end of the basin it has a section like the following:

SECTION OF UPPER FREEPORT COAL NEAR BARNUM, GARRETT COUNTY.

	Feet.	Inches.
Bone		3
Coal	1	7
Shale		½
Coal		3
Total	2	1½

From this point it thickens to the southward and in the vicinity of Blaine has the following section:

SECTION OF UPPER FREEPORT COAL, BLAINE, GARRETT COUNTY.

	Feet.	Inches.
Coal		6
Shale		2
Coal		11
Shale		2
Bony coal	1	1
Coal	2	
Total	4	10

[1] The Bakerstown seam is also called the "Fourfoot."

In the bore-hole at Henry the coal has this section:

SECTION OF UPPER FREEPORT COAL, HENRY, GARRETT COUNTY.

	Feet.	Inches.
Bony coal	1	8
Coal	3	5
Total	5	1

A prospect opening four miles west of Bayard showed the following:

SECTION OF UPPER FREEPORT COAL, 4 MILES WEST OF BAYARD, GARRETT COUNTY.

	Feet.	Inches.
No roof		
Coal	1	10
Shale		4
Coal	3	10
Total	6	

In the Castleman basin this seam does not outcrop except along the flanks of the fold and has not been opened; but it underlies a large area in the center of the basin. In the bore-hole at Jennings Mill it contains 26 inches of clean coal.

In the lower Youghiogheny basin the seam underlies a large area but has not been much worked because it is so largely shaft-coal. The following section was measured at Wm. Umbel's mine, one mile west of Asher Glade:

SECTION OF UPPER FREEPORT COAL, NEAR ASHER GLADE, GARRETT COUNTY.

	Feet.	Inches.
Coal		4
Shale		2
Coal	2	
Shale		0–2
Coal	1	8
Shale		1
Coal		8
Total	5	

In the Upper Youghiogheny basin this seam underlies several areas, but does not have as large an area as in the other basins. At W. T. Sines' mine near Swallow Falls the coal has the following section:

Section of Upper Freeport Coal, near Swallow Falls, Garrett County.

	Feet.	Inches.
Sandstone roof		
Coal (somewhat bony)	1	0–3
Shale		6
Coal	3	1
Total	4	7-10

The coal is very variable in this basin, sometimes not being as good as the above section would indicate, and sometimes better. At one opening a thickness of 49 inches of clean coal without bone or shale was seen.

The Conemaugh Coals.

The rocks of the Conemaugh formation were formerly known as the "Lower Barren Measures" because they were supposed to contain no workable coal. Later work has shown that in this region at least the Conemaugh contains several seams which are either workable at present or are likely to become so in the future. But there is no reason to believe that the coal of the Conemaugh will ever rival that of the Allegheny in importance.

The Mahoning Coal.—This seam belongs between the upper and the lower Mahoning sandstones at an interval of from 45 to 60 feet above the Upper Freeport coal. It has not been recognized in the Georges Creek or Upper Youghiogheny basins. In the Potomac basin it is frequently present but very thin and entirely worthless. In the lower Youghiogheny it has been opened for local use at two places.

Section of Mahoning Coal at Frazee's Mine, Selbysport, Garrett County.

				Feet.	Inches.
Sandstone, Upper Mahoning				2+	
Shale				4	
Coal, Mahoning	Coal		8″	10	8
	Shale	8′	0″		
	Coal		7″		
	Shale		¼″		
	Coal		3″		
	Shale		¼″		
	Coal	1′	1″		
Concealed				5	
Sandstone, Lower Mahoning				5+	

Mr. Cover's mine one mile south of Friendsville is probably in the same seam, as may also be several small mines in the Castleman basin.

THE MASONTOWN COAL.—This seam occurs at an interval of about 70 feet above the Mahoning coal, and from 110 to 135 feet above the Upper Freeport coal. It is extremely constant not only as regards its presence but also its character. It usually contains from 20 to 24 inches of clean coal.

SECTION OF MASONTOWN COAL, ONE MILE NORTH OF BLAINE, GARRETT COUNTY.

	Feet.	Inches.
Shale roof		
Coal	1	2
Bone		1
Coal		6
Total	1	9

SECTION OF MASONTOWN COAL IN THE JENNINGS MILL BORE-HOLE, CASTLEMAN'S VALLEY, GARRETT COUNTY.

	Feet.	Inches.
Coal	1	4
Bone		3
Total	1	7

SECTION OF MASONTOWN COAL, ONE MILE NORTH OF SELBYSPORT, GARRETT COUNTY.

	Feet.	Inches.
Coal	1	9

This seam has not been seen in the Upper Youghiogheny basin. Probably there is only one hill high enough to catch it.

THE BAKERSTOWN (BARTON OR FOUR-FOOT) COAL.—This seam occurs at an interval of from 90 to 130 feet above the Masontown coal. It is present in the Georges Creek, Potomac, Castleman and both Youghiogheny basins. In the Georges Creek basin it is popularly known as the "Three-foot" or less commonly but more correctly as the "Four-foot." In the report on the Geology of Allegany County it was called the Barton seam, but it is not the seam to which Stevenson applied the name "Barton" in the Pennsylvania reports in 1876. In the Potomac basin it is known as the "Four-foot." In the Castleman basin it is called the "Honeycomb" seam.

SECTION OF BAKERSTOWN COAL, ONE-HALF MILE NORTH OF FRANKLIN (CUMBERLAND-GEORGES CREEK COAL CO.'S MINE), ALLEGANY COUNTY.

	Feet.	Inches.
Bone		11½
Coal	2	11
Shale		½
Coal		4
Total	4	3

SECTION OF BAKERSTOWN COAL AT BARNUM (MONROE MINING COMPANY'S MINE).

	Feet.	Inches.
Coal		4
Bone		8
Coal	2	
Shale		1
Coal		4
Total	3	5

SECTION OF BAKERSTOWN COAL TWO MILES SOUTHEAST OF SWANTON (FRANK SHARPLESS' MINE).

	Feet.	Inches.
Bone		3
Coal		6
Bone	1	4
Coal	2	10
Total	4	11

SECTION OF BAKERSTOWN COAL ONE MILE SOUTHEAST OF BITTINGER (PETER LOHR'S MINE).

	Feet.	Inches.
Bone		10
Coal	2	3
Total	3	1

SECTION OF BAKERSTOWN COAL ONE MILE WEST OF FRIENDSVILLE (CAPT. FRIEND'S MINE).

	Feet.	Inches.
Coal	2	3

In all of these basins, except the Upper Youghiogheny, it is of wide extent and great persistence, and has already proved to be of considerable commercial value.

THE GRANTSVILLE ("BEACHEY") COAL.—This seam occurs in the Castleman basin only. Its position is apparently a short distance below the Bakerstown seam, but cannot be exactly determined.

SECTION OF GRANTSVILLE COAL ONE MILE WEST OF GRANTSVILLE (AARON BEACHEY'S MINE).

	Feet.	Inches.
Shale roof		
Coal		11
Shale		1
Coal	2	
Shale		2
Coal		7
Shale	1	3
Limestone	2	

SECTION OF GRANTSVILLE COAL ONE MILE NORTHWEST OF BEVANSVILLE (RIDGLEY'S MINE).

	Feet.	Inches.
Shale roof		
Coal		6
Shale		1
Coal		13
Shale		1
Coal		6
Shaly sandstone	5	
Bony coal		2
Coal		9
Bone		1
Coal	2	1
Shale		2
Coal		6
Bone		4

It can be seen from these sections that the seam is of considerable value, provided it has sufficient area and constancy. Unfortunately these points are in doubt. Three hypotheses concerning its occurrence may be considered.

1. That it is a local development of the Bakerstown.

2. That it is a constant seam, just near enough to the Bakerstown (within forty-six feet) at the point where the Jennings Mill bore-hole was put down so that no record was obtained by the drill, and far enough below it (over sixty feet) so that it was missed in a section one mile east of Bittinger.

3. That it was absent at one or both of the places where the above mentioned sections were obtained.

The problem must be left at present as an undetermined one. There is no doubt that the seam belongs above the Masontown coal, but whether it is a local development of the Bakerstown or belongs as much as one hundred feet below it is a question which cannot be decided.

It is named from the town of Grantsville, near which it is most extensively mined.

THE MAYNARDIER COAL.—This seam which is locally known as the "slate vein," is apparently confined to the Castleman basin and occurs at an interval of about 40 feet above the Bakerstown coal.

SECTION OF MAYNARDIER COAL AT WEST END OF MAYNARDIER RIDGE, ½ MILE EAST OF JENNINGS MILL, GARRETT COUNTY.

	Feet.	Inches.
Coal	1	1
Bone		9
Shale		2
Bone	1	
Total	3	

SECTION OF MAYNARDIER COAL TWO AND ONE-FOURTH MILES NORTHEAST OF BITTINGER, GARRETT COUNTY.

	Feet.	Inches.
Coal		11
Bone		6
Shale		5
Bone	1	1
Total	2	11

Wherever this seam has been opened it has proved too impure to mine even for local use, and must be considered as having no commercial value.

It is named from its occurrence along the western end of Maynardier Ridge.

THE FRIENDSVILLE COAL.—This seam occurs at an interval of from 90 to 160 feet above the Bakerstown coal. The interval is about 100 feet in the Georges Creek basin, 160 feet in the Castleman basin, and 90 feet in the lower Youghiogheny basin. This coal has not been exposed in that part of the Georges Creek basin which lies in Garrett county, although there are many square miles underlain by it. In the western part of Allegany county (one mile northwest of Mount Savage) it contains about 28 inches of coal without partings. In the Potomac basin it is about 22 inches thick, and is locally known as the "twenty-two inch." In the Castleman basin it varies in thickness from 19 to 24 inches, and is called the "fossil vein." In the Lower Youghiogheny basin it varies in thickness from 16 to 20 inches.

THE ELKLICK COAL.—This seam which occurs at an interval of about 35 feet above the Friendsville coal, is very irregular and thin in Garrett county. Frequently it is entirely absent, and it has never been seen with sufficient thickness to have any commercial value whatever.

THE FRANKLIN OR LITTLE CLARKSBURG COAL.—This seam occurs at an interval of from 50 to 100 feet above the Elklick coal, 80 to 140 feet above the Friendsville coal, and about 150 feet below the Pittsburg coal. In the Georges Creek basin it is known as the "Dirty Nine-foot."

SECTION OF FRANKLIN COAL ONE MILE NORTHWEST OF FRANKLIN.

	Feet.	Inches.
Shale roof		
Coal		2
Shale		1
Coal		10
Shale	2	3
Coal	2	9
Total	6	1

In the other basins its section is very different from this, it being represented by one or two seams each about 15 or 18 inches thick and separated by twenty feet or more of shale.

THE LITTLE PITTSBURG COALS.—Between the Franklin and Pittsburg seams there are one or two small seams which are quite variable in their positions. One of them seems to be always present and occasionally both are. When only one is present the usual position for it is from 60 to 80 feet below the Pittsburg seam. When both are present one is about 40 feet and the other about 90 feet below the Pittsburg. The thickness is quite variable.

SECTION OF LITTLE PITTSBURG COAL ONE MILE NORTHWEST OF FRIENDSVILLE (MR. RUMBAUGH'S MINE).

	Feet.	Inches.
Coal		6
Shale		2
Coal	1	5
Shale		1
Coal	1	6
Total	3	8

In the Castleman basin the thickness seems to be less than 20 inches. In the Georges Creek basin, measurements made in Allegany county show a thickness of over three feet. In the Potomac basin two seams are present, the upper of workable thickness, but they have been recognized only in Fairfax Knob.

The Monongahela Coals.

The Monongahela formation contains six seams of coal in Garrett county and the immediately adjoining regions. Five of these may be considered workable, while three of them have been mined in Garrett county at one time or another. However it is due entirely to the presence of one seam that the Monongahela coals have outranked the others of this region in importance. This is the Pittsburg seam from which nearly all the coal now being mined in Maryland is being taken.

THE PITTSBURG (ELKGARDEN, "FOURTEEN-FOOT" OR "BIG VEIN") COAL.—This seam occurs at the base of the Monongahela formation, at an interval of 145 or 150 feet above the Franklin coal. It is wholly restricted to the Georges Creek and Potomac basins, and almost wholly to the former. The following sections illustrate the structure of the seam and its variation from north to south.

SECTION OF PITTSBURG COAL AT BOWERY MINE, MIDLOTHIAN, ALLEGANY COUNTY.

	Feet.	Inches.
Shale with wild coals	10-12	
Black shale	2	
Coal, top	1	4
Parting		
Coal, breast	5	6

		Feet.	Inches.
"Mining ply"			4
Coal, bottom	Coal .. 8″ Shale . 1½″ Coal .. 9″ Shale . 2″ Coal ..12″ Shale . 1″ Coal ..14″	3	11½

SECTION OF PITTSBURG COAL AT KOONTZ MINE, GARRETT COUNTY.

		Feet.	Inches.
Shale			
Coal, wild			11
Shale			10
Coal, top		1	6
Coal, breast		7	6
Shale			1
Coal, bottom	Coal .. 2″ Shale . 1″ Coal ..15″ Shale .$\frac{1}{16}$″ Coal .. 9″	2	3
Total		13	1

SECTION OF PITTSBURG COAL ON FRANKLIN HILL (EXCELSIOR MINE), GARRETT COUNTY.

	Feet.	Inches.
Coal, wild	1	
Shale		11
Coal, top	2	4
Coal, breast	7	11
Shale		2
Coal, bottom	2	5
Total	14	9

SECTION OF PITTSBURG COAL ONE AND ONE-HALF MILES NORTHWEST OF SHAW, GARRETT COUNTY.

		Feet.	Inches.
Coal, top (not seen, 1′ 8½″ thick across the river at Elkgarden)		?	?
Coal, breast	Coal ....3′ 4″ Parting . Coal .... 3″ Bone ... 4″ Shale ... ½″ Coal ....3′ 7″	7	6½
	Shale ... 2″		
Coal, bottom	.............1′ 6″	1	6

SECTION OF PITTSBURG COAL ON FAIRFAX KNOB[1], WEST VIRGINIA.

	Feet.	Inches.
Coal, roof	2	
Shale	6	
Coal	8	2
Shale		2
Coal	1	2
Shales	5	
Limestone	4	
Shales	7	
Coal, "brick"	4	6
Fire-clay and shales	18	
Coal, "bottom," slaty	7	

The division of the coal into three members, known as the "Top" or "Roof" coal, "Breast" coal, and "Bottom" coal is a constant and characteristic one. The great variation in the thickness of the seam from the northern to the southern end of the Georges Creek basin is due chiefly to the thickening of the "breast." The "breast" coal is the purest and most valuable of these members and formerly it was the only one mined. But now there is no great difficulty in keeping the "top" and "bottom" coal clean enough to go on the market, and at most openings the full thickness of the seam is mined.

This coal is of exceptional quality, being very low in ash and sulphur and high in fixed carbon. It is in fact a semi-anthracite and is regarded as the best steam-coal known.

The extent of this coal, as can be seen upon the accompanying map, is not large, and the area in Garrett county will probably be exhausted before that of Allegany county. There are many mines which have been once abandoned because of the supposed exhaustion of the coal, which are now being or will be worked again for the coal contained in the roof, floor and pillars.

This coal is entirely restricted to the Georges Creek and Potomac basins, while the unexhausted areas are all in the former.

THE REDSTONE COAL.—This seam which occurs at an interval of from 20 to 30 feet above the Pittsburg coal has not been exposed in Garrett county, but appears to be so constant in Allegany county

[1] I. C. White, Bull. U. S. Geol. Survey, No. 65, p. 65, (somewhat modified).

in close proximity to the Garrett line, that there is little doubt that large areas in Garrett county are underlain by it. The quality of the coal and thickness of the seam are of course unknown. The seam is so near to the Pittsburg coal that where that coal has been mined it will be impossible to mine this, no matter how valuable it might otherwise be. For this reason the seam cannot be considered to have any great value.

The Lower Sewickley Coal.—This seam occurs at an interval of about 42 feet above the Redstone coal. Its presence in Garrett county has not yet been shown, but the fact that it is present in western Allegany county makes it very probable that it is present in Garrett county also.

The Upper Sewickley or Tyson Coal.—This seam, which is locally known as the "Gas" coal, occurs at an interval of from 105 to 120 feet above the Pittsburg coal, and about 45 feet above the lower Sewickley coal. It is entirely restricted to the Georges Creek basin, and its area is small.

Section of Upper Sewickley Coal at Caledonia Mine, West of Barton, Allegany County.

	Feet.	Inches.
Coal	2	7
Shale		9½
Coal	1	11½
Shale		4
Coal		9
Total	6	5

This seam like the Pittsburg coal thickens from north to south and has its maximum thickness in the lower end of the Georges Creek basin.

The Waynesburg (Koontz) Coal.—This seam occurs at an interval of from 90 to 120 feet above the Upper Sewickley and from 220 to 240 feet above the Pittsburg coal. Its area in Garrett county is extremely small, and even where it does occur the cover is so slight that it probably cannot be mined.

SECTION OF WAYNESBURG COAL AT KOONTZ,[1] ALLEGANY COUNTY.

	Feet.	Inches.
Coal	2	3
Bone		4
Coal		6
Bone		7
Coal	1	3
Shale		10
Coal		5
Total	6	2

The roof of this seam is the top of the Monongahela formation. The overlying Dunkard contains a very little coal in Allegany county and elsewhere, but there is no evidence that there is any coal in Garrett county above this seam.

STRUCTURAL OCCURRENCE.

The Georges Creek Basin.

The Georges Creek basin is a deep broad syncline containing the most complete sequence of the Coal Measures in Maryland. The axis of this syncline lies entirely to the east of the eastern boundary of Garrett county, and only half of the area west of the synclinal axis is in Garrett county. As the most valuable coal (the Pittsburg seam) is in the upper part of Coal Measures and consequently lies in the central portion of the basin, the larger part of its area is in Allegany county. It is only toward the southern end of the basin where the county line approaches the synclinal axis that Garrett county contains any large areas of Pittsburg coal.

The Conemaugh and Allegany coals are so overshadowed in importance by the Pittsburg coal that they have not been prospected for to any great extent in this basin. Consequently our knowledge of them is far less in this region than it is in the more western basins where the Pittsburg coal is absent and the lower seams are depended upon for local use. The coals of the Allegany and Conemaugh formations underlie a large area in the Garrett county part of this basin, and it is highly probable that when the Pittsburg coal is

[1] Md. Geol. Survey, Allegany County, p. 180.

exhausted the Bakerstown, Upper Freeport and Lower Kittanning coals will support an important industry.

The dip in the Garrett county part of this basin is entirely to the southeast (averaging E 30° S) and increases from almost nothing in the portion nearest the axis (near Westernport) to about 10° along the western outcrop of the Lower Kittanning coal.

The Allegheny coals can be worked by drift in the southern end of the Georges Creek valley and on many of the tributaries of that stream and of the Savage river. In the region north of Barton they can be mined only by shafts near the center of the basin or by slopes from the western outcrop. A far larger proportion of the area of the Conemaugh coals can be reached by drift from the Georges Creek valley.

The Potomac Basin.

The Potomac basin is a syncline which is wider and shallower than the Georges Creek basin. It is a simple syncline from Piedmont to a point near Harrison where the axis forks by the development of a low anticline in the center of the broad basin. Between Piedmont and Harrison the Potomac meanders near, and in general west of, the synclinal axis. Between Harrison and Schell the river flows not far from the western fork of the axis, probably crossing it several times. Above Schell the river seems to be constantly to the east of the western fork of the axis.

The Maryland part of this basin is not deep enough to contain any coal above the Conemaugh formation, except in the small knob near Shaw where the Pittsburg coal was formerly mined.

The Lower Kittanning coal is of workable thickness and quality throughout the greater part of this basin. Below Stoyer it can all be mined by drift from the Potomac valley.

Above Stoyer it is all shaft coal except along the western outcrop. The dip is not great enough to prevent the coal from being readily mined in all directions from shafts located anywhere along the line of the railroad. The coal is of exceptional thickness and quality above Gorman.

The Upper Freeport coal can be mined by drift from the center of the Potomac valley as far south as Bayard. Above this point it is all shaft coal except along the western outcrop. Like the Lower Kittanning, it becomes more valuable toward the south.

The Bakerstown coal is drift-coal in its entire area. It improves in quality and thickness toward the north, being most valuable in the region between Blaine and Windom. The Upper Kittanning and Lower Freeport are only locally workable. The former is known to be workable only in the region around Harrison, and the latter in the headwaters of Three-fork Run. Both of these seams are here drift-coal, and are shown by borings to be extremely thin or even absent in the upper part of the Potomac valley where they are below drainage.

The Castleman Basin.

The Castleman basin is a simple shallow syncline with gentle dips and a still gentler northeastward pitch of its axis. It does not contain any Pittsburg coal in its Maryland portion. The axis of the basin extends in an almost straight line through the eastern end of Grantsville, the forks of the Castleman river, and Bittinger.

The Conemaugh seams can be almost entirely mined by drift from the Castleman valley. The only exception to this is that the Grantsville seam in the very center of the basin would have to be reached by slopes or shallow shafts.

The Allegheny seams are almost entirely shaft coal. They underlie a very large area but their thickness and quality are very imperfectly known. The bore-hole at Jennings Mill which gives our only section of them showed that they were not workable at this immediate point. They should be tested at other points, where they will probably be found to be workable under large portions of the valley. The bore-hole at Jennings Mill, which was located very slightly east of the axis of the basin, showed the Upper Freeport at a depth of 193 feet, and the Lower Kittanning at a depth of 341 feet. The detailed record of this boring is given on pages 116 and 128 of this report. These seams can be reached at approximately these depths anywhere along the line of Jennings Bros. R. R. The deepest part of the basin is somewhat west of the railroad.

The Upper Youghiogheny Basin.

The Upper Youghiogheny basin is a broad shallow syncline, which undulates somewhat in its central part. The Monongahela coals, and the workable Conemaugh coals (excepting one area of the Bakerstown coal) are entirely absent from it. The Upper Freeport coal is workable in a few areas, especially along the Youghiogheny river below the mouth of Miller Run. It is largely drift coal. The Lower Kittanning coal underlies the larger part of the basin and has been mined to a small extent along the outcrop. It is almost all slope and shaft coal.

The Lower Youghiogheny Basin.

The Lower Youghiogheny basin is a broad shallow syncline with a low anticline buried in its western portion.

The deepest part of the basin is toward the eastern part of its area, the axis passing not far west of Friendsville.

It contains no Monongahela coals. The Conemaugh coals although all present are not, as a general thing, workable.

The Upper Freeport coal is workable by drift from the valleys of Buffalo Run, Laurel Run, Deep Creek, and Mill Run. The larger part of the area of this seam is, however, shaft coal, which can best be reached a short distance up the valley west of Friendsville, or along the railroad anywhere between Selbysport and the Pennsylvania line. It can probably be reached anywhere within a depth of 100 feet below the railroad. The quality and thickness in this buried portion have never been tested.

The Lower Kittanning coal is shaft coal in the greater part of the area of the basin. There are small areas around the outcrop which can be mined by drift, but only on a small scale, except in the region southwest of Krug, where the entire area can be reached by drift from the valley of the Youghiogheny. Below Friendsville this coal lies at a depth not exceeding 300 feet below the railroad.

HISTORY AND CONDITION OF THE COAL INDUSTRY.

Coal has been mined in the Georges Creek basin since 1830. Until recently only the Pittsburg seam has been mined, but with the approaching exhaustion of this coal, development of the thinner seams is rapidly increasing. The Bakerstown, Upper Freeport, and Lower Kittanning seams are at present being mined on a commercial scale in the Georges Creek and Potomac valleys. Extensive developments preparatory to mining the Upper Freeport and Lower Kittanning coals by shafting have been in progress for the last two years at Henry. The Lower Kittanning coal has been mined for several years in the upper Youghiogheny basin at Corinth. The coal in the Castleman and lower Youghiogheny basins has never been mined except for local use.

It is probable that within a few years there will be very extensive developments in the Potomac, Castleman, and Youghiogheny valleys, especially in the former. Development has been retarded in the Castleman basin by the lack of means of transportation, and by the fact that the Allegheny coals are buried in the central part of the basin. Now that a railroad has been constructed along the Castleman river, development of the coal may be expected.

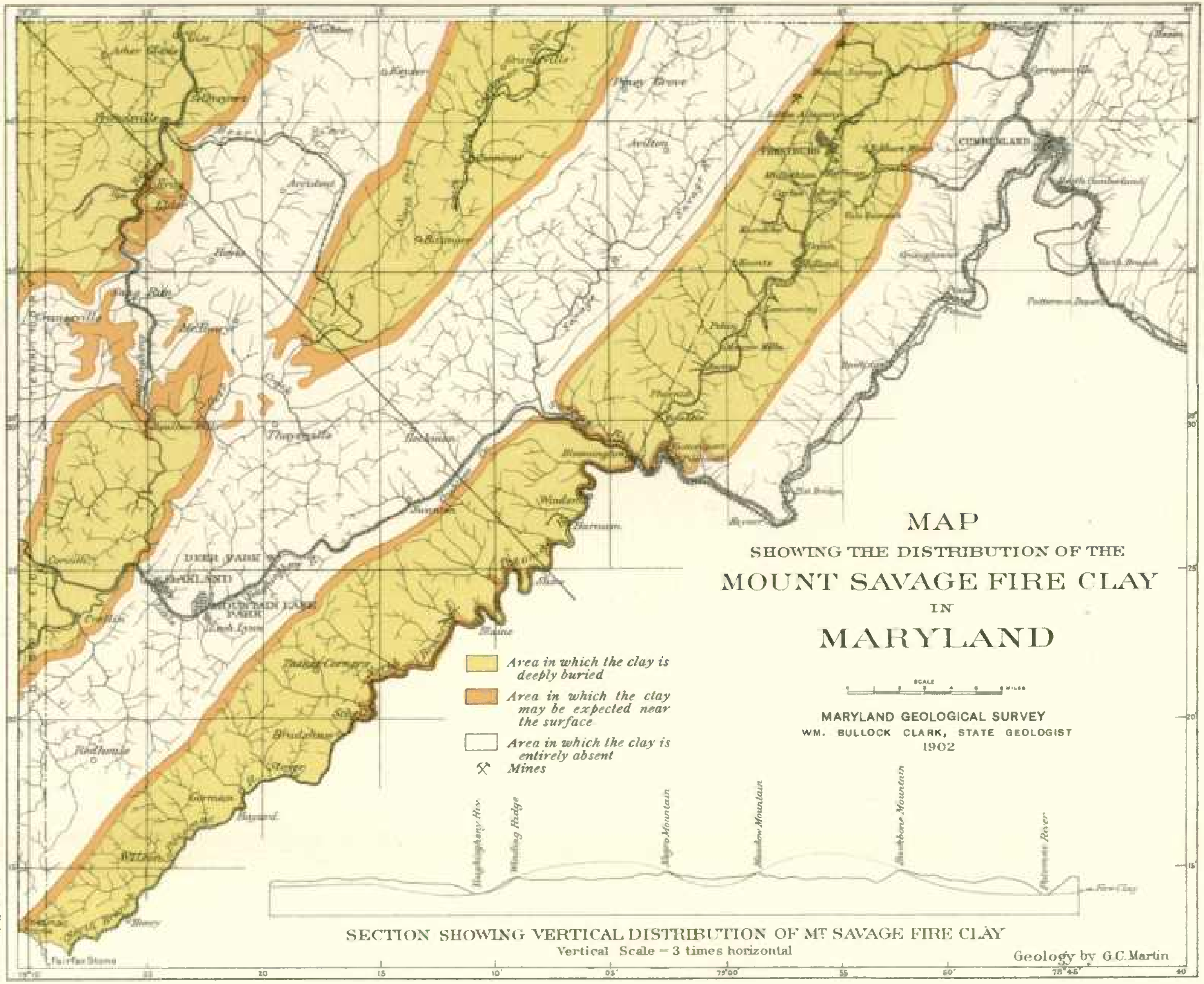
Ownership of the small-vein coal is principally in the hands of the farmers. Few large tracts have been acquired except in the Georges Creek and Potomac basins.

Clays.

Garrett county contains a great abundance of valuable clay of various kinds. These resources are entirely undeveloped except at the two fire-clay mines in the northeast corner of the county, but they promise great possibilities for the future. These materials include the highest grade of fire-clays, shales of various kinds, residual clays, and sedimentary clays.

Fire-clays.

Frequently any clay which underlies a seam of coal is spoken of as a fire-clay. This is not always true. Any clay, no matter what its occurrence or appearance, which will resist fusion and is thus suitable for the manufacture of fire-brick is a fire-clay. There are many clays which have all the external appearance of a fire-clay but which


MAP
SHOWING THE DISTRIBUTION OF THE
MOUNT SAVAGE FIRE CLAY
IN
MARYLAND
SCALE
MILES
MARYLAND GEOLOGICAL SURVEY
WM. BULLOCK CLARK, STATE GEOLOGIST
1902
Area in which the clay is deeply buried
Area in which the clay may be expected near the surface
Area in which the clay is entirely absent
Mines
CUMBERLAND
FROSTBURG
DEER PARK
OAKLAND
MOUNTAIN LAKE PARK
Youghiogheny Riv.
Winding Ridge
Negro Mountain
Meadow Mountain
Backbone Mountain
Potomac River
Fire Clay
SECTION SHOWING VERTICAL DISTRIBUTION OF MT SAVAGE FIRE CLAY
Vertical Scale = 3 times horizontal
Geology by G.C. Martin
A. Hoen & Co. Lith. Baltimore.
Fairfax Stone

P1213

will not stand a high enough temperature to be called or used as fire-clay. The only satisfactory means of telling whether a clay is a fire-clay or not is by testing its actual fusibility. Not all fire-clays, nor even all those of this region, underlie coal seams. There are at least two very valuable fire-clays now known in Garrett county.

The Mount Savage Fire-clay.—The Mount Savage fire-clay occurs at a very constant horizon in the Mercer group near the top of the Pottsville formation, and immediately under the Homewood sandstone. Its stratigraphic position is shown in the sections of the Pottsville formation on pages 103 and 104, and in the less complete sections on pages 107 and 108. This bed does not show at the surface as well as it should because its position is usually concealed by a talus from the overlying sandstone. Fragments of the flint clay can usually be found in the soil at the proper position. While not always present in the normal stratigraphic position, it usually is, and could be developed at a great many localities in various parts of Garrett county. The general location of the belts where it is to be sought is shown on the accompanying map (Plate XV). These belts are along the edge of the areas of outcrop of the Pottsville formation, not very far from the contact of the Pottsville and Allegheny, and their location can thus be found on the accompanying geological map.

In the mines of the Union Mining Co. and the Savage Mountain Fire-Brick Works in the northeast part of Garrett county the clay has a thickness of from eight to fourteen feet, averaging about ten feet. It is overlain within a short distance by a seam of coal about three feet in thickness, above which is the Homewood sandstone. There are usually two kinds of clay, the soft or plastic and the flint or non-plastic. Both are essential in the manufacture of the bricks. It is necessary that both should be refractory. There is no regularity in the occurrence of the two kinds of clay in relation to each other. Usually the plastic clay is above, but this is not always the case. The clay is well exposed in the west bank of the Potomac river, one mile above Blaine. Here the section is as follows:

SECTION OF FIRE-CLAY NEAR BLAINE.

	Feet.
Sandstone (Homewood)	
Coal (Mount Savage)	
Flint clay	6
Plastic clay	8
Concealed	

There is a very large adjacent area from which the clay can readily be mined by drift either here or around the hill to the north in the valley of Wolf Den Run. At the mouth of that run, or between there and Blaine are admirable locations for a manufacturing plant, as coal is being mined on the hill above, and there is a bridge across the river at this point leading to the tracks of the West Virginia Central and Pittsburg Railroad. Tests made by Dr. Heinrich Ries[1] show that the flint clay from this locality is fully equal in its refractory qualities to that from the mines on Savage Mountain, while the plastic clay from this locality is superior to that from Savage Mountain.

Another locality where the same clay was observed is in the tram-road cut at Swallow Falls, where the following section is exposed:

SECTION OF FIRE-CLAY NEAR SWALLOW FALLS.

	Feet.
Sandstone (Homewood)	50
Shale	6
Flint clay	1–3
Plastic clay	2–3
Coal	3

At no other place has the clay been observed *above* the coal as it is here. There is a large area underlain by the clay in this vicinity which can be easily worked by drift, and the dip is slight. Transportation can be furnished by the narrow-gauge road which extends from here to the terminus of the Confluence and Oakland branch of the Baltimore and Ohio Railroad. Power for the plant can be secured from the Youghiogheny river, and coal for the kilns can be obtained near at hand. Tests by Dr. Ries[2] show that this clay

[1] Md. Geol. Survey, vol. iv, pp. 450, 451.
[2] Md. Geol. Survey, vol. iv, pp. 449, 450.

(both plastic and flint) is fully equal in its fire-resisting qualities to that from Savage Mountain.

There are doubtless many other localities in the belt shown on the map (Plate XV) where clay of satisfactory quality could be found by careful prospecting.

The Bolivar Fire-clay.—A deposit of fire-clay which is probably the equivalent of the Bolivar fire-clay of Pennsylvania outcrops in the north bank of the North Fork of the Castleman river about $\frac{9}{10}$ of a mile above the mouth of Tarkill Run. The section is as follows:

Section near Tarkill Run, Castleman Valley.

	Feet.
Flint clay	3½
Concealed	6
Massive cross-bedded sandstone	7
Concealed	6
Gray shale	4
Coal, shale, and bone	7
Shale	8
Sandstone	5
Total	46½

The flint clay is in appearance much like that from the Mount Savage bed. It occurs not in rounded concretionary forms as the Mount Savage clay frequently does at its outcrop, but in a solid massive ledge. In this ledge the flint showed a thickness of 3½ feet, with both top and bottom concealed. The character of the outcrop was not such as to show whether or not a plastic clay were present in association with the flint.

A sample of this clay was tested by Dr. Ries, who says in regard to it:[1]

"The material is a flint clay which in general appearance is not unlike clays of that character, being hard and dense, and having conchoidal fracture. The chemical analysis of the material is as follows:

[1] Md. Geol. Survey, vol. iv, pp. 503-505.

ANALYSIS OF FLINT CLAY, CASTLEMAN RIVER, GARRETT COUNTY.

Silica	51.881
Alumina	36.461
Ferric oxide	1.01
Lime	.98
Magnesia	.10
Alkalies	trace
Total	100.932

"Being a flint clay it naturally has practically no plasticity when ground and mixed with water, and consequently its tensile strength is also exceedingly low, showing that it would have to be mixed with a plastic fire-clay in making it into fire-bricks. The refractoriness of the clay is, however, the most important item, and it was found on testing it that the fusion point of the clay is very nearly that of cone 35 of the Seger series, whose fusion point is about 3326° F. This makes the clay from Castleman river, therefore, one of the most refractory clays found in the United States.

"For comparison with this it is interesting to note an analysis of similar material from Westmoreland county, Pennsylvania, which is as follows:[1]

ANALYSIS OF FLINT CLAY FROM WESTMORELAND COUNTY, PENNSYLVANIA.

Silica	51.92
Alumina	31.64
Ferrous iron	1.134
Lime	.03
Magnesia	.443
Alkalies	.402
Water	13.49
TiO_2	1.16
Total	100.219

"Another analysis from the same pit gave:

Silica	47.25
Alumina	34.35
Ferrous oxide	.693
Lime	.58
Magnesia	.09
Carbonic acid	.455
Alkalies	.261
TiO_2	1.99
Water	13.695
Total	99.364

[1] Geol. Survey, Pa. MM, p. 259, Analyses Nos. 956a and 957 Kier Bros.

FIG. 1.—ENTRANCE TO FIRE-CLAY MINE ON SAVAGE MOUNTAIN.

FIG. 2.—HEAPS OF CLAY WEATHERING AT MINES ON SAVAGE MOUNTAIN

FIRE-CLAY MINES.

P. 216 B

"As may be seen these three analyses resemble each other in a general way but there may be variations even in the same pit, so that identity of composition is not necessarily required to give similarity in refractory behavior. Some of the other occurrences in Pennsylvania run as low as 9 or even 7 per cent of combined water."

There is a large area in the vicinity in which this clay could be mined, either by drifts or in open pits. The locality could be easily reached by a short spur, having almost no grade, from Jennings Bros. R. R. Abundant coal, and excellent sites for manufacturing plants are at hand. This clay is worthy of immediate development. It could probably be found at other localities in the Castleman valley.

Fragments of flint clay, probably from still another horizon, were found on the headwaters of Glade Run near the foot of Backbone Mountain. This locality is about three miles north of Gorman. This clay evidently belongs in the lower part of the Allegheny formation, and is possibly the equivalent of the Kittanning fire-clay of Pennsylvania. No tests have been made, nor have the thickness and extent of the deposit been determined.

Shales.

The shales in Garrett county which might be used for brick making have a wide geological distribution and occur in almost every formation.

The Jennings formation contains an abundance of shale, a large part of which is suitable for the manufacture of clay products. It is a shale from this horizon which is used by the Queen City Brick and Tile Company of Cumberland. There are many localities to the northeast, east, and southeast of Oakland where these shales could be used. Lack of local markets and of transportation facilities will render it unprofitable to work these shales anywhere in Garrett county except along the line of the Baltimore and Ohio Railroad where it crosses the outcrop of this formation between Oakland and a point one mile northeast of Deer Park. However there are good exposures of these shales in most parts of the large belt of this formation.

The Hampshire formation contains a vast amount of shale but much of it is too sandy to have any value. Along the Baltimore and Ohio Railroad between Deer Park and Altamont and again between Swanton and Floyd are numerous exposures of red and green shales some of which may be plastic enough to be of value for brick making. However, they have never been tested.

The Pocono formation is composed principally of sandstone. In the railroad cut at Altamont there is a good exposure of a bed of shale 30 feet thick which may be useful. It extends from 33 to 63 feet above the base of the Pocono, and has a bed of sandstone 1 foot thick 12 feet below the top.

The Greenbrier formation contains but little shale, and that is either too sandy or too calcareous to be of value.

The Mauch Chunk formation contains a great deal of red shale; but most of it, like the Hampshire shales, is too sandy to be of value. A sample from near the crest of Savage Mountain by the side of the National Road was tested by Dr. Ries who found that it was suitable for the manufacture of brick.

The Pottsville formation contains no material that can be used for the manufacture of clay products except the Mount Savage fire-clay. Sandstones and conglomerates predominate in this formation, and the shales are sandy.

The Allegheny formation contains considerable shale that may prove to be of value. The shales at the base of the formation are all more or less sandy and probably have no value. Those immediately under the Clarion sandstone look more promising. The shale under the Lower Kittanning coal is in other regions often refractory enough to be a fire-clay. In Garrett county it is not known to possess this quality, but can probably be used for ordinary or paving brick. The upper part of the Allegheny formation contains an abundance of shale. This is being used at Corinth for the manufacture of pressed-brick. The shale is apparently a short distance below the horizon of the Upper Freeport coal. There is a large area in the vicinity where these shales are at the surface and well exposed for working.

ANALYSES OF CLAYS FROM NEAR CORINTH.
(Analysed by the chemist of the Maryland Iron Co.)

	I		III	IV	V	VI	VII	VIII
Silica.......	56.42	69.51	62.98	51.53	53.49	56.36	61.70	56.32
Alumina....	20.94	22.27	18.54	22.60	22.83	24.18	22.24	23.00
Iron........	10.60	.80	5.70	6.80	6.90	6.40	5.60	5.80
Lime	trace	trace [1]	2.44	5.40	2.91	.50	trace	1.47
Magnesia ...	1.32	trace	.97	1.87	1.84	.82	1.44	.79
Water	7.30	7.45	8.85	11.77	9.44	7.50	6.50	11.08
Total...	96.58	100.03	99.48	99.97	97.41	95.76	97.48	98.46

I. Red shale (bottom).
II. Fire-clay or flint.
III. Buff, new opening.
IV. Bottom Blue, clay mine.
V. Top Blue, clay mine.
VI. Cistern.
VII. Railroad clay.
VIII. Black shale, coal mine.

The Conemaugh formation contains several thick beds of shale, but most of them are either sandy or are interstratified with thin beds of sandstone. The shales above the Mahoning sandstone are very fissile but probably contain too much carbonaceous material. The red shales below the Clarksburg limestone have been used for brick-making in Harrison county, West Virginia, but these beds are not well developed in Maryland.

The Monongahela and Dunkard formations probably do not contain in Garrett county any clays that are suitable for brick-making.

Residual Clays.

These are not of much economic importance in Garrett county except as they are used in connection with the partly weathered and unweathered shales from which they are derived. There are probably large areas in the Glades which are underlain by thick and extensive deposits of residual clay, but these cannot easily be worked because of the difficulties of drainage.

Sedimentary Clays.

The only sedimentary clays which have been observed in Garrett county occur in the terraces along the Castleman river to the south of Grantsville. The clay is a fine blue sticky deposit with a few

[1] Also trace of alkalies.

small rounded pebbles and crusts of limonite; it is interstratified with sand and loam, and resembles some of the later Pleistocene clays of the Coastal Plain. The amount is not known. The clay is suitable in character for the manufacture of common brick.

Lime.

Garrett county contains extensive deposits of limestone suitable for burning for agricultural and building purposes or for use as a flux. It is also probable that part at least of this limestone is suitable for the manufacture of cement, although it has not yet been tested for this purpose.

The limestones which might be quarried and burned for lime occur in the following stratigraphic positions:

- Dunkard Formation.
  - Various limestones.
- Monongahela Formation.
  - Waynesburg limestone.
  - Sewickley limestone.
  - Redstone limestone.
- Conemaugh Formation.
  - Pittsburg limestone.
  - Clarksburg limestone.
  - Elklick limestone.
  - Ames limestone.
  - Upper Cambridge limestone.
  - Lower Cambridge limestone.
  - Mahoning limestone.
- Allegheny Formation.
  - "Ferriferous" limestone.
- Pottsville Formation.
  - None.
- Mauch Chunk Formation.
  - None.
- Greenbrier Formation.
  - Upper Greenbrier limestone.
  - Middle Greenbrier limestone.
  - Lower Greenbrier limestone.
- Pocono Formation.
  - None.
- Hampshire Formation.
  - None.
- Jennings Formation.
  - None.

The Greenbrier formation, whose occurrence has already been described in the preceding pages, is composed principally of limestone. The most valuable deposits of this rock occur in the upper member of the formation. This member is about sixty-five feet thick and consists predominantly of limestone with a few shale-partings. Almost the whole thickness can be quarried. This rock has already been opened for agricultural purposes at numerous points, and is of such persistence that it can be worked anywhere except where the covering of soil and rock debris is too thick to be profitably removed. The middle member of the Greenbrier contains a few thin beds of limestone but they should always be neglected for the overlying beds which are much thicker and purer. The lower member contains a considerable thickness of limestone which can be quarried and burned but it is very impure and is far less valuable than the upper member. The limestone of the Greenbrier formation is by far the most valuable of that in Garrett county.

The following analyses of samples of Greenbrier limestone from Garrett county, collected by the Maryland Geological Survey, were made by Mr. T. Malcolm Price for the Maryland Agricultural Experiment Station, and were published in Bulletin No. 66 of that institution by H. J. Patterson :

Analyses of Greenbrier Limestone, Garrett County.

	Insoluble.	Fe_2O_3 & Al_2O_3	$Ca\,CO_3$	$Mg\,CO_3$	Total.
Gerringer and Inglehart's quarry	13.65	5.44	79.16	1.21	99.46
Offutt's quarry	13.46	12.48	72.92	1.15	100.01
Crabtree	8.57	2.38	88.73	.86	100.54
South of Negro Mountain	20.95	41.10	37.35	.91	100.31
Offutt's quarry	17.00	2.74	64.12	15.75	99.61
Findley's quarry, Piney Run	4.47	2.70	86.73	6.38	100.28

The great variety obtained in these analyses shows the great difference in quality between the different strata. This is even better shown by the following analyses (for which the same acknowledgment is made as for the above), the first three of which are of specimens from one locality but probably from different beds.

ANALYSES OF GREENBRIER LIMESTONE, ALLEGANY COUNTY.

	Insoluble	Fe_2O_3 & Al_2O_3	Ca CO_3	Mg CO_3	Total.
Mouth of Stony Run, Allegany Co.	3.65	8.44	85.87	1.30	99.26
"	11.52	3.37	74.48	10.99	100.36
"	5.11	2.56	89.08	3.17	99.92
Barrelville, Allegany Co.	5.24	1.98	84.58	7.49	99.29

Probably any of the rock will furnish a lime that is suitable for agricultural purposes. But when a lime is desired which may be placed on the market for general and constructive uses or for use as a flux, care should be taken in selecting the purer beds in quarrying. The average of the analyses given above would indicate a rock far less pure than that generally used for commercial purposes. But some of the analyses show that there are purer bands in the formation, and there is no doubt that if proper care were taken in locating the quarries and in keeping impurities out of the kilns a product could be obtained which would successfully compete with that now shipped from Allegany, Washington, and Frederick counties.

A short distance below the Lower Kittanning coal is the "Ferriferous limestone" which is of great importance in Pennsylvania as a source of agricultural lime and as a flux. This bed has been seen in Garrett county at several points. It outcrops about one-half mile north of Stoyer in the bed of the run, immediately under the Lower Kittanning coal. Here only the top is exposed and the thickness is not known. About four miles north of Gorman, in the bed of Glade Run, a limestone which is apparently this one is exposed. About two miles southwest of Crellin there is a good exposure of this rock in the west bank of Laurel Run, a short distance above the bridge at the mines of the Preston Coal and Lumber Co. Here nearly three feet of limestone are exposed. About one mile southwest of this point across the West Virginia line the rock has been quarried on a small scale by Mr. Van Werth.

This rock is called the "Ferriferous" limestone because it is frequently overlain by a stratum of iron ore, which is a carbonate of iron very rich in lime. This ore grades downward into the limestone, which (especially in its upper part) contains a great deal of iron. Complaint is frequently made that this rock "although it looks like limestone will not burn." The trouble seems to be that in testing, the rock samples are taken from the top of the stratum which is very impure. The lower part will be found to be purer and more valuable.

There are a number of limestones in the Conemaugh formation which have been or may prove to be of value for local use. Between the upper and the lower Mahoning sandstones there is occasionally a limestone which, however, has never been observed at the surface in Garrett county. The Cambridge limestones whose position has been described in the chapter on Stratigraphy (pp. 134, 135) may have some local value—although they are probably too thin for even this purpose. The greatest thickness known in Garrett county for any of these beds is that recorded from the bore-hole at Jennings where the Lower Cambridge is three feet thick. All surface exposures hitherto observed are less than this. The Ames limestone which overlies the Friendsville coal is exposed at many points in the Castleman and lower Youghiogheny basins. At most exposures there is also an impure limestone below the coal. It is probable that the coal and one or both of the limestones could be mined or quarried together and burned for local use. This has been done occasionally. A short distance below the Morgantown sandstone is the horizon of the Elklick limestone. This bed has not been definitely recognized in Garrett county, but there is in the Georges Creek basin a limestone about seven feet thick which belongs either at this horizon or immediately above the Morgantown sandstone. This is well exposed about two miles northwest of Franklin in the southern branch of Mill Run. Here it has been quarried and burned quite extensively. About 100 feet above this limestone is another which is the thickest, and is the most constant in the Coal Measures. This is the Clarksburg limestone. It has a thickness of about six feet, and is of excellent quality. It is usually overlain by the Franklin coal which is immediately below the Connellsville sandstone. It is possible that the limestone already described as outcropping two miles northwest of Franklin is the same as this one. The limestone which underlies the Little Pittsburg coal has been quarried and burned for local use about one mile northwest of Gise, and has been exposed elsewhere in the lower Youghiogheny basin.

The Monongahela and Dunkard formations contain several limestones which have been quarried in western Allegany county, and which might be opened in the adjoining part of Garrett county.

Building Stone.

Garrett county contains an abundance of building stone suitable for certain purposes. This is of two kinds, sandstone and limestone.

Sandstones.

The sandstones which can be used as building stone are as follows:

Dunkard Formation.
- None.

Monongahela Formation.
- None.

Conemaugh Formation.
- Connellsville sandstone.
- Morgantown sandstone.
- Saltsburg sandstone.
- Mahoning sandstone.

Allegheny Formation.
- Freeport sandstone.
- Clarion sandstone.

Pottsville Formation.
- Homewood sandstone.
- Connoquenessing sandstone.

Mauch Chunk Formation.
- None.

Greenbrier Formation.
- None.

Pocono Formation.
- Various sandstone members.

Hampshire Formation.
- Various sandstone members.

Jennings Formation.
- Various sandstone members.

Many of the Carboniferous sandstones are well adapted for use as building stone, although none of them could be used for ornamental work. Until the present all the building stone that has been quarried in Garrett county has come from the Carboniferous and has been used only for rough work such as foundations, embankments, and bridges. While it is possible that some of the stone could be used for a better class of work, it is not likely that any such demand will be made for it in the immediate future.

The Jennings formation contains various sandstone and conglomerate members but none of them have any textural or ornamental features which would make them especially valuable as a building stone. The lower part of the formation contains the stratigraphic equivalent of the well-known Portage flags which are extensively quarried in eastern New York for flag-stones. It is possible that a similar industry could be developed in Garrett county.

The Hampshire formation contains a number of sandstones which at first sight appear well adapted for use as building stone. However most of them readily develop a shaly parting under the influence of the weather and are for that reason worthless. Near Accident, along the Savage river for several miles above Crabtree, and south of Redhouse the sandstones in this formation have a very massive character and may prove to be durable enough to be used for building. These sandstones are very attractive in appearance, being of a very uniform and desirable shade of brown. If this rock proves durable enough it ought to find a market outside the county as an ornamental building stone. If it is used it should always be laid on the bedding and never on edge, for the tendency to become shaly and flake would be many times greater in the latter case. About four miles west of Frostburg and one and one-half miles south of the National Road is a small quarry from which a flag-stone has been obtained from this formation. The stones are from one to two inches thick, and as a rule are very smooth, without ripple-marks, and not warped. Only a small amount has been taken out.

The Pocono formation contains a large amount of sandstone and conglomerate, but it is not easy to work or of attractive appearance.

It will probably never be used except locally for rough work. Its durability makes it valuable for this purpose.

The Greenbrier and Mauch Chunk formations, although they contain some sandstone, contain none that can ever be of any value for structural purposes.

The Pottsville formation contains a large amount of sandstone and conglomerate which, although it possesses no ornamental features, is extremely strong and durable and is well adapted for such work as the construction of foundations, bridges and railway embankments. The Connoquenessing sandstone is the most durable, but the most difficult to work. The Homewood sandstone at the top of the Pottsville has been largely used for all kinds of rough work.

The Allegheny formation contains two sandstones which may be used for some kinds of construction. The lower or Clarion sandstone, although not of a very desirable color, is abundant, durable and easy to work when first taken from the quarry. It is much used for bridges and foundations, and doubtless could at some localities be quarried for higher grades of work. It is frequently badly iron-stained, but doubtless this could be avoided by a proper location of the quarry. The Freeport sandstone which occupies a very constant position slightly above the middle of the formation is a very durable but not attractive stone. It is probable, however, that this cannot be obtained in blocks thick enough for most purposes. It is characterized by an abundance of yellow mica flakes, which make it split readily along the bedding.

The Conemaugh formation contains several sandstones which have been quarried and sold in one region or another. The Mahoning sandstone at the base of the formation is well adapted for local use. The next higher sandstone, the Saltsburg, is occasionally massive enough to be used for foundations and bridges. The Morgantown sandstone has been extensively quarried in various regions. It works easily, is durable, and in some places is of attractive appearance. There is an abandoned quarry in the western edge of Grantsville where a considerable quantity of stone was taken out. Probably this stone was used for many of the bridges on the National Road. In many parts of West Virginia it has been very extensively quarried and many important buildings have been constructed of it. The Connellsville sandstone is also an important quarry rock which has been extensively used in West Virginia and elsewhere.

The Monongahela and Dunkard formations contain sandstone members, but their extent is so slight in Garrett county, and they are so inferior to the sandstones of the Conemaugh, Allegheny, and Pottsville formations, that it is not worth while to consider them here.

Limestone.

The only limestone in Garrett county which can be considered of value as a building stone is that of the Greenbrier formation. The limestones of the Coal Measures are too limited in quantity, too much broken up by joints and bedding planes, and of too much value for other purposes, to be considered as building stones.

The siliceous limestone at the base of the Greenbrier formation would probably make a valuable building stone. It is of a desirable color (light grey or buff), is very durable, and is easily worked. In some parts of the bed are bands of sandy material which would stand out on weathering, but these are not distributed all through the bed. The portions of the bed which do not contain these bands are very uniform in color and texture.

The upper part of the formation contains some layers of massive limestone which would make an attractive and durable building stone. These layers range in color from very light gray to a dark reddish buff. There would be no difficulty in obtaining blocks of considerable size. Some of these layers are well shown in the quarry at Crabtree.

Road Materials.

The following materials have been or can be used as road material in Garrett county,—limestone, sandstone, shale, gravel, slag.

The limestone is by far the most important road material in Garrett county. The distribution and character of the limestone have already been given under the headings of *Stratigraphy, Lime,* and *Building Stone.* The most important source of limestone is the

Greenbrier formation, although some of the higher limestones could just as well be used if it were not for their limited extent. The Greenbrier limestone makes a valuable road metal because it combines a high cementing quality with good wearing power. Probably the siliceous limestone at the base of the formation will be found the most valuable for this purpose, because of its high wearing power. It has the additional qualification of not being sought for burning as lime.

The celebrated "Ligonier blocks" used to such a great extent in Pittsburg for paving, come from the basal siliceous beds of the Greenbrier limestone, and are identical in character with the rock from Garrett county.

All of the sandstones are of some value as road metal, although those of the Pottsville are far more valuable than the more friable ones in the other formations. They all possess the disadvantage of having low cementation power, but the Pottsville sandstones have a high wearing power and are well adapted for use on a very heavily traveled road.

The shales, especially the arenaceous shales of the Devonian, make a good road for light travel, but will not stand heavy wear. They are less economical and less satisfactory in the long run than the limestones. Fire-clay has been used to a limited extent, but it makes a very sticky road in wet weather and a very dusty one in dry weather, so cannot be considered an important road material.

The gravel of Garrett county is not adapted for highway construction and should never be used for this purpose.

Slag from iron-furnaces has been used to a limited extent on the roads of Garrett county—especially near Friendsville. Slag which contains a large amount of lime makes a very good road material, but the slag produced at the old Friendsville furnace was not of this character. For this reason, and because the supply is so nearly exhausted, slag need not be considered as an important road material in this region.

Iron Ore.

No iron ore is now mined in Garrett county, and this industry has never been of any great importance in the past. The only place where iron has ever been smelted within the limits of the county is at Friendsville where there still exist the ruins of a small blast-furnace which was built many years ago and has long been out of use. The ore for this furnace was dug from a number of small pits on the western slope of Winding Ridge. It probably consisted of both siderite nodules from the shales of the Coal Measures, and limonite concretions from the residual soil. The location of the pits is not known. Charcoal was used as a fuel, and Greenbrier limestone as a flux. Probably no attempt was made to supply more than the demands of the local forges.

Small pockets of limonite exist in the Jennings, Hampshire, and Mauch Chunk shales, but these could not have been considered workable deposits in any condition of the iron industry.

In the shales between the Clarion coal and the overlying Clarion sandstone there are abundant nodules of siderite or carbonate of iron, which frequently form a locally continuous stratum, which occasionally becomes thick enough to possibly possess some commercial value. This deposit is well exposed in the railroad cut on the West Virginia side of the Potomac at Chaffee. It was also cut through in the large tunnel (intended to reach tho Mount Savage fire-clay) on the eastern side of Savage Mountain between the National Road and the Savage Mountain fire-clay mine. At this place a large quantity of the ore was taken out, but the thickness of the bed is not now known. Some ore may always be expected at this horizon, and the bed may prove thick enough in places to mine, but it is doubtful if it can be done profitably in the present condition of the industry.

There are also small bands of siderite higher in the Coal Measures, especially in the middle of the Conemaugh, and in the Monongahela and Dunkard.

Miscellaneous Materials.

Phosphate Rock.—Attention was called in a preceding report of this organization[1] to the occurrence of a stratum of phosphatic rock near the base of the Pottsville formation in Allegany county.

[1] Md. Geol. Survey, Allegany County, p. 193.

A black sand has been observed at the same horizon on the crest of Savage Mountain near the National Road. An analysis showed that this sand contained a small amount of phosphate of lime, but not enough to give it any value. The sample was obtained at the surface, and it is possible that the amount of phosphate is greater in the fresh material below the surface.

Precious Metals.—Considerable misdirected time and money have been spent in search for precious metals in the valley of Savage river. Belief in their presence was occasioned by the discovery of thin flakes of the sulphides of lead, zinc, iron and copper in the Devonian shales and sandstones. The rocks have been slightly faulted and slickensided and on the planes of movement a little calcite (carbonate of lime) is deposited. This calcite (which was incorrectly determined as vein-quartz) contains, as it often does in other regions, small amounts of the metallic sulphides. The parties interested have had assays made which showed small amounts of gold and silver. Even if the assayed samples were correctly selected the deposit would be absolutely valueless, for the sulphides are confined entirely to fractures in the rock in a very narrow zone and never permeate the sandstone. The calcite vein does not exceed one inch in thickness at any point seen by the writer, and does not average $\frac{1}{8}$ of an inch in thickness. Even at the rate of the highest reputed assay, the value of the entire amount of ore which could be taken out in a year of extensive mining operations would not pay for the powder used in a single blast. Further prospecting is useless, for the conditions essential to the formation of workable metallic veins never existed in this region. Similar occurrences of the sulphides have long been known in the adjacent regions of Pennsylvania and West Virginia, and careful investigation has in every case shown the deposits to be valueless.

Petroleum and Natural Gas.—The idea prevails in some quarters that Garrett county lies in the oil and gas belt and that these products can be secured by drilling. This belief has been encouraged by drillers who wish to secure employment for their outfits, and by promoters. As a matter of fact no oil or gas has ever been found in a region geologically similar to Garrett county. Moreover it is impossible for any to exist in such a region at ordinary depths, because of the extent to which the rocks have been folded and fractured. Dr. I. C. White, the foremost authority on oil and gas in this country, says:[1] "In most mountain regions, the fracturing of the strata has been carried on to such an extent that all the available stores of gas and oil that may once have existed in the beds have passed out of the original reservoirs through their defective covers, escaping into the air, and hence it is useless to drill for oil or gas to any ordinary depth in typical mountain regions.

"It is barely possible that under great thickness of close grained beds or shales the gas and petroleum originally contained in rock reservoirs so situated may still be imprisoned. No borings in mountain regions have been sunk to a depth sufficiently great (4000-5000 feet) to test the truth of this supposition."

This is not mere theory. Numerous wells have been put down in regions similar to this and not one has ever been productive. The deep wells near Mountain Lake Park and Cumberland, which were complete failures, have fully tested the possibilities of this region in this regard.

LIST OF OPERATORS IN MINERAL PRODUCTS IN GARRETT COUNTY.[2]

Coal.

Consolidation Coal Co........Baltimore.
American Coal Co...........New York.
Maryland Coal Co.. ....New York.
New Central Coal Co........New York.
Davis Coal and Coke Co. Philadelphia, Pa.
Piedmont Mining Co..Piedmont, W. Va.
Cumberland-Georges Creek Coal Co..........Philadelphia, Pa.
North American Coal Co..Blaine, W. Va.
Garrett County Coal and Mining Co ....Blaine, W. Va.
G. C. Pattison............Bloomington.
Monroe Mining Co......Barnum, W. Va.

Clay.

Union Mining Co........Mount Savage.
Savage Mountain Fire Brick Works ....Frostburg.

Lime.

J. Fredlock Manufacturing and Building Co ......Piedmont, W. Va.

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[1] West Virginia Geological Survey, vol. i, p. 184.

[2] The list comprises only those operators engaged in making shipments by rail whose properties lie wholly or in part in Garrett county.

THE SOILS OF GARRETT COUNTY

BY

CLARENCE W. DORSEY

Introductory.

It is important that a volume dealing with the natural resources of the county should devote some attention to a consideration of the soils and their agricultural possibilities. Everywhere over the surface of Garrett county, covering hills and valleys alike, is found a coating of soil, varying in depth, and grading imperceptibly into the underlying rocks or resting directly upon the surface of the rocks. This soil covering supports a vegetable growth more or less abundant, depending on the conditions surrounding the soil and those present within the soil itself. In the valleys the soil is usually deep and productive, on the mountain slopes it is shallow and stony, furnishing scant nourishment to only the hardiest trees and plants. In places the soil is stained a deep red not unlike the underlying beds of shale and sandstone. At other times the productive clays seem to bear no relation whatever to the deeply buried limestones, while on the mountain tops the soils seem but a mass of broken gray sandstone fragments mixed with small amounts of sand and clay.

It is this soil covering with which the farmer has to deal, and the science of agriculture has been advanced if the labor of cultivation can be made lighter, or the practice of husbandry be made more remunerative. We may now touch briefly upon the processes concerned in the formation of soils, and then pass to a consideration of some of the properties of soils.

Origin of Soils.

Upon examination soils are seen to consist of particles of sand, silt, and clay, bits of rocks, and partially decomposed organic matter, together with a variable amount of water containing various substances in solution. When the soil grades imperceptibly into broken and partially decomposed rocks and these in turn pass into fresh and solid rock, it is reasonable to suppose that the soil has actually been derived from the rocks beneath it. The color of the soil and the fresh rock may be the same, or the bits of rock mingled with the soil may be similar in appearance and composition to that found several feet below the surface. In either case the supposition would be strengthened that the soils were merely the result of the reduction of the rock masses. Soils formed from the underlying rocks in place are called residual soils, and it is to this class that the greater part of the soils found in Garrett county belong. The sandstones, shales, and limestones, which constitute the rocky framework of the county, are, without interruption, being subjected to the forces which result in breaking them down and wearing them away. These forces are everywhere about us, always active, and the ultimate result of their action is wonderful although the period of a lifetime sees but little of these operations. The action of the atmosphere with its many daily changes of temperature tends to loosen the rocks and cause them to fall apart by alternately expanding and contracting the rock particles. The winds carry away fine particles of sand and dust, and help to reduce the size of rock masses. The air contains traces of various gases which also promote rock decay. Rain water, especially when it contains carbon dioxide, dissolves the cementing substances of the rocks also and causes them to disintegrate. Water readily penetrates the crevices and on freezing tends to disrupt the rock masses. The rains wash away the loosened particles and the streams carve out valleys and gorges.

The oxygen of the air unites with the iron bearing minerals of certain rocks and oxidation takes place, or, as we commonly speak of it, they rust. Water also chemically unites with certain of the rock-forming minerals, and this hydration, as it is called, is recognized as a powerful agent in the decomposition of rocks into soils. Some plants, such as lichens and especially bacteria, tend to break down large masses of rocks and render them suitable for the more highly organized forms of plant life. Thus it is seen that a multitude of forces and agencies are constantly at work which result in the accumulation of a covering of soil upon the rocks. Whether the soil covering will become deeper depends on the forces which carry away the loosened rock particles. On steep hillsides the transporting agents are the rains and the slow creeping of the soil particles down the slopes by the force of gravity. These forces are so powerful on the steepest slopes that the soil covering is either shallow or wanting altogether. In the valleys and on the gentler slopes, however, the soils are little disturbed and accumulate to much greater depths. Along stream bottoms, where the floods spread at certain portions of the year, the soil deposit is seen to consist almost altogether of materials that have been carried from slopes and hillsides by the rains. Such soils are called transported soils. In Garrett county there are few cases of transported soils, although all of the soils have been carried short distances down the hillsides by soil-creep.

The Fertility of Soils.

The productiveness of a soil depends upon the soil itself and the external conditions surrounding it. The depth, character, composition and texture of the soil must be considered. A shallow soil is seldom productive, while a soil composed of coarse quartz sand is never fertile. The essential elements of plant food such as potash, nitrogen, lime, phosphoric acid and other substances must be present in the soil in such condition that the growing plant can use them, or the soil is considered unproductive. The texture of the soil in the humid regions determines largely its capacity for holding water, and this power of conserving moisture is highly essential. Climate exerts a great influence on the fertility of the soil; for, if the rainfall is insufficient or if the winter is too long and severe, vegetation will not thrive no matter how rich the soil may be in plant food. The arid plains of our western states afford an excellent example of sterile and unproductive soils rendered so by unfavorable climatic conditions. Only supply the necessary moisture, and they will prove most valuable farming lands, as the many irrigation districts attest. The distribution of sugar cane, cotton, corn, and wheat, also show forcibly the effect of climate in limiting the sections of the country in which these crops can be grown.

The position of the soil with reference to large bodies of water, to elevation above sea-level and to prevailing winds, must be studied in any consideration of the soil relating to crop production.

Even though a soil may be rich and productive, no great agricultural development can take place upon it when its position with reference to markets is unfavorable and transportation facilities are limited.

Relation of Agriculture to Physiography and Climate.

Garrett county is the most western and also the largest county of the state, containing 680 square miles. Its surface is that of a broad rolling plateau whose continuity is broken in places by mountain ridges, which traverse the county in a northeasterly and northwesterly direction. These ridges rise several hundred feet above the general level. The elevation of the lower portions of the plateau in Garrett county ranges from 2000 to 2500 feet above sea-level, while the mountain ridges rise to elevations of 2500 to 3400 feet. The North Branch of the Potomac and Savage river receive the drainage of the eastern part of the county, while the Youghiogheny and Castleman rivers, with their many tributaries, drain the western and by far the greater part of the county. The latter eventually discharge their waters into the Gulf of Mexico, but the former streams flow into Chesapeake Bay and finally into the Atlantic. The greater part of the county is well drained, but there are several areas of considerable size in the central portion which are swampy and characterized by sluggish, meandering streams. These are known as "Glades," and any section which has a tendency to be swampy is called "glady."

While a complete description of the climate is given elsewhere in this volume, a few facts which have a direct bearing upon the agricultural conditions of Garrett county may be given here. In general the climatic conditions for maturing crops are perhaps less favorable here than in any other section of Maryland. Greater extremes of cold are experienced in the winter, while the growing season is much shorter. This is due principally to the considerable elevation of the

VIEW FROM THE EAST SIDE OF THE COVE, LOOKING SOUTHWEST.

county as compared with the other counties. Usually spring[1] does not begin until the middle of April, although it begins in the early part of March in the southeastern part of the state. The highest recorded temperature is 99°, while the lowest is —26°, recorded at Sunnyside. These figures give an extreme range of temperature of 125°, probably the greatest range in the entire state. The mean daily range of temperature is about 20°, or slightly more than that of the state. The normal annual temperature of the county is 47°, while that of the state is between 53 and 54 degrees. Frosts are possible in almost any month of the year, but during a period of three years ending 1898 the last frost in the spring occurred May 30, and the first frost in the fall, September 12. The normal annual precipitation for Garrett county is 53.3 inches, of which about 28 inches fall during the spring and summer months. The annual precipitation is about ten inches greater than the recorded rainfall of the rest of the state.

Agriculture in Garrett County.

Garrett county is not very thickly settled, although the increase in population has been considerable during the last decade. The population in 1900 was about 18,000, an increase of nearly 25 per cent over that of 1890.

For a long time Garrett county made but little advance along the lines of agriculture, but in more recent years larger tracts of forest have been cleared and farming interests have begun to improve. There is a large portion of the county, however, that is still in what may be termed the "saw mill" stage of development, and many years must elapse before extensive farming operations can be practiced in such sections. A large portion of the county is included within farm boundaries and more than half of the farm area is not improved. The average sized farm includes about 150 acres, but there are many farms which are over 1000 acres.

The principal crops grown are buckwheat, oats, hay, potatoes, rye, and wheat. Formerly it was considered that corn and wheat could

[1] Md. State Weather Service, vol. i, p. 487.

not succeed, but recently both of these crops have been grown, and, in increasing amounts, with good results. While the seasons are comparatively short, farming can be carried on almost as profitably as in the more eastern counties of Maryland. Considerable profit is realized from the sale of butter and maple sugar, and in favorable seasons the chestnut crop nets handsome returns. The winters are too cold for peaches, but apples thrive, although no special effort has been made to make apple growing profitable. In the neighborhood of Deer Park and Oakland raising truck crops and small fruits has proven quite profitable.

The lumbering business has for many years provided means of livelihood for a large number of families and been a source of considerable income to the county. Along the Youghiogheny river are several extensive saw mill plants, and there are others scattered about the county. Formerly there were large cuttings of white pine timber, but of late years the lumber output has been chiefly of hemlock and hard woods.

The county is furnished with means of easy access to the eastern and middle western markets by the Baltimore and Ohio Railroad, which crosses the southern part of the county, and by a branch of that system which follows the Youghiogheny river to a point several miles above Friendsville. The greater number of wagon roads, especially where they traverse the more mountainous sections, are stony and narrow, and on many of them the grades are very steep. The old National Road crosses the northern part of the county, but it has become, through lack of care, rough and worn. The best roads are to be found in the neighborhood of Oakland and Deer Park.

Historical Sketch.

Less has been written of the soils of Garrett county than of any other county in the state. In 1854 the Fourth Annual Report of Dr. James Higgins, State Agricultural Chemist, was published. This report contains some account of the soils of Allegany county, which, at that time, included the area at present comprised in Garrett county.

Dr. Higgins described the "glades," which, he says, are one of the most curious and striking features of the county. "These," he says, "are famous pastures for large flocks of cattle, which are driven from the neighboring counties of Virginia to be pastured in the summer months. They were doubtless at one time lakes, and have become filled up gradually by washings from the surrounding hills, and by the decay of plants and trees." He likens the dark, light, and chaffy soils of the glades to the blackgum swamp soils of the lower Eastern Shore counties. This report also describes the soils of the country between Savage river and Meadow Mountain, and the soils of the Cove country. These are the Hampshire soils, and are described as quick soils, which produce fine crops. The soils of the middle and western coal fields are described as light sandy soils, and they are said to be deficient in potash and chlorine. This description doubtless refers to the northern central and extreme western portions of the county. With the exception of these short descriptions nothing more than brief references have been made to the soils of the county.

Soil Formations.

There are comparatively few types of soil in Garrett county. They consist mostly of sandy loams and loams in the valleys and more gently rolling areas. In the mountainous districts there are always present large amounts of boulders, which make cultivation difficult. As has been stated, the soils are mainly residual, derived from the weathering of the shales, sandstones, and limestones. These are all sedimentary rocks, and the manner in which the soils are derived from them is comparatively simple. The cementing materials are dissolved, setting free the sand or silt particles, which, mingling with partially decomposed organic matter, form the soils. The soils derived from the degradation of the various geologic formations preserve many of the features of the parent rocks. Many of the formations weather into similar soil-types; thus for example, the soils derived from coarse, gray sandstones are found to bear a close resemblance to each other, while the soils derived from the two red shale formations are also similar in many respects. The soils derived from the various geologic formations will now be described, beginning with the oldest.

THE JENNINGS SOILS.

The soils derived from the weathering of the Jennings formation are found over large areas. They occupy the gently rolling valley lands west of Backbone and Savage mountains and an area west of Negro Mountain. The largest areas of this formation lie in the valley between Savage and Meadow mountains. In the southern central portion of the county these soils surround the considerable areas of "Glades." Much of the material composing the Glades has been washed from the gently sloping stretches of land underlain by the Jennings formation. The Jennings soils are residual and have been formed directly from the fine-grained sandy and argillaceous shales, by the weathering agencies that have dissolved the cementing materials and set free the small particles of sand and clay. The rocks of which this formation is composed are comparatively soft, hence they do not resist erosion but are covered with deep soils. The soils are yellowish-brown loams and sandy loams to a depth of 6 or 8 inches, and are underlain often to a depth of several feet by heavy, sandy loams and clay loams. Where the rocks are fine-grained argillaceous shales the soils are generally shallow and pass into broken fragments of shale, but where the rocks are more sandy the soils are heavy, sandy loams of much greater depth. The soils are much the same color as the yellow and brown shales from which they are derived. Frequently the surface is covered with scattered fragments of the broken rock although the percentage of such material is seldom sufficient to interfere with cultivation. These soils dry out during periods of drought, but such periods are not of frequent occurrence, for the cool nights and heavy dews help to conserve the soil moisture. On account of the sandy nature of the soil and of the rolling character of the country these soils possess good natural drainage.

While these soils cannot be classed as strong fertile soils they can be improved, and by careful methods of cultivation be made to produce well the crops grown in Garrett county. Much of the area occupied by this formation is forested, but where the soils are cultivated fair crops of buckwheat, corn, wheat, timothy, and clover hay, and oats are harvested. Reported yields of these crops are as follows: One ton of timothy hay per acre, 1½ tons of clover hay, 20 to 35 bushels of oats with 25 bushels per acre as an average crop. In a good year from 20 to even 30 bushels of wheat can be harvested although the average yield per acre is somewhat less. From 25 to 35 bushels of corn can be grown although these soils are not fine corn lands. Little commercial fertilizer or stable manure is used on these soils, although lime is frequently used with beneficial results. Where the original timber growth has been cut and the land allowed to become reforested a scant growth of pine and oak springs up. Originally these soils were said to have been covered with a heavy growth of white pine, maple, white, red and chestnut oaks, chestnut, ash and other hard wood trees. In the table of mechanical analyses is shown the texture of representative samples of the Jennings formation.

MECHANICAL ANALYSES OF SOILS DERIVED FROM THE JENNINGS FORMATION.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3513	Garrett Co........	Subsoil, 12-37 ins. Composite sample.	7.49	5.80	4.54	2.56	2.16	10.00	44.46	22.12
3516	Oakland, 1 mi. E..	Yellow clay, 24-38 ins.	5.12	trace	0.54	0.60	12.90	34.08	24.79	22.77
3515	" " " ..	" 12-24 "	7.80	trace	0.44	0.62	8.69	24.19	30.07	27.63

THE HAMPSHIRE SOILS.

The soils of the Hampshire formation occupy large areas in the central portion of Garrett county. These areas occur on both sides of the areas of Jennings just described. They are more rolling and possess stronger soils than the Jennings. The same rolling character of valley country is noticed wherever this formation occurs, and the greater part of the area is cleared and farmed. The largest areas of the Hampshire formation lie between Savage and Backbone mountains on the east and Meadow Mountain on the west. The region west of Negro Mountain and east of Winding Ridge in the northwestern part of the county includes some of the finest farming land.

This Hampshire soil is also residual, and is the decomposition product of the fine-grained, red and brown shales and sandstones which constitute this formation. The ferruginous cement has been dissolved and the sand particles have been set free, and often the individual sand particles composing the rock itself have been further disintegrated into clay. Where the sand grains composing the rock were originally sharp angular grains of quartz they have undergone little change and the resultant soil is sandy. Generally, however, the rocks of the Hampshire formation are covered with a coating of heavy sandy loams and clays several feet thick. Frequently the soils are heavy red clay loams and stiff clays, and the table showing the texture shows these soils to contain the greatest amount of clay of any of the soils found in Garrett county. The soil to a depth of 7 or 8 inches consists of a red or reddish brown, sandy loam or loam depending on whether it has been derived from a sandy rock or a fine-grained shale. The subsoil to a depth of 36 inches is a heavy, red loam, clay loam, or clay, also depending on the character of rock from which it is derived. Occasionally there are fragments of the more resistant beds of sandstone scattered about on the surface, but these soils are generally free from stones and can be easily cultivated. These are the strongest found in the county. They are well drained, of the proper texture to hold moisture well, and are considered naturally fertile soils that can be brought to a high state of cultivation. Artificial drainage is unnecessary and where the heavier loams and clays occur they suffer little from drought in dry seasons.

The greater part of this formation is cleared, and when not cultivated the fields furnish excellent pasturage for cattle and sheep. Where farming is practiced good crops are harvested except in some of the areas where the soils are quite sandy. The Cove country, as it is called, in the vicinity of Accident and Cove contains some beautiful farming country and has been a noted wheat growing section for many years. Here the soils are deep and rich and good farming is practiced with fine yields as the result. In this locality it is said that from 20 to 35 bushels of wheat can be grown in good years. Forty to 50 bushels of oats are harvested and good crops of potatoes, rye, buckwheat and hay produced. In other sections of the county, while the yields are not reported as large as this, still they are good and show the productiveness of the Hampshire soils. Grass, wheat, buckwheat, corn, and oats are the principal crops grown on these soils. Where the original forest growth had never been cleared a thick, heavy tree growth was always noticed. Among other trees are the following: Black, white, red, chestnut, and pin oaks, chestnut, hard and soft maple, ash, beech, locust, hickory, poplar, linden or basswood, white and yellow pine, spruce and hemlock. The texture of a number of representative Hampshire soils and subsoils is shown in the following table.

MECHANICAL ANALYSES OF SOILS DERIVED FROM THE HAMPSHIRE FORMATION.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3718	Cove, 1 mi. S.	Red loam, 0-8 ins.	3.5	2.74	2.20	1.84	18.40	11.26	41.18	19.28
3527	Redhouse, mi. S.	Red clayey soil, 0-6 ins.	5.74	3.32	2.46	1.14	8.38	15.74	41.78	19.54
3532	Accident, 2 mi. N.W	Red sandy soil, 0-10 ins.	4.92	4.14	2.58	1.26	6.28	21.62	36.98	21.58
3523	Backbone Mt., W. of	Loam, 0-9 ins. Composite sample	5.27	3.09	5.03	5.55	13.82	13.94	24.32	29.98
3719	Cove, 1 mi. S.	Red clay loam, 8-24 ins. Subsoil of 3718	3.84	2.92	1.70	0.86	16.06	3.32	50.06	21.38
3524	Backbone Mt., W. of	Subsoil of 3523. Composite sample	4.68	1.83	2.59	4.01	14.98	19.07	27.75	24.92
3531	Oakland, 3 mi. S. W.	Red stony subsoil, 8-24 ins.	5.47	1.97	3.85	3.06	6.62	32.14	21.53	25.87
3526	Hoyes, 2 mi. N. E.	D'k red clayey subsoil 8-24 ins.	5.00	0.75	1.06	2.08	11.43	28.25	18.89	32.06
3528	Redhouse, 4 mi. S.	Red clayey subsoil 20-30 ins. Subsoil of 3527	6.05	1.47	1.61	1.43	2.38	11.23	43.36	32.57
3533	Accident, 2 mi. N.W	Red clay, 10-24 ins. Subsoil of 3532	5.90	0.57	0.84	1.05	1.95	7.90	29.71	51.55

THE POCONO SOILS.

The soils derived from the weathering of the Pocono sandstone are more or less valuable, depending on the size of the area occupied by the formation. Generally the formation occurs as a rather prominent ridge a short distance from the higher mountain tops. In such locations the soils are of little value to the agriculturist and seldom are these steep narrow ridges cleared and cultivated. The principal occurrences of this character are the long narrow ridges extending in a northeast and southwest direction across the entire county just west of Great Backbone and Big Savage mountains and east of Meadow Mountain. In these areas the soils consist of loose, sandy loams, representing the broken fragments of grayish sandstone. Where the sandstone is coarse, the soils consist of coarse, gray, sandy soils, but where the formation is made up of finer material the soil consists of a finer, sandy loam. In these areas the soils are always shallow and seldom attain a depth of 24 inches. Generally they are not over 15 inches in depth and consist of coarse, or fine, grayish, sandy loams that grade into masses of broken sandstone fragments. The soil is mixed with angular stones and boulders ranging from a few inches to several feet in diameter. Such areas are difficult to cultivate and generally there is no attempt at cultivation. The forest growth consists of pine, hemlock, oak, and chestnut.

In the western part of the county the areas occupied by the Pocono are considerably wider. These areas are rolling tablelands rather than narrow ridges, and possess soils that are much better adapted to farming purposes. About Keyser such an area of Pocono is found where the soils are fair general farm lands and corn, wheat, grass, oats, and buckwheat are grown. The yields are not large but the soils are warm and dry and farming is successfully carried on in this area as well as in the other large areas of this formation. The soils are sandy loams often stony and rough, but much deeper than where the formation occurs as narrow ridges. In a few places the original rock is composed of white quartz pebbles firmly cemented together. When this rock decomposes it gives rise to a fine gravelly soil for the quartz pebbles are seldom altered in the processes of decomposition.

Oats, rye and buckwheat succeed best on these soils, for the soil is too light for the best results with wheat or grass. If markets were available truck crops could be profitably introduced on the sandy soils of this formation. The original timber growth consists of chestnut, oaks of several varieties, white pine, spruce and hemlock.

The texture of samples of soil derived from the Pocono formation is given in the table below.

FIG. 1.—VIEW NEAR THAYERVILLE.

FIG. 2.—VIEW AT MOUTH OF CHERRY CREEK.

AGRICULTURAL LAND AND SWAMP FOREST.

MECHANICAL ANALYSES OF SOILS DERIVED FROM THE POCONO FORMATION.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse Sand, 1 to 0.5 mm.	Medium Sand, 0.5 to 0.25 mm.	Fine Sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3539	Garrett Co.	Stony soil, 0-10″ Composite sample	10.60	1.63	1.53	1.86	15.57	26.55	24.31	16.06
3538	Garrett Co.	Light sandy soil, 0-8″ Composite sample	5.28	1.52	2.07	8.32	21.36	18.59	25.39	16.89
3540	Garrett Co.	Subsoil, 7-24″ Composite sample	3.66	3.42	3.57	5.59	19.94	20.01	30.35	13.57

THE GREENBRIER-MAUCH CHUNK SOILS.

The soils derived from these two geological formations may be similar in character or they may differ widely, but from their close geographic association it is quite generally difficult to separate them These formations in the eastern and central portions of the county form small narrow valleys between the mountain tops and the ridges of Pocono sandstone that have been mentioned. In these valleys heavy red soils are the characteristic residual products of the Greenbrier limestone and Mauch Chunk red shales. They closely resemble the heavy, red loams and clays derived from the red shales of the Hampshire. These soils are deep and if found in more level areas could be farmed with profit, but occupying steep hillsides they are seldom cleared and cultivated. They are always covered with large boulders of sandstone that slowly creep down the mountain sides. In many areas the boulders are so thickly strewn on the surface that cultivation cannot be carried on until the boulders are removed. In these narrow valleys the heavy yellow and brown clay soils derived from the decomposition of the limestone of the Greenbrier formation are found in narrow belts often not more than an eighth of a mile in width.

In the western part of the county the limestone soils of the Greenbrier in some places attain a considerable width. They are considered strong clay soils, and they make good crops of grass, wheat, oats, buckwheat, and rye. In the table of mechanical analyses is shown the texture of soils derived from the Mauch Chunk shales as well as the heavy clays derived from the Greenbrier limestone.

Mechanical Analyses of Soils Derived from the Greenbrier and Mauch Chunk Formations.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3544	Oakland, 1½ mi. S.W	Black loam, 0-7″	11.49	trace	.55	2.28	14.93	28.47	24.44	18.22
3545	Oakland, 1½ mi. S.W	Heavy clay, 7-35″ Subsoil of 3544	7.61	.22	.37	.11	2.17	23.65	41.41	23.81
3546	New Germany S. of	Subsoil 48″ Decay product from limestone	6.64	trace	.96	1.64	10.31	19.06	26.89	33.50
3543	Sang Run	Heavy clay 8-24″	7.83	trace	.30	.44	1.17	7.86	36.72	43.93
3547	Garrett Co.	Soil 0-10″ Composite sample.	5.38	2.72	4.24	2.46	6.26	3.88	46.10	28.80
3548	Garrett Co.	Subsoil of 3547, 10-22″ Composite sample	5.30	trace	.77	1.50	1.92	35.25	32.70	22.56

THE POTTSVILLE SOILS.

The soils derived from the Pottsville formation depend largely on their location for their agricultural value. The formation is found capping Backbone, Savage, Meadow, Negro, and other of the more important mountains of the county. On the tops of the higher mountains the soils possess little value for farming purposes. The soils are shallow, sandy loams mixed with large boulders of the coarse sandstone or conglomerate that constitutes the formation. Occasionally on the mountain tops where the fine-grained, carbonaceous shales crop out on the surface a heavier type of soil is found. Usually, however, the soil is a yellow, coarse, sandy loam about 15 or 18 inches deep. In such places there are only a few scattered fields in which rye, oats, and buckwheat are successfully grown, but the yields of these crops are seldom large. Chestnut, oak, and pine abound in the areas that have never been cleared. In the rolling and more level areas of the western part of the county the soils are deeper, and there considerable more farming is practiced. Oats, buckwheat, rye, grass, wheat, and corn are grown and the yields compare favorably with those on the better class of soils in this section of the county derived from the Pocono and Allegheny formations. The soils closely resemble the soils derived from these formations and in many places little difference is seen in crossing all of the formations. The rocks composing these formations consist largely of sandstones, hence the soils are sandy, stony loams of a grayish-yellow color that become heavier in texture only when they are underlain by rocks of a more shaly character. While these soils are not strong soils they can by careful cultivation be made productive and farmed with profit. Much of the area is still forested and considerable profit is derived from the sale of the heavy timber growth, which consists of oak, pine, chestnut, hemlock, and spruce. In old fields that have been abandoned sufficiently long a scant growth of scrub oak and pine is noticed. The table of mechanical analyses shows the texture of representative samples of soils and subsoils of this formation.

MECHANICAL ANALYSES OF SOILS DERIVED FROM THE POTTSVILLE FORMATION.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine Sand. 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3552	Garrett Co., South part....	Soil, 0–12″ Composite sample.	6.82	3.72	8.06	5.14	6.79	10.10	42.57	16.56
3553	Backbone Mt., Garrett Co.	Yellow clay, 8–17″	6.30	7.92	4.68	1.60	4.00	9.04	47.92	18.64

THE ALLEGHENY SOILS.

This formation occurs in several large areas in the county, and the agricultural value of the soils depends largely on location. Large areas of Allegheny soils are found east of Backbone and Savage mountains; in the large rolling valley between Meadow and Negro mountains and also west of Winding Ridge. Frequently the surface of the country occupied by this formation is rough and mountainous while in other areas the country is gently rolling. As the rocks are composed of sandstones and sandy shales the soils are sandy, although in some places heavy clays are found—the decomposition products of narrow bands of shale and limestone. Sandy soils predominate in most of the areas. The surface soil to a depth of 6 or 8 inches consists of a coarse, or fine, sandy loam of a gray or yellow color. The soil is often strewn with huge sandstone boulders especially in the more mountainous localities. The subsoil where the sandy beds predominate is coarse sandy loam which seldom exceeds 18 or 20 inches in depth. Along the eastern slopes of Backbone and Savage mountains the drainage has become obstructed, and swamp conditions prevail near the mountain tops. In such areas the soils are wet and black with decaying vegetable matter, and support a thick growth of large ferns and dense growth of underbrush. Such areas are seldom drained and no attempt has been made to cultivate them. These swamps in addition to the ferns and underbrush support a growth of oak, locust, maple, chestnut and hickory. In the region southwest of Bittinger the swampy condition of these soils was also noticed. Here such crops as oats, buckwheat, and timothy would succeed quite well if the soils were thoroughly drained. Oats and buckwheat are the principal crops, while grass, corn, wheat, and rye are also grown to a considerable extent. Thirty bushels of oats per acre are said to be an average crop and from 25 to 30 bushels of buckwheat and 1½ tons of grass. Many state that the seasons are too short for the corn crop to mature, but, again, others claim that if the seed is planted early no damage is suffered from the early frosts in the autumn. Much of this formation is forested with a growth of trees common to the sandy soils of Garrett county. The texture of the soils of this formation is given in the table of mechanical analyses.

MECHANICAL ANALYSES OF SOILS DERIVED FROM THE ALLEGHENY FORMATION.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3557	Garrett Co	Clayey loam, 0-12″ Composite sample	7.85	4.32	6.16	4.40	9.42	15.41	39.54	11.67
3560	Near top of Backbone Mt.	Yellow sandy loam, 0-8″	3.80	1.18	2.42	2.06	18.30	19.36	36.52	15.28
3574	Garrett Co	Soil, 0-10″ Composite sample	7.08	4.28	3.52	2.00	9.76	3.26	45.48	25.52
3570	"Corunna," Garrett Co	Gravelly soil, 0-8″	8.14	3.66	3.26	1.84	3.76	5.70	41.02	31.72
3569	Garrett Co	Light loam, 9-20″ Composite sample	5.91	8.30	8.96	6.50	11.98	11.08	32.56	14.73
3561	Near top of Backbone Mt.	Yellow sandy loam, 8-18″ Subsoil of 3560	4.78	1.88	3.20	3.16	20.60	10.98	32.40	22.94

THE CONEMAUGH SOILS.

This formation occupies areas surrounded by those of the Allegheny just described. The principal areas are east of Backbone and Savage mountains and in the Castleman valley south of Grantsville between Meadow and Negro mountains. There are also large areas along the western border of the county. All of the areas are comparatively level or gently rolling and hence well adapted to farming. The rocks which compose this formation contain, in addition to heavy massive sandstone, thick beds of shale and some limestone, so that deeper and heavier soils are of more general occurrence within the limits of this formation than in the three last described. In many places the soils are shallow, sandy loams mixed with fragments of coarse sandstone. The top soil is yellow and rarely over 7 or 8 inches deep, while the subsoil passes into masses of flaggy sandstone at a depth rarely exceeding 2 feet. Where such sandy soils are found oats, buckwheat, and rye are the principal crops and the yields are not large. Where, however, heavier loams and clays are found the soils have a much greater value to the farmer, for good yields of the above crops can be harvested as well as grass, wheat, and corn. Reported yields in the southeastern part of the county are 1½ tons of timothy hay per acre, 30 bushels of oats, 20 bushels of buckwheat, 15 bushels of rye. In other sections crops of wheat as high as 35 bushels per acre are said to have been grown in good years. In the vicinity of Grantsville good crop yields are reported, and potatoes are said to make large yields of a very good quality on the sandy soils of the formation. In several of the areas where this formation occurs (notably in the Castleman valley), there are large groves of maple trees that net a handsome profit each year from the sale of maple sugar. The timber growth is much the same as in other sections of the county, several varieties of oaks, chestnut, ash, maple, and hickory are the trees more commonly found. The texture of typical samples of this soil are given below.

MECHANICAL ANALYSES OF SOILS DERIVED FROM THE CONEMAUGH FORMATION.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3730	Buffalo Run, 1 mi. N. W.	Yellow loam, 0-7″	4.82	3.98	1.96	1.28	8.46	6.26	59.96	13.24
3578	Barnum Sta, 1½ mi. S.W.	Clayey subsoil, 8-18″.....	4.92	5.38	2.90	1.80	5.92	3.68	55.22	18.96
3731	Buffalo Run, 1 mi. N.W.	Sandy loam, 7-24″ Subsoil of 3730............	5.60	2.36	1.76	1.32	6.94	8.48	53.16	20.36
3584	Grantsville, 1 mi. N. ..	Yellow clay loam, 8-27″..	5.74	1.90	1.90	1.30	5.86	8.10	43.38	31.60

THE MONONGAHELA SOILS.

This formation is limited in its occurrence to the eastern part of the county and is of minor importance from an agricultural standpoint. The rocks from which the soils are derived consist of fine-grained and sandy shales, thin-bedded sandstones, coal seams, and beds of limestone. The soils vary in texture and range from shallow sandy loams possessing little value to heavier loams and clays that make good yields of the crops commonly grown in this region. The small areas of this formation are mostly cleared, and near the mining towns in Georges Creek valley, potatoes, rye, oats, and grass are extensively grown. Where the soils are sandy potatoes are successfully grown if they are heavily manured. Where the heavier loams are found clover and timothy hay are the principal crops.

THE DUNKARD SOILS.

As this formation is limited in its occurrence in Garrett county the soils need only be briefly considered. The soils derived from the shales and sandy shales and limestones of this formation consist of shallow, yellow loams, sandy and stony on the steeper hill slopes. They closely resemble the soils derived from some of the areas of the Conemaugh formation where it occurs capping hills. Oats, rye, corn, and buckwheat are the crops grown on the small areas of this formation.

THE QUATERNARY SOILS.

The Quaternary includes in Garrett county the Glades, or upland swamps, the terraces confined to some of the valleys, and the narrow strips of bottom land along the rivers and principal streams. Of these the soils of the Glades are by far the most important and will be considered first. The Glades, or open, grassy pastures, have long been known as one of the prominent physiographic features of western Maryland. For many years they have been famous natural pasture land and mention has already been made of the fact that nearly fifty years ago thousands of cattle were annually fattened in the large tracts of Glades occurring in the central portion of the county. The largest areas of Glades are found within the limits of the Jennings formation in the central part of the county to the northwest of Swanton along Green Glade and North Glade runs. Other Glades are found in the southwestern and southeastern parts of the county, where they are frequently underlain by the Carboniferous formations.

In their natural condition the Glades were open pastures surrounded by rolling country thickly forested. The Glades were covered with a rank undergrowth of tall coarse grass, thickets of alderbush, and thick growth of underbrush. In wet seasons, the Glades are often covered with standing water and frequently cattle and other stock grazing on them have lost their lives by becoming mired in the more swampy places. Except for use as pasture lands the Glades are of little use for farming purposes unless thoroughly drained. In many areas they have been drained and the soils are now producing good yields of the crops that are especially adapted to them. Open ditches have been cut through them and tile, box and stone drains have been used so that the soils are as dry as soils situated in more sloping or rolling regions. For the first few years after draining the soils produce a rank growth of whatever crops are planted on them, but by proper cultivation and liberal applications of burned lime the acidity and tendency to rank growth are gradually overcome. In their reclaimed condition these soils rank among the most productive found in the county.

The surface soil is usually a rich, dark, mucky soil consisting of a large proportion of decomposed organic matter mixed with sand or clay. Frequently the soils have a depth of 2 feet but the average depth of soil is about 12 inches. Underlying this black soil is found a yellowish clay loam that in a natural condition is always saturated with water. The subsoil usually has a depth of several feet and the clay content increases generally in the lower depths. These soils represent the decomposition products of nearby rock formations that have been transported short distances and have become thoroughly mixed with decaying vegetable matter. Where the rocks underlying the Glades are coarse-grained sandstones the soils contain a large proportion of sand and likewise where shales occur the soils are usually heavy wet clay loams.

After the Glades have been thoroughly drained, timothy hay has been found to be a paying crop, and yields as high as 3 tons per acre are reported. Oats make large yields, and from 50 to 60 bushels per acre are said to have been harvested in good years. On dry Glade land potatoes make good yields. It is said that the winter freezes out wheat, and the growth of straw is rank, so that these are not considered good wheat lands. Yields of 20 bushels per acre are reported, however. The early frosts in autumn usually damage the corn crop which does not succeed as well as on higher, drier ground.

To the east of Oakland considerable market-gardening is carried on with good results; cabbage, especially, being one of the successful crops. In some areas of the glades no attempt is made at cultivation, and year after year the coarse grass is harvested with little effort to increase the productiveness of these fertile soils. The texture of Glade soils is shown in the following table:

MECHANICAL ANALYSES OF SOILS DERIVED FROM THE GLADES.

No.	Locality.	Description.	Organic matter.	Gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0001 mm.
			%	%	%	%	%	%	%	%
3514	Oakland, 1 mi. E..	Black loam, -8''....	13.61	0.00	0.74	0.78	13.33	32.29	25.26	15.86
3518	Sunnyside	Clayey subsoil, 8-36''	7.38	0.67	0.64	1.05	6.68	23.61	33.38	26.94

The soils of the terraces consist of sandy and gravelly loams that are adapted to crops which require light soils such as truck and small fruits. Rye, oats, and buckwheat are the principal crops on such soils. The principal areas are in the Castleman and Youghiogheny valleys.

The river bottoms are not important in Garrett county. The streams are swift and are depositing coarse beds of sand, gravel and boulders rather than building up flood-plains of fine sand and silt. The valleys are narrow and only on the larger rivers are found bottom lands of sufficient size to be farmed to any extent. The principal areas of river bottom soils are situated along the Youghiogheny river.

THE CLIMATE OF GARRETT COUNTY

BY

OLIVER L. FASSIG

Introductory.

The available records of the weather in Garrett county are all of comparatively recent date. The present sketch of the climate of the county is based entirely upon the records of Mr. J. G. Knauer at Sunnyside from January, 1893, of Mr. J. S. Miller at Grantsville from August, 1894, and of Mr. S. P. Specht at Deer Park from October, 1894. All of these records are still being maintained daily by the voluntary observers named, who report to the office of the United States Weather Bureau at Baltimore. The stations were established by the Maryland State Weather Service and have since been maintained under the joint auspices of the latter service and the United States Department of Agriculture. Observations were made at earlier periods at Deer Park and Oakland by observers reporting to the Smithsonian Institution, but only for a few months at a time. In the early part of 1858 Mr. L. R. Capran kept a record of the weather at Oakland, while Mr. George W. Harrison and Mr. L. H. Schoolfield did the same at Deer Park in 1880 and 1881. From January, 1893, to March, 1896, observations were made at Oakland under the auspices of the U. S. Weather Bureau and the Maryland State Weather Service by Dr. J. Lee McComas. Details respecting equipment and location of stations are contained in the statements on pages 272, 273.

The meteorological elements daily observed at the active stations are temperature of the air, rainfall and snowfall, wind direction, the amount of cloudiness, and special phenomena such as thunderstorms, hail storms, frosts, optical phenomena, etc.

All of the stations named have an elevation above sea-level of over 2400 feet, or somewhat above the average elevation of the county; and the records of their climatic conditions represent fairly the atmospheric history of Garrett county. Though the periods of observation are not long compared with many other points within the state of Maryland, the nine years from 1893 to 1901 comprised within their limits some of the greatest extremes of atmospheric conditions experienced in the state in over three-quarters of a century.

The topography of the county is described in full in earlier chapters of this volume and calls for only a brief reference here. Practically the entire county, with the exception of the Potomac and Youghiogheny valleys, is above 2000 feet, with an average elevation between 2300 and 2400 feet. This elevated plateau is crossed from northeast to southwest by numerous ridges and knolls, rising to elevations of 2800 to 3400 feet. Two of the stations of observation, namely, Deer Park and Sunnyside, are in the southern portion of the county between Great Backbone Mountain on the east and Hoop Pole Ridge on the west, while Grantsville is in the more open northern area near the Pennsylvania line.

So far as practicable the results of observations have been reduced to tabular and graphic form and published in the following pages. To these tables and diagrams the reader is referred for details. In the text special reference is made to the more conspicuous features of the climatic history of the county and to comparisons with conditions in other parts of the state.

Temperature.

In consequence of its greater elevation above sea-level, Garrett county has a mean annual temperature considerably below that of any other county in Maryland. The generally accepted law of decrease of temperature with elevation, namely, one degree Fahrenheit for every 300 feet, is found to agree very closely with local observations. For instance, the average elevation of the three stations in Garrett county upon which these calculations are based, Deer Park, Grantsville, and Sunnyside, is slightly above 2400 feet, while their average annual temperature is 47°. At Baltimore, with approximately the same latitude, and at sea-level, the mean annual temperature is 55°, showing a difference of about 8° for a difference in elevation of 2400 feet, or 1° for every 300 feet.

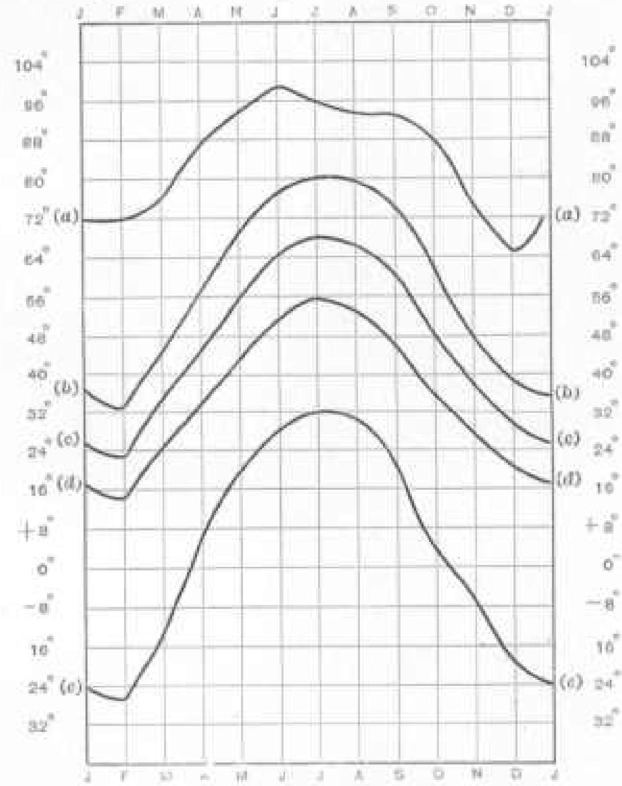


Fig. 3. Temperature Variations in Garrett County.

(*a*) Absolute monthly maximum.
(*b*) Average daily maximum.
(*c*) Mean daily temperature.
(*d*) Average daily minimum.
(*e*) Absolute monthly minimum.

The monthly average temperature varies from 68° in July to 24° in February. During the past nine years the February temperatures have averaged fully two degrees below those of January, a somewhat unusual relation for so long a period; for while the coldest weather occurs in the early days of February, the month as a whole

TABLE I.

MEAN MONTHLY AND ANNUAL TEMPERATURES IN GARRETT COUNTY.

DEER PARK.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1894	...	....	....	....	....	....	....	....	....	48.8	33.4	29.8	....
1895	21.4	16.7	33.0	45.0	55.2	66.1	62.3	66.0	64.2	41.2	37.8	29.6	44.9
1896	27.4	27.2	28.6	48.4	61.3	63.0	67.6	65.6	59.5	44.8	43.1	30.1	47.2
1897	24.0*	28.6*	39.8*	45.6*	53.0*	62.2	67.6	62.7	57.6	49.6	38.0	31.7	46.6
1898	30.4	26.8	42.3	40.8	57.8	63.9	69.6	67.0	60.6	50.2	37.5	26.7	47.8
1899	27.0	21.3	37.9	46.2	57.3	64.9	66.8	66.6	58.6	50.8	39.7	27.8	47.1
1900	27.8	24.4	32.4	46.2	55.4	64.6	67.6	69.7	65.0	53.2	39.6	28.3	47.8
1901	27.7	19.8	36.4	41.8	55.2	64.4	71.6	67.4	58.2	48.9	31.8	26.5	45.8
Highest means...	30.4	28.0	42.3	48.4	61.3	66.1	71.0	69.7	65.0	53.2	43.1	31.7	47.8
Average for 7 yrs..	26.5	23.5	35.8	44.9	56.5	64.1	67.4	66.4	60.5	48.4	37.7	28.8	46.7
Lowest means......	21.4	16.7	28.6	40.8	53.0	62.2	62.3	62.7	57.6	41.2	31.8	26.5	44.9
GRANTSVILLE.													
1894	....	...	....	....	....	...	....	66.4	64.6	51.4	37.0	33.0	....
1895	22.8	18.2	33.8	46.2	55.8	66.5	64.0	67.4	65.2	44.3	41.6	31.8	46.4
1896	26.6	27.4	29.4	51.5	62.6	63.4	68.0	67.4	60.9	46.6	43.8	30.2	48.0
1897	22.7	29.6	40.5	45.7	53.3	63.8	72.4	65.4	62.6	53.7	38.6	32.2	48.4
1898	30.8	27.9	42.3	42.0	59.4	65.5	69.8	69.6	62.6	50.6	36.8	26.8	48.6
1899	26.8	22.2	34.9	47.4	58.9	66.2	68.3	68.1	58.6	53.2	41.2	28.5	48.0
1900	28.0	24.1	31.6	45.4	57.2	65.4	69.6	71.4	66.3	55.6	46.9	29.9	48.8
1901	29.4	20.8	36.4	43.3	56.1	65.4	73.6	68.4	66.0	51.6	32.8	28.0	46.8
Highest means.....	30.8	29.0	42.3	51.5	62.0	66.5	73.6	71.4	66.3	53.7	43.8	33.6	48.8
Average for 7 yrs..	26.5	24.2	35.5	45.9	57.5	65.2	69.3	67.9	62.5	56.8	39.6	30.0	47.9
Lowest means......	22.7	18.2	29.4	42.6	53.3	63.4	64.0	65.4	58.6	44.3	32.8	26.8	46.4
SUNNYSIDE.													
1893	13.5	24.4	34.0	46.2	53.2	65.0	68.9	64.4	60.6	49.0	34.1	30.8	45.3
1894	31.4	27.6	39.4	43.5	57.2	64.2	66.4	64.8	62.2	48.5	33.6	30.3	47.4
1895	22.4	15.0	31.4	47.0	54.0	66.4	63.4	66.7	63.5	43.8	39.6	31.2	45.4
1896	25.1	26.5	26.4	50.4	61.5	64.6	68.6	66.6	59.3	44.6	42.6	28.9	46.9
1897	22.8	29.4	40.6	45.4	51.3	62.1	68.8	63.6	60.4	51.9	39.0	30.5	47.2
1898	31.6	26.2	43.8	46.6	57.8	64.4	69.0	66.5	60.9	48.6	35.7	26.5	47.5
1899	26.4	21.2	36.3	36.3	55.9*	65.4*	67.1	67.3	58.8	51.0	39.5	26.0	46.6
1900	27.2	22.9	36.6	44.4	56.3	64.7	68.0	71.6	65.6	55.8	40.4	27.2	47.9
1901	26.3	18.6	36.2	40.4	54.9	64.3	71.4	66.6	58.0	50.4	30.5	26.4	45.3
Highest means.....	31.4	29.4	43.8	50.4	61.5	66.4	71.4	71.6	65.6	55.8	42.0	31.2	47.9
Average for 9 yrs..	25.1	23.5	35.4	43.8	55.8	64.5	67.9	66.3	61.6	49.2	37.2	28.6	46.5
Lowest means.....	13.5	15.0	26.4	36.3	51.3	62.1	63.4	63.6	58.0	43.8	30.5	26.4	45.3

* Interpolated values.

usually averages higher than that of January. The difference between the summer and winter temperatures becomes more marked when we contrast an abnormally warm summer month like that of July, 1901 (73° at Grantsville) with that of a cold winter month,

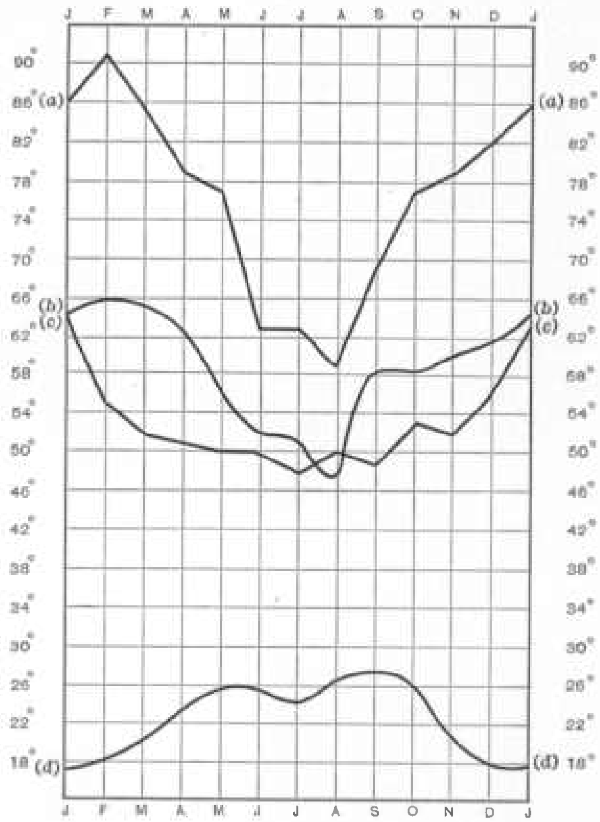


Fig. 4. Temperature Ranges in Garrett County.
(*a*) Greatest monthly range.
(*b*) Average monthly range.
(*c*) Greatest daily range.
(*d*) Average daily range.

for instance, the month of January, 1893 (13.5° at Sunnyside) a difference in monthly mean temperatures of nearly 60°. While such figures mark the climate as one of great changes from month to month, the full extent of temperature variability is not shown until comparisons are made between absolute extremes occurring within

TABLE II.

Highest Recorded Temperatures in Garrett County.

Deer Park,	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1894	..	..	..	..	..	..	..	..	..	75	65	50	..
1895	50	48	67	80	93	99	89	90	90	69	70	65	99
1896	50	57	60	84	85	85	86	91	87	73	69	57	91
1897	..	..	..	..	..	84	91	88	87	80	66	59	91
1898	61	61	75	73	83	88	94	89	90	77	66	58	94
1899	59	56	70	81	82	90	90	90	88	80	63	58	90
1900	55	72	56	77	88	87	90	89	89	82	72	55	90
1901	53	47	69	81	84	89	94	87	83	77	66	64	94
Average for 7 yrs..	54.7	56.8	66.1	79.3	85.8	89.0	90.6	89.1	87.7	76.6	67.1	58.2	93.1
Absolute maximum.	61	72	75	84	93	99	94	91	90	82	72	65	99
Grantsville.													
1894	..	..	..	..	..	..	..	85	86	78	67	61	..
1895	53	48	67	76	89	90	88	85	90	70	72	62	90
1896	50	58	62	87	86	86	87	91	90	75	72	60	91
1897	56	57	71	79	78	86	94	93	92	85	67	62	94
1898	72	67	76	74	83	88	94	89	91	78	68	60	94
1899	61	58	68	85	88	89	92	90	86	80	63	59	92
1900	57	69	57	76	88	88	92	91	91	85	71	57	92
1901	53	46	68	79	82	89	93	89	84	77	64	64	93
Average for 7 yrs..	57.4	57.6	65.6	79.4	84.9	88.0	91.4	89.1	88.8	78.5	68.0	60.6	91.6
Absolute maximum.	72	69	76	87	89	90	94	93	92	85	72	64	94
Sunnyside.													
1893	..	..	70	81	79	91	90	90	82	81	66	56	91
1894	56	56	74	78	84	87	92	87	88	79	68	65	92
1895	56	49	69	79	90	92	90	90	91	70	73	65	92
1896	50	57	64	87	84	85	91	90	86	75	70	59	91
1897	60	59	69	78	76	87	93	87	89	82	69	60	93
1898	61	64	75	73	83	87	93	88	88	77	68	59	93
1899	56	56	68	68	89	..	89	89	90	81	69	56	90
1900	55	52	56	75	87	89	91	93	93	87	75	58	93
1901	54	45	76	80	82	90	96	90	84	78	69	65	96
Average for 9 yrs..	56.0	54 8	69.0	77.7	83.8	88.5	91.7	89.3	87.9	78.9	69.7	60.3	92.3
Absolute maximum.	61	64	76	87	90	92	96	93	93	87	75	65	96

TABLE III.

Lowest Recorded Temperatures in Garrett County.

Deer Park.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1894	..	..	..	..	..	..	..	..	..	25	2	−10	..
1895	−15	−18	− 7	20	20	37	32	31	27	4	0	− 7	−18
1896	−13	−13	−13	12	33	32	40	34	29	16	13	2	−13
1897	−12	3	12	17	27	30	41	39	22	21	5	− 4	−12
1898	− 2	− 6	7	6	25	35	32	46	29	18	− 6	−20	−20
1899	−23	−25	3	14	31	36	37	41	28	15	13	− 3	−25
1900	− 8	−15	− 2	19	20	39	35	41	29	20	4	0	−15
1901	− 4	− 6	− 6	15	25	32	46	44	29	16	9	−13	− 6
Average for 7 yrs..	−11.0	−11.4	−0.9	14.7	25.9	34.4	37.6	39.4	27.6	16.9	5.0	−6.9	−15.6
Absolute minimum.	−23	−25	−13	6	20	30	32	31	22	4	−6	−20	−25
Grantsville.													
1894	..	..	..	..	..	..	..	42	31	28	−15	− 7	..
1895	−14	−12	9	22	27	41	41	40	34	17	14	− 2	−14
1896	− 8	− 7	−1	17	38	37	44	38	33	22	18	3	− 8
1897	− 9	3	14	18	30	29	49	43	29	26	8	1	− 9
1898	1	− 5	10	12	29	40	37	47	34	19	9	− 4	− 5
1899	−10	−22	5	18	31	39	41	41	31	21	17	− 3	−22
1900	− 5	−10	−2	19	25	41	39	45	33	26	11	8	−10
1901	2	2	−5	25	33	35	48	48	32	25	14	− 8	− 8
Average for 7 yrs..	−6.1	−7.3	4.3	18.7	30.4	37.4	42.7	43.0	32.1	23.0	13.2	−2.1	−10.4
Absolute minimum.	−14	−22	−5	12	25	29	37	38	29	17	8	− 8	−22
Sunnyside.													
1893	−12	−10	6	..	33	40	43	49	28	13	0	6	−12
1894	3	− 3	2	9	28	32	34	39	29	24	6	−10	−10
1895	−17	−15	2	18	20	39	39	37	29	10	11	− 2	−17
1896	− 6	−12	−2	14	35	33	40	36	28	19	12	− 2	−12
1897	−11	4	15	15	28	29	46	39	24	20	9	0	−11
1898	3	− 9	9	8	25	36	33	48	29	17	−4	−17	−17
1899	−24	−26	1	14	34	..	39	43	25	17	12	− 6	−26
1900	− 8	−15	− 4	16	23	36	38	42	30	21	5	− 2	−15
1901	− 3	− 5	− 9	17	28	33	40	42	29	17	4	−15	−15
Average for 9 yrs..	−8.4	−10.1	2.2	13.9	28.2	39.7	39.1	41.7	27.9	17.6	6.1	−5.3	−15.0
Absolute minimum.	−24	−26	− 9	8	20	29	33	36	24	10	− 4	−17	−26

a given month or a year, rather than between average monthly values. On the 8th of February, 1900, the temperature rose to 72° at Deer Park; on the 20th of the same month a minimum temperature was recorded of 14° below zero, a range of 86° within 12 days. The highest temperature recorded in Garrett county since 1893 was 99° at Deer Park on June 4, 1895; the lowest temperature, 26° below zero, occurred at Sunnyside on the 10th of February, 1899, making an annual range of 125° for the county.

The average difference between the maximum and minimum temperatures of the day is 23°; this difference varies with the season of the year, being the greatest in the month of September (27.5°) and least in January (17.7°). The daily fluctuations may, however, greatly exceed these values. Differences of 40° or more between the afternoon and early morning temperatures are of frequent occurrence. The greatest fluctuations within a twenty-four hour period occur in the winter months in connection with the passage of cold waves. The following figures represent the greatest daily ranges of temperature recorded in Garrett county since 1893, during each month of the year:

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
64	55	52	51	50	50	48	50	49	53	52	56

While the *average* daily range increases steadily from the winter months to the summer months, following the increasing power and duration of solar radiation, the non-periodic changes accompanying the passage of cold waves, together with the intense nocturnal radiation, cause the *extreme* daily ranges to be greatest in midwinter.

THE FREQUENCY OF FROST DAYS.

In the frequency of cold days, and in the degree of cold experienced, Garrett county differs materially from all other counties of the state. This difference is easily accounted for by the greater elevation resulting in greater intensity of radiation from the ground during the night hours. The lowest temperatures recorded within the limits of the state have usually occurred at the station Sunnyside, about six miles to the southwest of Oakland. Here a minimum of

26° below zero occurred in the early morning of February 10, 1899, a period of cold never equaled in the annals of Maryland weather.

The lowest temperatures of the year are most likely to occur in the month of February. The average of the lowest recorded temperatures of February is 10° below zero, while the January average is 8° below. Freezing weather has occurred at one time or another in every month of the year. The average number of days per year in which a minimum of 32° or less has been recorded since 1893 is 160. The frequency has varied from a minimum of 140, as at Grantsville in 1897, to a maximum of 187, as at Deer Park in 1895. The annual frequency of days with a freezing temperature is shown in the following table:

THE FREQUENCY OF FROST DAYS PER YEAR.

		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Deer Park..	Greatest number.	31	28	28	19	10	1	1	1	6	23	29	30	187
	Least number....	26	26	15	12	0	0	0	0	1	10	17	24	152
Grantsville..	Greatest number.	31	28	28	15	5	1	0	0	3	17	29	29	156
	Least number.	24	24	17	10	0	0	0	0	0	5	14	22	142
Sunnyside..	Greatest number.	31	28	28	22	9	1	0	0	4	19	29	30	184
	Least number.	24	23	18	11	0	0	0	0	1	5	15	24	152

THE COLD WAVE OF FEBRUARY, 1899.

The storm generally referred to as the "Blizzard" of February, 1899, was the occasion of the severest weather ever experienced in Maryland. Records for extremely low temperatures, as well as for heavy snowfall, were broken throughout the Middle Atlantic states. In Fig. 5 on page 262, the fluctuations of the minimum thermometer from day to day from February 1 to 21 at Sunnyside are graphically represented in comparison with simultaneous changes at Baltimore. The changes in temperature at the two points were in the main similar in direction and occurred within the same twenty-four hour period; differences are shown in absolute values, which were very marked and were doubtless due to the more intense nocturnal radiation at the high level station of Sunnyside. Fig. 6 on page 263 represents the average movement of the minimum thermometer at Baltimore (a) compared with that at Sunnyside (b) during the passage of ten "cold waves" from 1895 to 1901.

THE FREQUENCY OF HOT DAYS.

The frequency of days with a maximum afternoon temperature of 90° or above is far less in Garrett county than in any other county of the state. The intense solar radiation of a summer day results in

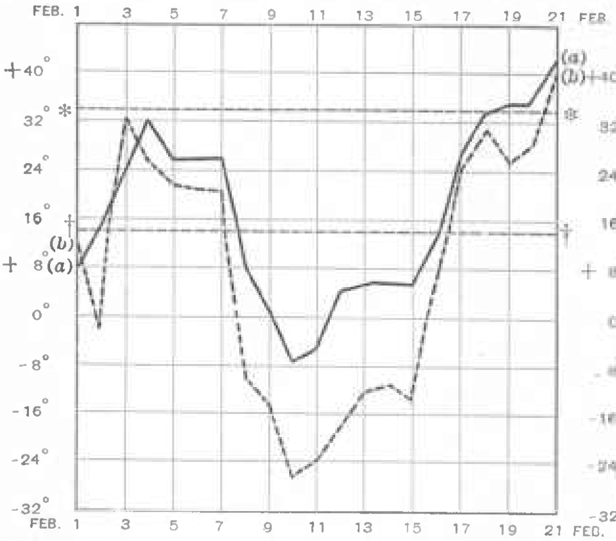


Fig. 5. Movement of the minimum thermometer during the great "Blizzard" of February, 1899, at Baltimore (*a*) and at Sunnyside (*b*).

* Average minimum at Baltimore.

† Average minimum at Sunnyside.

shade temperatures at the low level stations far in excess of those registered at the higher stations. The month of August, 1900, affords a striking illustration of the freedom from excessive summer afternoon temperatures enjoyed in Garrett county. This was the month which witnessed so much suffering from heat throughout the central and eastern sections of the country. At Baltimore the temperatures from the 6th to the 12th of August were far in excess of anything experienced during a period of 85 years. In Figure 7 on page 264 a comparison is made between temperature conditions at Deer

Park and Baltimore during the period referred to. While the maximum afternoon temperatures at Baltimore were 15° above the normal for the period, registering from 99° to 100° for six successive days, the highest afternoon temperatures at Deer Park during the same days ranged from 87° to 89°, not greatly exceeding their average values. Temperatures similar to those at Baltimore were recorded at Cumberland, not more than 30 miles northeast of Deer Park, but at an elevation of only 750 feet. Consulting Figure 7, page 264, in which (a) and (b) represent graphically the daily afternoon

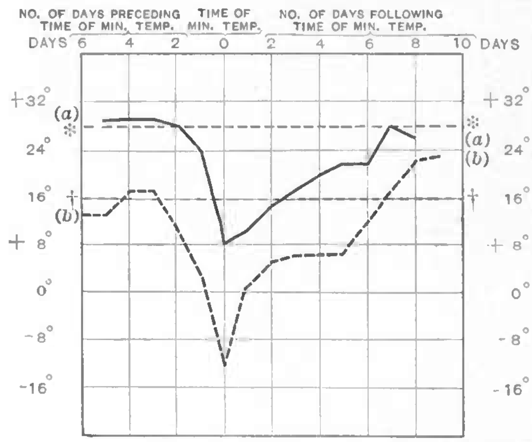


Fig. 6. Average movement of the minimum thermometer during the passage of ten cold waves from 1895 to 1901, at Baltimore (*a*) and Sunnyside (*b*).

* Average minimum temperature at Baltimore.

† Average minimum temperature at Sunnyside.

maximum temperatures at Baltimore and Deer Park during the month of August, 1900, we notice a similarity in changes from day to day, but a difference of 8° to 13° in absolute values.

The path of the curve representing the night temperatures at Deer Park during this period is remarkable (see curve (d), Figure 7). While the curves of maximum and minimum temperatures at Baltimore and the maximum at Deer Park show similar changes from day to day, the minimum temperatures at Deer Park are quite out of agreement, showing a steady rise in the night temperatures, which did not reach their highest point until the hot wave had entirely passed and a brief " cool spell " had set in.

As Garrett county was in the center of an area of excessively high temperatures during this period, embracing nearly all of the country east of the Rocky Mountains, the small excess of temperatures above the normal in the county at this time would seem to indicate that the "hot wave" of August, 1900, was confined to a comparatively

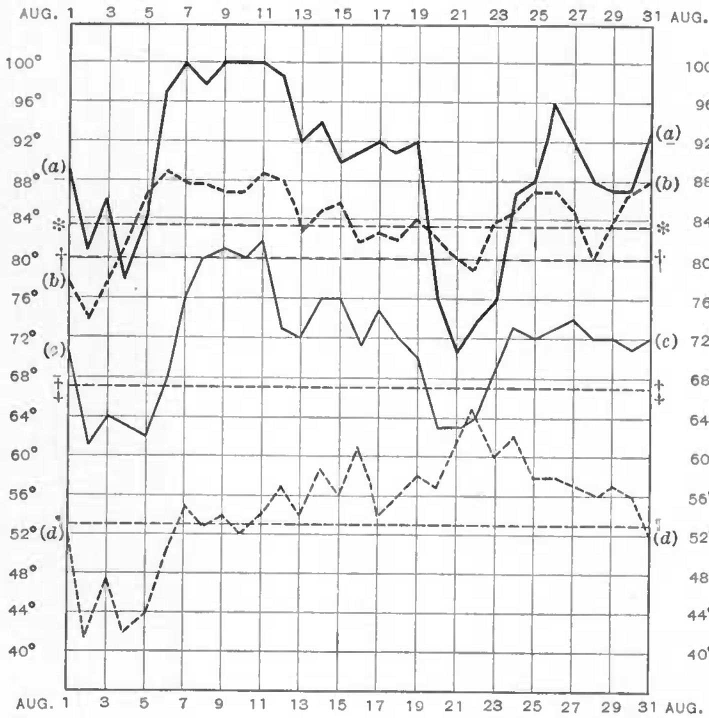


Fig. 7. Daily maximum and minimum temperatures at Baltimore and Deer Park, during the hot weather of August, 1900.

(*a*) Daily maximum temperature at Baltimore.
(*b*) " " " " Deer Park.
(*c*) " minimum " " Baltimore.
(*d*) " " " " Deer Park.
* Average maximum " " Baltimore.
† " " " " Deer Park.
‡ " minimum " " Baltimore.
¶ " " " " Deer Park.

thin stratum of air near the surface of the earth. Another illustration of the comparative freedom from hot days in the county is afforded by the curves in Figure 8, on page 265, which represent the paths of the maximum and minimum thermometers at Baltimore and Deer Park during the more intense but briefer hot wave of June 26 to July 7, 1901. While the departures from the normal tempera-

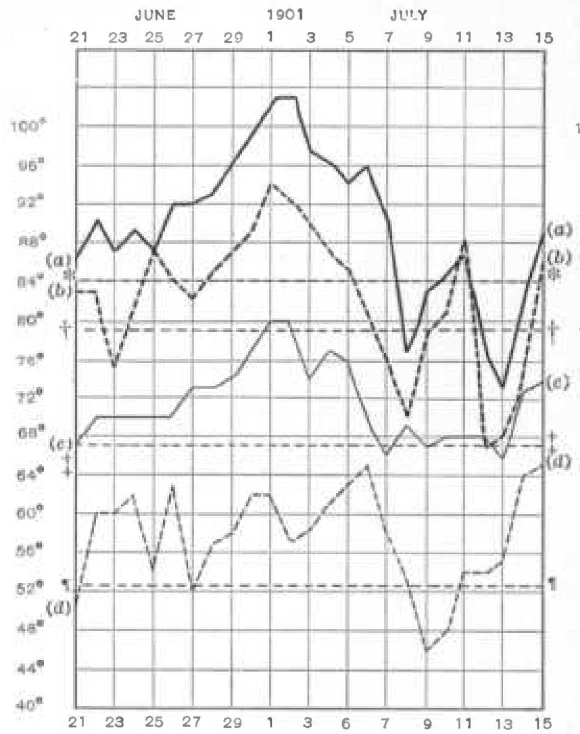


Fig. 8. Daily maximum and minimum temperatures at Baltimore and Deer Park during the hot weather of June 26–July 7, 1901.

(*a*) Daily maximum temperature at Baltimore.
(*b*) " " " " Deer Park.
(*c*) " minimum " " Baltimore.
(*d*) " " " " Deer Park.
* Average maximum " " Baltimore.
† " " " " Deer Park.
‡ " minimum " " Baltimore.
¶ " " " " Deer Park.

tures at Deer Park were quite pronounced, the absolute degrees of heat were from 8° to 10° less than at Baltimore.

As stated above, days with an afternoon temperature of 90° and above are of comparatively infrequent occurrence in Garrett county. Since 1893 there have been, on an average, five such days in each year. The maximum frequency occurred in 1897 and 1901, when there were eleven; the minimum in 1894, 1895, and 1896, when there were but two per year. Compared with the frequency of such days in other parts of the state, these figures are small. The geographic position and topographic character of Baltimore give it a climate which is fairly representative of the greater part of the state of Maryland. Placing in parallel columns the figures representing the frequency of days with a temperature of 90° and above at Baltimore and Deer Park the contrast becomes strikingly apparent:

FREQUENCY OF HOT DAYS AT BALTIMORE, DEER PARK AND GRANTSVILLE.
(Days with a temperature of 90° or above.)

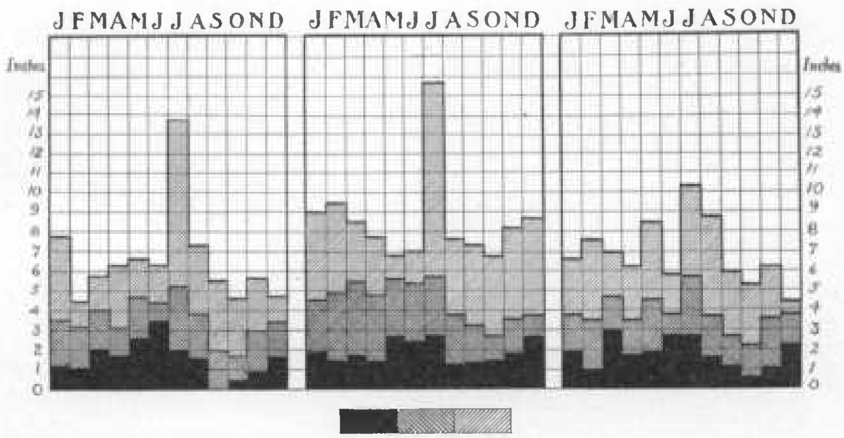
	Baltimore.	Deer Park.	Grantsville.
Greatest number of days in any year..	43 in 1900	9 in 1895	11 in 1897
Least number of days in any year....	8 in 1871	2 in 1896	2 in 1895 and 1899
Average number of days per year....	20	4	6

PRECIPITATION.

Precipitation in Garrett county is at all seasons of the year abundant. It is far in excess of that of any other county in Maryland and nearly double that of the valley portions of Washington county. There is considerable variation even within the narrow limits of the county. Thus at Deer Park it has averaged, during the past seven years, 41 inches a year; at Grantsville, about twenty miles farther north, 44 inches; while at Sunnyside the average for nine years is slightly above 54 inches. The average monthly precipitation for the county is least in the month of October (2.26 inches), and greatest in July (5.53 inches). The great difference between the precipitation at Deer Park and Sunnyside is rather remarkable. The two stations are only about eight miles removed from one another, their elevations are practically the same, while their topographic conditions are very much alike. They are both in the broad valley between the Great Backbone Mountain on the east, with elevations of 2800 to 3400 feet, and Hoop Pole Ridge on the west with elevations of 2600 to 2800 feet.

In the total amount of rainfall and the number of rainy days, Sunnyside always leads other stations in Garrett county:

	Sunnyside.	Grantsville.	Deer Park.
Average annual precipitation	54.41	43.88	41.17
Greatest annual rainfall	65.77	55.52	53.12
Greatest monthly rainfall	15.27	10.17	13.65
Greatest annual number of days with precipitation	183	132	109
Average annual number of days with precipitation	165	114	88
Least annual number of days with precipitation	144	95	59
Greatest amount in 24 hours	3.20	4.20	4.10



Least. Average. Greatest.

Deer Park. Sunnyside. Grantsville.

Fig. 9. Greatest, average and least precipitation for each month in the year at Deer Park, Sunnyside and Grantsville.

The monthly amount of precipitation for the county rarely falls below one inch. At times less than one inch has been recorded at one or two stations, but never, since 1893, at the three stations. Deer Park reports a record of no rainfall during the month of September, 1895, but 1.53 inch fell at Grantsville, and 0.47 inch at Sunnyside. The lightest rains have always occurred in September or October. The excessive rains have usually occurred during the summer months in connection with thunder-storms; in July, 1898, the observer at Grantsville reported a fall of four inches within two

TABLE IV.

MONTHLY AND ANNUAL RAINFALL IN GARRETT COUNTY.

DEER PARK.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
1894	....	....	....	...	....	....	....	....	....	2.31	1.13	3.36	....
1895	1.09	0.90	3.25	3.20	2.85	4.01	3.55	1.31	0.0	0.99	0.94	1.50	23.59
1890	0.90	3.57	4.63	2.04	5.65	4.23	13.65	1.37	5.32	1.37	3.33	2.55	48.61
1897	2.80	4.20	3.48	2.77	3.73	3.49	5.13	5.23	1.67	1.37	5.84	4.93	44.64
1898	7.69	3.21	5.69	4.25	5.76	3.36	3.76	7.01	1.87	4.47	2.06	3.99	53.12
1899	2.33	4.40	5.71	1.65	6.44	6.24	2.03	2.06	3.05	0.39	0.89	2.73	37.82
1900	1.97	3.29	3.15	1.41	2.63	4.62	4.49	3.65	0.40	2.26	5.68	2.66	36.21
1901	0.22	1.80	2.03	6.04	5.40	3.88	3.33	4.74	1.70	0.87	3.75	4.39	44.21
Greatest Amount..	7.69	4.40	5.71	6.04	6.44	6.24	13.65	7.01	5.32	4.47	5.84	4.93	53.12
Average for 7 yrs..	3.29	3.05	3.99	3.05	4.64	4.26	5.13	3.62	2.01	1.74	2.95	3.26	3.44
Least Amount.....	0.90	0.90	2.03	1.41	2.63	3.36	2.03	1.31	0.0	0.39	0.89	1.50	23.59
GRANTSVILLE.													
1894	....	....	....	....	....	...	....	1.62	2.87	2.95	2.32	3.86	...
1895	5.42	1.45	3.10	4.18	2.28	4.07	4.68	2.27	1.53	1.22	1.00	2.90	34.10
1896	1.81	4.77	5.12	2.98	4.07	5.88	10.17	1.90	5.85	2.61	3.37	2.22	50.75
1897	3.97	7.53	3.52	2.99	3.86	2.72	6.16	2.04	2.27	0.55	6.20	4.11	45.92
1898	6.53	2.06	6.98	3.42	3.94	3.07	7.77	8.93	1.51	5.34	3.24	2.73	55.52
1899	1.93	3.27	5.24	2.21	6.73	3.67	3.15	2.57	3.77	2.37	2.13	2.85	39.89
1900	1.86	3.88	4.14	1.05	1.07	4.09	5.61	2.50	0.87	1.92	5.89	2.52	36.00
1901	2.52	0.80	4.99	6.08	8.32	2.79	2.63	4.34	2.24	0.76	2.56	6.87	44.90
Greatest Amount..	6.53	7.53	6.98	6.08	8.32	5.88	10.17	8.93	5.85	5.34	6.20	6.87	55.52
Average for 7 yrs..	3.43	3.39	4.73	3.27	4.41	3.76	5.74	3.27	2.61	2.21	3.34	3.52	43.88
Least Amount.....	1.81	0.80	3.10	1.05	1.67	2.72	2.63	1.62	0.87	0.55	1.00	2.22	34.16
SUNNYSIDE.													
1893	3.50	5.42	1.24	1.10	6.58	3.95	2.61	3.68	1.40	5.02	2.97	2.65	40.12
1894	2.84	6.15	2.51	5.38	3.78	3.77	3.91	1.01	3.00	2.82	3.34	5.26	43.77
1895	5.48	1.16	6.20	4.69	2.50	5.97	4.21	1.29	0.47	1.61	1.68	2.66	37.92
1896	1.73	5.45	6.80	2.53	5 92	5.88	15.27	2.90	7.21	3.25	5.29	2.71	64.94
1897	3.07	9.17	4.69	5.06	5.83	6.47	5.51	5.10	3.37	1.06	8.14	6.38	63.85
1898	8.95	2.65	8.34	5.65	6.74	2.33	5.56	7.66	2.92	0.39	4.27	4.31	65.77
1899	6.59	6.36	7.42	7.42	6.82	6.95*	3.58	2.47	3.76	1.12	2.98	4.63	60.10
1900	3.31	5.28	5.05	1.75	3.11	6.81	5.31	5.04	2.71	3.24	6.52	4.06	52.19
1901	5.14	2.39	4.93	7.70	6.94	5.72	5.42	5.17	2.85	0.98	5.20	8.57	61.01
Greatest Amount..	8.95	9.17	8.34	7.70	6.94	6.95	15.27	7.66	7.21	6.39	8.14	8.57	65.77
Average for 9 yrs..	4.40	4.89	5.24	4.59	5.36	5.32	5.71	3.81	3.08	2.83	4.49	4.58	54.41
Least Amount.....	1.73	1.16	1.24	1.10	2.50	2.33	2.61	1.01	0.47	0.98	1.68	2.65	37.92

*Interpolated value.

hours accompanying a severe storm of this character. At each of the three stations the largest amount recorded in any month fell in the month of July, 1896; at Grantsville 10.17 inches; at Deer Park, 13.65 inches; at Sunnyside, 15.27 inches. Figure 9, on page 267, exhibits graphically the greatest, the least, and the average amount of precipitation for each month of the year at Deer Park, Grantsville, and Sunnyside.

SNOWFALL.

As might be anticipated from the number of days with a temperature at or below freezing point, a large percentage of the annual precipitation of Garrett county is in the form of snow. Snow always falls from November to April, frequently in October and May, and occasionally in September. The monthly amounts vary from a trace to over 48.5 inches, while the annual amounts have varied from 36 inches at Deer Park in 1895 to 126.5 inches at the same station in 1901. Reducing the snowfall records we have as average, greatest, and least amounts of the entire county:

SNOWFALL IN GARRETT COUNTY.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Average amounts..	16.4	17.0	16.1	6.7	2.9	0	0	0	T	0.2	5.9	12.0	75.2
Greatest amounts..	40.0	41.8	48.5	25.0	6.0	0	0	0	T	2.0	31.0	33.0	126.5
Least amounts.....	3.0	4.0	2.0	0	0	0	0	0	0	0	0	5.0	35.9

CLOUDINESS.

The following figures indicate approximately the amount of cloudiness which prevails over Garrett county expressed in terms of the average number of clear, partly cloudy, and cloudy days per year at Grantsville and Sunnyside:

CLOUDINESS.

Number of.		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Grantsville	Clear days....................	6	4	8	12	10	8	6	11	13	16	7	8	109
	Partly cloudy days..........	6	8	6	7	10	15	18	15	10	6	18	17	116
	Cloudy days.................	19	16	17	11	11	7	7	15	7	9	15	16	140
Sunnyside.	Clear days....................	8	8	9	10	11	12	14	15	17	16	9	9	138
	Partly cloudy days	7	7	7	3	8	6	7	6	6	6	5	7	74
	Cloudy days.................	16	13	15	17	12	12	10	10	7	9	16	15	153

TABLE V.

MONTHLY AND ANNUAL SNOWFALL IN GARRETT COUNTY.

DEER PARK.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Annl
1894	..	..	..	..	..	..	..	..	..	0	0	13.0	..
1895	7.4	6.3	9.2	0	1.0	0	0	0	0	0	1.0	11.0	35.9
1896	4.0	13.0	40.0	3.0	0	0	0	0	0	T*	0	12.0	72.0
1897	20.0	4.0	3.0	0	3.0	0	0	0	0	0	2.0	6.0	38.0
1898	25.0	22.0	2.0	7.0	0	0	0	0	0	0	4.0	33.0	93.0
1899	3.0	20.0	9.0	T*	0	0	0	0	0	0	0.5	13.0	45.5
1900	4.0	17.0	27.0	3.0	0	0	0	0	0	0	5.0	6.0	62.0
1901	40.0	18.0	7.5	25.0	0	0	0	0	0	0	31.0	5.0	126.5
Greatest Amount..	40.0	22.0	40.0	25.0	3.0	0	0	0	0	T*	31.0	33.0	126.5
Average for 7 yrs...	14.8	14.3	14.0	5.4	0.6	0	0	0	0	T*	5.4	12.4	67.6
Least Amount.....	3.0	4.0	2.0	0	0	0	0	0	0	0	0	5.0	35.9
GRANTSVILLE.													
1894	..	..	..	..	..	..	..	0	0	T*	3.0	15.0	..
1895	24.5	12.0	14.0	0	1.5	0	0	0	0	0	1.0	5.0	58.0
1896	5.5	14.5	41.0	6.5	0	0	0	0	0	0.2	3.5	10.0	81.2
1897	28.5	31.0	7.0	0.2	0	0	0	0	0	0	2.0	7.0	75.7
1898	19.5	14.5	5.0	7.0	0	0	0	0	0	2.0	12.0	22.5	82.5
1899	13.0	19.0	10.0	4.0	0	0	0	0	0	0	T*	13.5	59.5
1900	4.5	10.0	30.0	2.0	0	0	0	0	0	0	7.5	7.0	61.0
1901	11.0	7.5	8.0	22.2	0	0	0	0	0	0	14.0	6.5	69.2
Greatest Amount..	28.5	31.0	41.0	22.2	1.5	0	0	0	0	2.0	14.0	22.5	82.5
Average for 7 yrs..	15.2	15.5	16.4	6.0	0.2	0	0	0	0	0.3	5.4	10.8	69.6
Least Amount.....	4.5	7.5	5.0	0	0	0	0	0	0	0	T*	5.0	58.0
SUNNYSIDE.													
1893	31.5	22.0	10.9	3.5	0	0	0	0	0	T*	1.5	8.2	77.6
1894	17.5	41.8	9.5	13.5	0	0	0	0	0	1.0	10.8	17.0	111.1
1895	27.5	11.4	22.2	5.5	5.0	0	0	0	T*	T*	2.0	7.5	81.1
1896	8.5	17.3	48.5	2.0	0	0	0	0	0	0.8	2.8	7.5	87.4
1897	19.0	28.5	7.2	0.4	6.0	0	0	0	0	0	2.5	7.0	65.6
1898	29.0	13.0	5.0	8.5	0	0	0	0	0	2.0	9.0	26.0	92.5
1899	12.2	26.5	15.0	15.0	0	0	0	0	T*	0	1.4	20.2	90.3
1900	7.5	13.0	26.8	5.2	0	0	0	0	0	0	7.8	8.0	68.3
1901	21.0	21.0	17.0	25.0	0	0	0	0	0	T*	25.5	15.0	124.5
Greatest Amount..	31.5	41.8	48.5	25.0	6.0	0	0	0	T*	2.0	25.5	26.0	124.5
Average for 7 yrs...	19.3	21.1	18.0	8.7	11.0	0	0	0	T*	0.4	7.0	12.9	88.7
Least Amount......	7.5	11.4	5.0	0.4	0.0	0	0	0	0	0	1.4	7.0	65.6

*T indicates trace of snowfall.

THUNDER-STORMS.

Thunder-storms occur at all seasons of the year. They are of rare occurrence, however, from November to February. The month of greatest frequency is July, when the average number is twelve to fourteen. The seasonal distribution of these storms and their frequency in Garrett county as compared with Baltimore during the same period (1893 to 1901) are shown in the following tabular statement:

FREQUENCY OF THUNDER-STORMS AT GRANTSVILLE, SUNNYSIDE AND BALTIMORE.

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Grantsville	Greatest number	1	1	3	5	10	16	17	11	9	1	1	0	56
	Least number	0	0	0	0	0	4	11	6	0	0	0	0	27
	Average number	0.3	0.4	1.6	1.4	5.9	10.1	14.0	8.0	3.6	0.1	0.3	0	45.7
Baltimore	Greatest number	1	2	4	3	7	10	9	9	4	2	2	1	36
	Least number	0	0	0	0	0	4	5	1	1	0	0	0	20
	Average number	0.2	0.6	1.0	0.6	3.8	6.0	7.0	4.7	2.7	0.3	0.2	0.1	29.4
Sunnyside	Greatest number	1	3	6	6	12	16	12	13	8	4	2	1	58
	Least number	0	0	0	0	3	7	6	2	2	0	0	0	29
	Average number	0.2	0.8	2.0	2.6	7.1	10.1	9.1	7.8	3.7	1.1	0.4	0.1	45.0

WIND DIRECTION.

The local topography in the vicinity of Sunnyside and Deer Park admits of but little freedom of movement of surface winds. Accordingly we have a prevailingly southwesterly wind at all seasons of the year, with an occasional month with a predominating northwest wind. At Grantsville the situation is more open and we have accordingly a freer movement of the air. During the winter and autumn months the winds are generally from the west and northwest; in the spring and summer months from the southwest and south. The predominant wind directions at Sunnyside and Grantsville are as follows:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Grantsville	W	W	W	SW W	SW	SW	SW S	S	W	NW	W	W	W
Sunnyside	SW	NW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW

Meteorological Stations.

Deer Park (a).—Observers: George W. Harrison and L. H. Schoolfield. Latitude 39° 25′ north; longitude 79° 20′ west from Greenwich; elevation 2500 feet. Observations were made by George W. Harrison from August to November, 1880, and by L. H. Schoolfield from December, 1880, to March, 1881. Instruments: Thermometer, read at sunset from August to November, 1880; wet and dry-bulb thermometers and barometer, read at 7 A. M., 2 P. M., and 9 P. M.; rain-gauge. Maintained under the auspices of the U. S. Weather Bureau.

Deer Park (b).—Observer: S. P. Specht. Latitude 39° 26′ north; longitude 79° 20′ west from Greenwich; elevation 2457 feet. Observations were begun October 1, 1894, and maintained without interruption to the present time. Instrumental equipment: Maximum and minimum self-registering thermometers and rain-gauge. Maintained under the auspices of the Maryland State Weather Service, and the U. S. Weather Bureau.

Grantsville.—Observer: Jacob S. Miller. Latitude 39° 43′ north; longitude 79° 9′ west from Greenwich; elevation 2400 feet. Observations were begun August 1, 1894, and were maintained without interruption to date. Instrumental equipment: Maximum and minimum self-registering thermometers, a rain-gauge, and a thermometer shelter. Maintained under the auspices of the Maryland State Weather Service and the U. S. Weather Bureau.

Oakland (a).—Observer: L. R. Capran: Latitude 39° 24′ north; longitude 79° 24′ west from Greenwich; elevation 2400 feet. Observations were made from December, 1857, to June, 1858. Instruments: Thermometer, read at 7 A. M., 2 P. M., and 9 P. M. Maintained under the auspices of the Smithsonian Institution.

Oakland (b).—Observers: James D. Hamill and Dr. J. Lee McComas. Latitude 39° 24′ north; longitude 79° 24′ west from Greenwich; elevation 2400 feet. Observations were made by Mr. James D. Hamill during January and February, 1893, and by Dr. J. Lee McComas from April, 1893, to March, 1896. Instruments: Thermometer, read at 7 A. M., during January, 1893, and at 9 P. M.

during February. Thermometer, read at 7 A. M., 2 P. M., and 9 P. M., from April, 1893, to July, 1895. Instruments: Maximum thermometer from April, 1893, to March, 1896; minimum thermometer from October, 1893, to March, 1896; rain-gauge from April, 1896, to March, 1896. Maintained under the auspices of the Maryland State Weather Service and the U. S. Weather Bureau.

Sunnyside.—Observer: John George Knauer. Latitude 39° 20′ north; longitude 79° 27′ west from Greenwich; elevation 2500 feet. Observations were begun on January 1, 1893, and maintained without interruption to the present time. Instrumental equipment: Thermometer, read at 8 A. M. and 8 P. M. in January and February, 1893; and at 7 A. M., 2 P. M., and 9 P. M. from March, 1893, to July, 1896. Maximum and minimum self-registering thermometers since June, 1893. Rain-gauge. Maintained under the auspices of the Maryland State Weather Service and the U. S. Weather Bureau.

HYDROGRAPHY OF GARRETT COUNTY

BY

H. A. PRESSEY AND E. G. PAUL

INTRODUCTORY.

Garrett, the westernmost county of Maryland, is situated in the Appalachian mountain region, and like the adjoining regions to the north and south, has a rough and rugged topography. The Appalachian System, starting in the mountains of New England and extending through New York and Pennsylvania, crossing the western part of Maryland and passing on through Virginia, West Virginia, and the states to the south, dies out in the foot-hills of the Gulf states. In the three western counties of Maryland these mountains reach elevations of from 2000 to 3400 feet with a general trend of the ranges from northeast to southwest. The mountains rise abruptly from the plains and river beds, forming narrow valleys with steep slopes and sharp drainage lines. The rainfall in western Maryland is copious and Garrett county is accordingly well-watered.

The North Branch of the Potomac river, flowing in a northeasterly direction, forms its southern boundary. This stream with its numerous short tributaries drains the southeast slopes of Backbone Mountain. These tributaries are in general only five or six miles in length, and come tumbling down as mountain torrents to add their water to the larger stream, itself a swift and precipitous river. Savage river breaks through the gap between Backbone Mountain and Savage Mountain, and with its numerous branches drains a large portion of the northeastern part of the county, between Big Savage and Meadow mountains.

Rain falling upon the northwestern slope of the southern part of Backbone Mountain flows down the steep mountain sides in rivulets which unite to form the various tributaries of the Youghiogheny.

That stream flowing due north drains all of the western part of Garrett county, and flows into Pennsylvania, its waters finally reaching the Ohio and Mississippi rivers through the Monongahela.

The north central part of Garrett county between Negro and Meadow mountains is drained by the Castleman river, which flows to the north into Pennsylvania, and after a winding course joins the Youghiogheny and Laurel Hill Creek at Confluence, or Three Forks as it was formerly called. Backbone and Meadow mountains and an irregular group of foot-hills connecting them, it will be seen, form a continental divide. Rain falling on the southeast side flows into the Potomac and reaches the Atlantic ocean; while that falling on the northwest slopes of the divide, after a course of hundreds of miles through the Youghiogheny, Monongahela, Ohio, and Mississippi, reaches the Gulf of Mexico. It is a peculiar fact at once apparent that Garrett county receives practically no water from the surrounding territory, but is a collecting and conserving area for the large rivers to the north and south.

The mountain slopes are so steep and the valleys of all the streams in the county are so narrow that the precipitation quickly reaches the main streams, causing very marked fluctuations of flow. During rainy weather a very large percentage of the water flowing swiftly down the mountain sides does not have an opportunity to seep into the ground, so that during the dry season there is no ground storage to keep up the flow and the streams show a very small run-off in comparison to their drainage areas. Lakes and ponds which would store to some extent the waters of the wet season are also entirely lacking. For these reasons the low water-flow of streams in Garrett county in common with most of the upper tributaries of the Potomac, is exceedingly small and sudden rises to flood height are frequent. Most of the mountain slopes, however, are covered with a heavy growth of hard wood which acts to some extent as a water conserver. The roots of the trees keep the ground open and porous, allowing the water falling as rain to seep quickly into the soil, and the foliage prevents evaporation by its cooling shade. This ground-water may be held for months and be given up gradually to the rivers below by springs and rivulets, thereby keeping the flow far more constant and increasing materially the minimum flow of the stream.

The United States Geological Survey, cooperating with the Maryland Geological Survey, has made investigations of a number of streams receiving water from Garrett county. Systematic measurements were made upon the North Branch of the Potomac river at Cumberland and later at Piedmont. The methods used in these investigations were briefly described in the Allegany county report published by the Maryland Geological Survey, and more fully in Water Supply and Irrigation Paper No. 56 of the U. S. Geological Survey.

During the season of 1897 a reconnaissance of the entire Potomac river drainage basin above Washington was made by the U. S. Geological Survey, to determine primarily the amount of pollution. A number of discharge measurements were made on the North Branch and several of its tributaries. The results of these measurements were published in the report on Allegany county by the Maryland Geological Survey above referred to, and also in the Annual Report of the U. S. Geological Survey. A measurement on September 23, 1897, made at Gorman, gave a discharge of 54 second-feet. On September, 25, 1897, the discharge of the river at Schell was 136 second-feet. Measurements made above the junction with Savage river on September 27 and October 27 gave discharges of 122 and 102 second-feet respectively, the latter fairly representing the capacity of the North Branch at this point during the severe drought of 1897. In June, 1899, a station was established at Piedmont, on the North Branch, and at the same time one was established at Springfield, West Virginia, on the south branch.

Results of measurements at these points are given in the reports of the U. S. Geological Survey, and for convenience the records at Piedmont are given here. Measurements made at this point, located near the boundary line of Garrett and Allegany counties on the Potomac river, will show the total flow of North Branch at the point where it leaves Garrett county. This station was established June 27, 1897, by E. G. Paul, and is located at the iron highway, the bridge connecting Luke, Md., with Piedmont, W. Va. The height of water in the river is determined daily by a wire-gage suspended from the bridge and so arranged that a metal weight can be lowered to the surface of the water and a direct reading of the river height made upon a gage board 14 feet long attached to the bridge 90 feet from the first pier, and graduated into feet and tenths.

Measurements are made with the current-meter at frequent intervals and the height of water in the river noted. From these data a rating curve for the station can be drawn, showing graphically the relation between the river height and the discharge. The channel of the river is straight for one-eighth of a mile above and below the station. The current is swift and unobstructed. The right bank is high and rocky, but the left bank is low and liable to overflow. The bed of the stream is rocky and permanent in sections. The observer is Charles W. Beck, a bookkeeper at Piedmont, W. Va.

Systematic measurements are made of the South Branch, Potomac river, at Romney, West Virginia.

Below the junction of the two main branches of the Potomac and the mouths of a number of large tributaries, the Potomac is measured at Point of Rocks, this being a regular station of the U. S. Geological Survey. Records of flow were made of North Branch at Cumberland from 1895-1897, and were published in the Hydrography of Allegany County, the first paper of this series.

The Potomac River.[1]

The headwaters of the North Branch proper are at the Potomac Spring near the Fairfax Stone on the present West Virginia and Maryland state line at an elevation of about 3200 feet. From this the river flows in a northeasterly direction for about 46 miles, forming the dividing line between Garrett county, Maryland, and Grant and Mineral counties, West Virginia, to the confluence of Savage river, where the elevation is about 1000 feet. From this point on, it forms the boundary of Allegany county, separating it from Mineral county, West Virginia.

[1] In this description of the Potomac river use is made of a discussion of the Hydrography of Allegany County by F. H. Newell (Md. Geol. Survey, Allegany County, pp. 243-246). Portions of Mr. Newell's discussions are quoted with slight modification.

Along the upper part of its course, down to Westernport, the most westerly town in Allegany county, the North Branch flows through a narrow, tortuous valley, the steep, wooded hillsides of which afford little opportunity for settlement. The roads are few and bad, and the West Virginia Central and Pittsburg Railway affords the only means of transportation. The extensive lumber trade in this region was responsible for a number of small settlements along the river and the existence of the two towns of Bayard, West Virginia, with an estimated population of 700, and Gormania, West Virginia, with an estimated population of 600 inhabitants. The only other towns are Henry, Blaine, Barnum, and Bloomington, which owe their existence to the coal mines.

Owing to its considerable fall along this section, which averages 46 feet per mile, but in some portions exceeds 60 feet per mile, the river assumes much the nature of a mountain torrent, presenting one continuous series of riffles and falls, the latter in some instances having a drop of 5 feet and over. There seems to be little opportunity for developing the waterpowers of this stream, however considerable they may be. Freshets are frequent and heavy, and would inflict serious damage to the cheaper forms of milldams. Stone and brush dams, crib dams, and loose-rock dams would either be swept away or would require incessant repairs and rebuilding. On account of the narrowness of the valley, waste-weirs would often be impracticable, and dams would have to be built to withstand the heaviest floods passing over them, which would render their construction elaborate and expensive. The following discharge measurements, made in September and October of 1897, will serve to throw light upon the capacity of the river during the dry season. A measurement made at Gormania, West Virginia, on September 23, gave a discharge of 54 second-feet. On September 25 the discharge of the river at Schell was 136 second-feet. Measurements made above the junction with Savage river on September 27 and October 27 gave discharges of 122 and 102 second-feet, respectively, the latter fairly representing the capacity of the North Branch at this point during the severe drought of 1897. These results, together with the large amount of available head, and the fact that the river does not freeze over in winter, seem to indicate that there would be ample power at all times for average milling purposes. The fact that no attempt has been made by any of the sawmills and tanneries along the river to make use of waterpower has, however, sufficient explanation. The first-named enterprises use steam by preference, because they are primarily of a temporary character, liable to be shifted whenever it may be found advantageous to shorten the distance which the raw materials are to be hauled, and also because they are supplied with an abundance of fuel, at no cost, in the form of sawdust. The tanneries, though of a more permanent character, invariably prefer steam power, because, besides being able to utilize tan bark as fuel, they require the use of steam in their processes.

A small waterpower has been developed by two mills at Blaine, West Virginia, but the amount is trifling in comparison with what might be obtained at that point. One 15-inch and one 18-inch turbine under 7½ feet head furnish about 8 horsepower to a small woolen mill. On the same mill-race is situated a sawmill and grist-mill combined, which obtains about 25 horsepower from one 36-inch turbine under 9 feet head. Water is taken from the river at a point about one-half mile above the mills, where there is a low natural dam across the river. No other waterpower has been developed on this stream.

The more important tributaries have been visited and the discharges measured. September 24, 1897, the discharge of Buffalo Creek at Bayard, West Virginia, was found to be 23 second-feet. The water was heavily laden with sawdust from the Buffalo Lumber Company. Stony river, the principal tributary above the mouth of Savage river, which enters the Potomac from West Virginia near Bradshaw, was visited September 25. Its discharge was 38 second-feet. This stream flows through a hilly region, covered with thick timber growths, and has no settlements along it except a few logging camps. The headwaters rise in the highest part of the Potomac Basin, at an altitude of 4000 feet. Abram Creek showed a discharge of 7.4 second-feet on September 25. The waters of this creek are much polluted by the coal mines at Elk Garden, West Virginia, and also receive sawdust from a sawmill at Emory, West Virginia.

FIG. 1.—POTOMAC VALLEY ABOVE BLAINE.

FIG. 2.—BED OF THE POTOMAC AT BARNUM.

THE POTOMAC RIVER.

The North Branch all along this upper section is polluted by large quantities of sawdust produced by fourteen sawmills, some of which discharge the sawdust directly into the river, and others into the tributaries. The more important of these are the sawmill of the J. L. Rumbarger Company, at Dobbin, West Virginia, with a capacity of 100,000 feet of lumber a day, the saw- and planing-mills of M. N. Wilson, at Wilson, Maryland, with a capacity of 20,000 feet of lumber a day, and of the Buffalo Lumber Company, at Bayard, West Virginia, with a capacity of 50,000 feet of lumber a day. It furthermore receives the wastes from two tanneries—those of the Middlesex Leather Company, at Bayard, West Virginia, with a capacity of from 600 to 800 hides a day, and of the J. T. Hoffmann's Sons Company, at Gormania, West Virginia, with a capacity of 300 hides a day. The wastes from the latter establishments consist of tan liquor, lime water, and a certain amount of tan bark, which is washed from the banks at times of high water. The total amount of this pollution is such that the river, especially during the dry season, has a foul appearance in spite of its dashing course over the bowlders of its rough but picturesque bed. The water has a dark-brown tinge, very suggestive of contamination by tan liquor, and particles of sawdust are extremely plentiful and are carried for long distances. In many places where irregularities in the current have caused accumulations of sawdust, small banks and bars composed of solid strata of sawdust are to be found. It is a noteworthy fact that Stony river, though free from artificial pollution, exhibits to a certain degree the same dark color peculiar to the waters of the main river.

The water of the North Branch of the Potomac, even near its head, is naturally somewhat dark in color, and it is stated by the older inhabitants of the region that it has always been thus dark, owing, probably, to the presence of decaying vegetable matter from the forests. This discoloration is further increased by the effluents from sawmills, tanneries and coal mines, so that at the old mill-dam near Keyser, West Virginia, where the polluted water, agitated by the falls, boils and foams, a thick layer of whitish-brown froth is formed.

DAILY GAGE HEIGHT OF POTOMAC RIVER AT PIEDMONT, W. VA., FOR 1899.

Day.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	..	3.15	2.50	2.20	2.20	3.75	2.60
2	..	2.90	2.35	2.20	2.20	3.90	2.60
3	..	2.80	2.25	2.10	2.15	3.05	2.60
4	..	2.70	2.40	2.00	2.10	2.80	2.55
5	..	2.65	2.40	2.30	2.10	2.70	2.50
6	..	2.70	2.40	2.20	2.10	2.55	2.40
7	..	2.80	2.55	2.15	2.20	2.50	2.40
8	..	2.70	2.30	2.10	2.10	2.40	2.40
9	..	2.70	2.30	2.20	2.15	2.40	2.35
10	..	2.70	2.25	2.30	2.10	2.40	2.40
11	..	2.65	2.10	2.95	2.10	2.40	2.50
12	..	2.50	2.15	3.40	2.20	2.40	5.20
13	..	2.40	2.10	2.75	2.10	2.30	4.60
14	..	2.85	2.10	2.45	2.10	2.30	3.75
15	..	2.85	2.10	2.35	2.00	2.30	3.60
16	..	2.50	2.00	2.30	2.20	2.30	3.35
17	..	2.70	2.00	2.30	2.10	2.30	3.05
18	..	2.90	2.00	2.15	2.10	2.20	3.15
19	..	2.65	2.00	2.10	2.10	2.40	3.20
20	..	2.50	2.00	2.45	2.10	3.35	3.70
21	..	2.35	2.00	2.90	2.10	3.00	3.30
22	..	..	1.95	2.65	2.00	2.80	3.20
23	..	2.30	1.90	2.40	2.00	2.85	3.10
24	..	2.30	1.90	2.40	2.10	3.30	3.00
25	..	2.30	1.90	2.25	2.10	3.20	3.00
26	..	2.20	1.90	2.20	2.10	3.00	2.90
27	3.00	2.15	2.10	2.30	2.10	2.80	2.80
28	2.90	2.50	3.00	2.55	2.10	2.80	2.80
29	3.85	2.35	2.90	2.40	2.20	2.70	2.80
30	3.50	2.30	2.55	2.25	2.15	2.60	2.80
31	..	2.45	2.35	..	2.15	..	2.70

DAILY GAGE HEIGHT OF POTOMAC RIVER AT PIEDMONT, W. VA., FOR 1900.

Day	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.70	3.00	3.55	4.60	3.15	3.30	3.00	2.95	2.10	2.85	2.10	3.55
2	2.70	3.05	4.50	4.80	3.10	3.25	2.85	2.75	2.00	2.45	2.10	3.45
3	2.70	3.10	4.10	4.65	3.10	3.25	2.70	2.65	2.00	2.20	2.25	3.25
4	2.70	3.10	4.00	4.50	3.10	3.05	2.70	2.60	2.00	2.10	2.65	5.80
5	2.70	3.35	4.30	4.25	3.00	2.90	2.70	2.40	2.00	2.20	2.70	5.65
6	2.80	3.60	4.25	4.15	2.95	2.85	2.60	2.30	1.95	2.20	2.50	4.70
7	2.90	3.70	5.80	4.15	2.90	2.85	2.70	2.30	1.90	2.20	2.40	4.25
8	3.00	5.30	5.00	4.30	2.90	3.15	3.00	2.20	1.90	2.10	2.30	4.00
9	3.30	5.40	4.55	4.20	2.95	3.15	2.85	2.20	1.90	2.05	2.40	3.80
10	3.50	4.65	4.40	3.95	3.20	2.95	2.70	2.10	1.90	2.00	2.50	3.60
11	3.50	4.40	4.30	3.75	3.05	2.80	2.60	2.05	1.80	2.00	2.50	3.40
12	4.70	4.05	4.15	3.70	3.00	2.70	2.45	2.00	1.80	2.00	2.60	3.40
13	4.25	5.90	4.10	3.65	2.90	2.70	2.60	2.10	1.80	2.00	2.60	3.40
14	3.90	5.50	4.10	3.55	2.80	3.15	2.65	2.00	1.80	3.05	2.50	3.30
15	3.90	4.80	4.00	3.40	2.80	3.20	2.55	2.00	1.80	3.20	2.50	3.30
16	3.90	4.35	3.80	3.40	2.80	3.95	2.35	2.10	1.80	2.65	2.40	3.20
17	4.40	4.15	3.70	3.40	2.80	7.55	2.30	2.40	1.90	2.45	2.40	3.05
18	4.10	4.05	3.70	3.55	2.70	5.85	2.25	2.25	1.90	2.40	2.40	3.15
19	4.15	3.70	4.00	3.75	3.40	4.95	2.35	2.25	1.90	2.25	2.40	3.20
20	5.80	3.65	5.95	3.65	3.95	4.45	2.90	2.45	1.90	2.20	2.50	3.25
21	5.70	3.60	5.35	3.50	3.55	3.95	2.75	2.20	1.80	2.10	2.60	3.25
22	4.75	3.75	4.75	3.50	3.35	3.65	2.55	2.20	1.80	2.10	3.20	3.05
23	4.35	4.00	4.60	3.65	3.20	3.50	2.45	2.65	1.80	2.15	3.00	3.00
24	4.10	3.70	4.60	3.85	3.15	3.35	2.40	2.45	1.80	2.35	2.90	3.05
25	3.95	3.60	4.50	3.65	3.05	3.25	3.20	2.40	1.80	2.80	3.35	3.05
26	3.80	3.40	4.25	3.50	3.00	3.25	4.05	2.45	1.80	2.50	7.95	2.05
27	3.55	3.40	4.35	3.40	2.95	3.05	4.40	2.45	1.85	2.35	5.20	2.90
28	3.40	3.40	4.15	3.40	2.90	2.90	3.20	2.30	1.90	2.30	4.45	3.90
29	3.30	....	4.00	3.30	3.30	3.55	3.00	2.20	1.95	2.20	4.05	3.45
30	3.20	....	4.75	3.25	3.25	3.15	3.00	2.15	2.70	2.20	3.75	3.05
31	3.10	....	4.60	....	3.10	....	3.25	2.10	....	2.20	....	3.30

List of Discharge Measurements made on Potomac River at Piedmont, West Virginia.

Date.	Hydrographer.	Gage heig't (feet.)	Discharge (sec. ft.)
June 27, 1899	E. G. Paul.	3.00	350
February 22, 1900	" "	3.75	735
June 20, 1900	" "	4.40	1,249
September 12, 1900	C. R. Olberg.	1.80	34

Estimated Monthly Discharge of Potomac River at Piedmont, W. Va.
(Drainage area, 407 square miles.)

MONTH.	DISCHARGE IN SECOND-FEET			TOTAL IN ACRE-FEET.	RUN-OFF.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1899.						
June 27 to 30	....	....	515	....	....	....
July	410	112	228	14,019	0.56	0.65
August	352	55	132	8,116	0.32	0.37
September	525	77	174	10,354	0.43	0.48
October	124	77	104	6,395	0.26	0.30
November	845	124	287	17,078	0.71	0.79
December	1,880	162	419	25,763	1.03	1.19
The year	....	....	....	....	....	....
1900.						
January	2,360	259	799	49,129	1.96	2.26
February	2,440	352	961	53,371	2.36	2.45
March	2,480	705	1,237	76,060	3.04	3.50
April	1,560	452	808	48,079	1.99	2.22
May	883	259	393	24,165	0.96	1.11
June	3,760	259	691	41,117	1.70	1.90
July	1,240	136	321	19,737	0.79	0.91
August	336	77	154	9,469	0.38	0.44
September	259	34	58	3,451	0.14	0.16
October	430	77	158	9,715	0.39	0.45
November	4,080	100	483	28,740	1.19	1.33
December	2,360	320	648	39,844	1.59	1.83
The year	4,080	34	558	402,877	1.37	18.56

The Savage River.

The Savage river rises in the valley west of Backbone and Savage mountains, and enters the North Branch of the Potomac about two

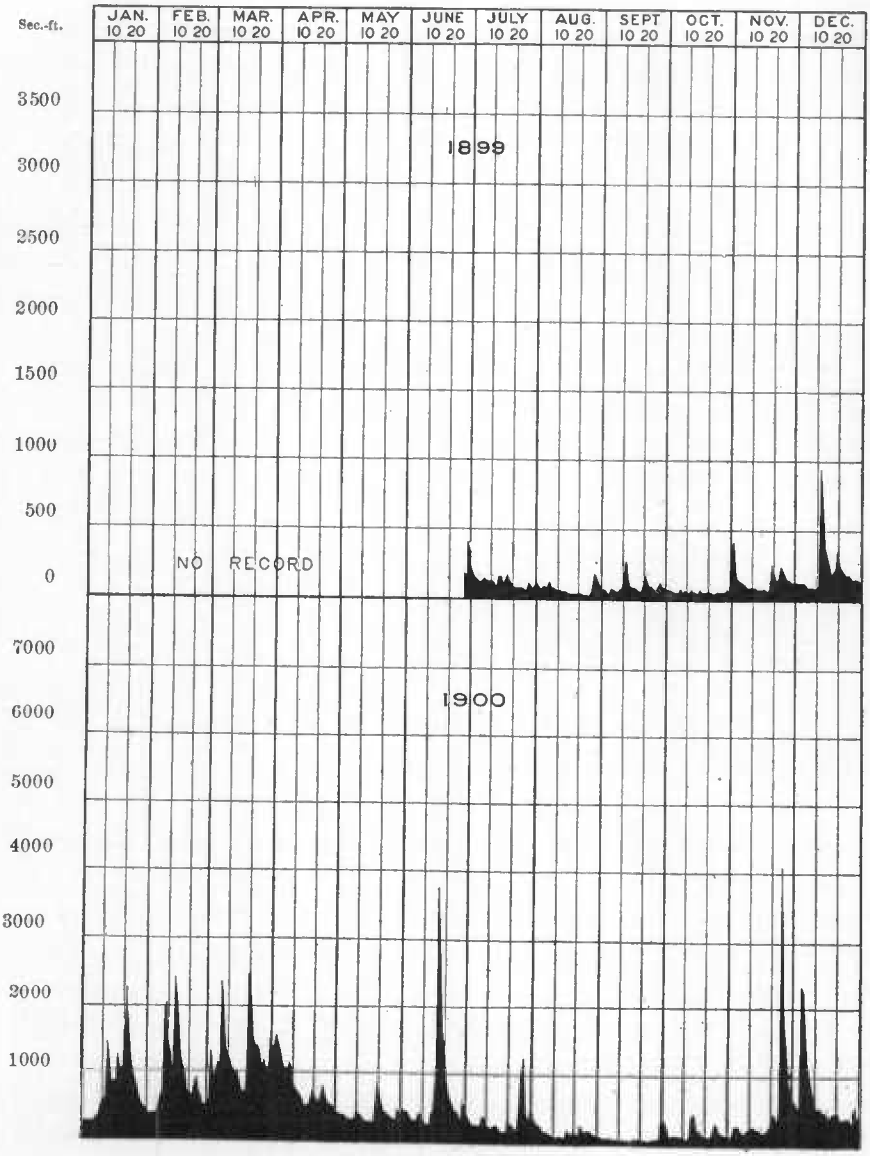


Fig. 10. Diagram showing discharge of the Potomac River at Piedmont, W. Va., for 1899 and 1900.

miles above Westernport, at the Garrett-Allegany line. It is a small stream of great purity. Only two small sawmills are located on its bank, so that the pollution is insignificant. This is important because the town of Piedmont and part of Westernport are supplied with drinking water by a gravity system from a reservoir which is filled by pumping water from Savage river. The quantity pumped daily is estimated at 375,000 gallons. On October 27, 1897, a discharge measurement was made at the mouth of this stream above the intake of the Piedmont water supply, the discharge being 11.3 second-feet.

The Castleman River.

As has been stated, the Castleman river and Laurel Hill Creek join the Youghiogheny at Confluence, Pa. The Castleman drains the north-central portion of Garrett county and has a drainage area of much the same character as that of the Youghiogheny. On May 16, 1898, meter measurements were made of the discharge of the three rivers at Confluence, Pa., by E. G. Paul. The discharges were found to be as follows:

Youghiogheny River	1745	second-feet.
Castleman "	698	" "
Laurel Hill Creek	225	" "

The drainage area of the Youghiogheny at Confluence is 782 square miles.

The Youghiogheny River.

The Youghiogheny river is the largest which actually flows through Garrett county. Its waters reach the Monongahela about 15 miles above Pittsburg, Pa. The waters falling on the western slope of the Alleghany Mountains at a maximum elevation of 3400 feet unite to form the tributaries of the Youghiogheny. The main stream for 19 miles above its mouth has an average fall of about 2 feet per mile, but above that point it soon increases to an average fall of nearly 5 feet per mile. The average width of the river from its mouth to West Newton, Pa., is 546 feet. On August 17, 1898, a station was established by the U. S. Geological Survey at Friendsville. The drainage area of the stream at this point is 295 square miles. The height of water is obtained by means of a wire-gage attached to the floor-timber on the lower side of the iron highway bridge connecting the east and west portions of the village. A scale board is graduated

DAILY GAGE HEIGHT OF YOUGHIOGHENY RIVER AT FRIENDSVILLE, MD., FOR 1898.

Day.	August	Sept.	October	Nov.	December
1	..	4.20	4.00	4.90	4.90
2	..	4.10	4.00	4.90	4.90
3	..	4.10	4.00	4.80	4.80
4	..	4.10	4.00	4.70	4.70
5	..	4.10	4.00	4.70	4.70
6	..	4.30	4.10	4.80	4.70
7	..	4.40	4.20	4.70	4.70
8	..	4.50	4.20	4.90	4.70
9	..	4.40	4.20	5.10	4.70
10	..	4.40	4.10	5.10	4.80
11	..	4.10	4.10	6.30	4.90
12	..	4.00	4.10	5.90	5.10
13	..	4.00	4.10	5.70	5.10
14	..	4.00	4.20	5.50	5.10
15	..	4.00	4.20	5.40	5.20
16	..	4.00	4.30	5.30	5.20
17	4.90	4.00	4.20	5.20	5.20
18	4.80	4.00	4.40	5.20	5.10
19	4.70	4.00	4.40	5.20	5.10
20	5.90	4.00	4.90	5.70	6.10
21	5.20	4.00	4.70	5.60	7.50
22	4.90	4.00	7.90	5.40	7.60
23	4.70	4.00	7.00	5.40	7.70
24	4.60	4.40	6.10	5.20	7.10
25	4.60	4.30	5.60	5.10	6.50
26	4.50	4.30	5.60	5.00	5.60
27	4.50	4.20	5.50	4.80	5.60
28	4.40	4.00	5.30	4.90	5.60
29	4.30	4.00	5.10	4.80	5.40
30	4.20	4.00	5.00	4.80	5.30
31	4.20	..	5.00	..	5.20

DAILY GAGE HEIGHT OF YOUGHIOGHENY RIVER AT FRIENDSVILLE, MD., FOR 1899.

Day	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.20	5.00	6.50	6.50	4.60	4.90	5.20	4.50	4.00	4.10	4.10	4.30
2	5.20	4.90	6.40	6.30	5.00	4.90	4.80	4.30	4.10	4.10	4.60	4.30
3	5.20	5.00	6.30	6.00	5.20	4.80	4.60	4.20	4.00	4.10	5.00	4.30
4	5.40	7.40	6.30	5.80	5.30	4.80	4.40	4.20	4.00	4.10	4.80	4.30
5	6.50	7.00	7.70	5.30	5.30	4.80	4.60	4.60	3.90	4.00	4.50	4.30
6	6.30	6.20	8.20	5.20	5.20	4.60	4.50	4.80	3.90	4.00	4.50	4.50
7	6.10	5.90	6.60	5.10	5.20	4.50	4.50	4.50	3.90	4.00	4.40	4.60
8	6.00	5.60	6.20	6.90	5.10	4.50	4.50	4.30	4.10	4.00	4.30	4.60
9	5.80	5.40	5.90	6.50	6.90	4.40	4.40	4.20	4.00	4.00	4.30	4.80
10	5.60	5.30	6.30	5.90	6.50	5.20	4.40	4.20	4.40	4.00	4.40	4.90
11	5.30	5.20	6.10	5.70	6.30	5.90	4.30	4.30	4.40	3.90	4.30	4.90
12	5.20	5.10	6.00	5.50	5.90	5.80	4.20	4.20	4.30	3.90	4.20	5.40
13	5.10	5.10	5.90	5.30	5.60	5.60	4.20	4.20	4.30	3.90	4.20	5.80
14	6.10	Frozen	5.70	5.20	5.60	5.60	4.30	4.20	4.20	3.90	4.20	5.50
15	8.00	"	5.60	5.10	5.50	5.70	4.40	4.10	4.10	3.90	4.20	5.30
16	7.10	"	5.60	5.10	5.60	6.50	4.60	4.10	4.10	3.90	4.10	5.10
17	6.80	"	5.70	5.00	5.70	6.20	4.60	4.10	4.00	3.90	4.10	5.10
18	6.50	"	5.70	5.00	8.00	5.40	4.90	4.00	4.00	3.90	4.10	5.20
19	6.20	5.10	5.70	5.00	9.50	5.00	4.70	4.00	4.10	3.90	4.30	5.40
20	5.80	5.20	5.70	4.90	7.20	4.80	4.50	4.00	4.10	3.90	4.40	5.40
21	5.50	5.40	6.00	4.90	6.90	4.80	4.40	4.00	4.30	3.90	4.60	5.30
22	5.40	6.80	6.00	4.80	6.50	4.70	4.30	4.00	4.20	3.90	4.70	5.30
23	5.30	7.20	6.30	4.70	6.10	4.60	4.20	4.00	4.20	3.90	4.60	5.30
24	5.30	6.40	6.30	4.70	5.60	4.50	4.20	4.00	4.10	3.90	4.60	5.20
25	6.40	5.90	6.00	4.70	5.30	5.30	4.40	4.00	4.00	3.90	4.60	5.20
26	6.00	6.20	5.80	4.60	5.10	5.10	4.20	4.00	4.00	3.90	4.40	5.20
27	5.70	7.90	5.60	4.60	4.90	5.20	4.20	4.00	4.10	3.90	4.40	5.10
28	5.50	7.20	6.60	4.70	4.90	5.20	4.20	4.00	4.10	4.00	4.40	5.10
29	5.30	....	8.00	4.70	4.80	5.40	4.40	4.10	4.10	4.00	4.40	5.10
30	5.10	....	7.30	4.60	4.90	5.60	4.30	4.10	4.10	4.00	4.30	5.10
31	5.10	....	6.90	....	4.90	....	4.30	4.00	....	4.00	....	5.10

to feet and tenths and firmly fastened to the guard rail of the bridge. The stream channel is straight for several hundred feet above and below the bridge and has a rocky bottom with high banks on the right side. The observer is Mr. J. H. Cuppet, a merchant residing within a short distance of the gage. There are at a number of points along this river, rapids and falls which might be utilized for water-power.

DAILY GAGE HEIGHT OF YOUGHIOGHENY RIVER AT FRIENDSVILLE FOR 1900.

Day.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.1	4.8	6.3	5.8	4.6	4.3	4.8	4.7	4.0	3.9	4.1	5.3
2	5.1	4.8	6.8	5.8	4.6	4.3	4.8	4.5	4.0	3.9	4.1	5.2
3	5.1	4.8	6.6	5.8	4.5	4.3	4.7	4.3	4.0	3.9	4.1	5.1
4	5.1	4.8	6.3	5.6	4.5	4.4	4.8	4.2	4.0	3.9	4.4	5.3
5	5.1	4.8	6.2	5.5	4.5	4.3	4.6	4.2	4.0	3.9	4.3	5.6
6	5.1	5.4	6.3	5.5	4.6	4.3	4.4	4.2	4.0	3.9	4.2	5.8
7	5.2	5.6	6.1	5.5	4.6	4.2	4.3	4.1	4.0	3.9	4.2	7.5
8	5.3	6.6	6.0	5.4	4.7	4.2	..	4.1	3.9	3.9	4.2	7.3
9	5.3	6.8	5.8	5.4	4.7	4.2	4.3	4.0	3.9	3.9	4.4	6.9
10	5.3	6.6	5.7	5.3	4.6	4.2	4.2	4.0	3.9	3.9	4.3	6.4
11	5.4	6.4	5.6	5.3	4.5	4.1	4.2	4.0	3.9	3.9	4.3	6.1
12	6.3	6.2	5.5	5.2	4.6	4.1	4.1	4.0	3.9	3.9	4.3	5.8
13	6.3	6.3	5.3	5.1	4.7	4.2	4.1	4.0	3.9	3.9	4.3	5.6
14	6.0	6.4	5.3	5.0	4.7	4.5	4.1	4.0	3.9	4.1	4.3	5.4
15	5.8	6.3	5.3	5.0	4.8	4.7	4.1	4.1	3.9	4.3	4.2	5.4
16	5.8	6.1	5.4	4.9	4.9	5.4	4.1	4.2	3.8	4.3	4.2	5.3
17	5.6	5.8	5.3	4.9	4.9	6.7	4.0	4.5	3.8	4.2	4.2	5.2
18	5.6	5.6	5.5	4.8	4.8	7.1	4.0	4.5	3.8	4.2	4.3	5.1
19	5.6	5.2	5.7	4.8	4.7	7.0	4.0	4.4	8.8	4.2	4.4	4.9
20	5.7	5.1	5.9	4.7	4.7	6.5	4.1	4.3	3.8	4.1	4.4	4.7
21	6.0	5.0	7.0	4.7	4.7	6.0	4.1	4.2	3.8	4.2	4.5	4.6
22	6.3	5.0	6.5	4.7	4.7	5.3	4.2	4.2	3.8	4.2	4.7	4.6
23	6.1	5.0	6.1	4.6	4.7	4.8	4.3	4.6	3.8	4.1	4.8	4.5
24	5.7	5.0	5.8	4.6	4.6	4.7	4.3	4.2	3.8	4.0	4.9	4.3
25	5.5	5.0	5.6	4.7	4.5	4.7	4.4	4.3	3.8	4.0	5.2	4.3
26	5.4	5.0	5.5	4.7	4.4	4.6	4.7	4.3	3.8	4.0	9.5	4.4
27	5.3	5.1	5.4	4.8	4.4	4.5	5.0	4.1	3.9	4.1	8.3	4.6
28	5.2	5.1	5.4	4.8	4.4	4.6	4.6	4.1	3.9	4.2	6.9	4.8
29	5.0	..	5.5	4.7	4.4	4.8	4.7	4.2	3.9	4.1	5.8	5.0
30	5.0	..	5.7	4.7	4.4	4.9	4.9	4.1	3.9	4.1	5.5	5.2
31	5.0	..	5.7	..	4.4	..	5.5	4.1	..	4.1	..	5.2

RATING TABLE FOR YOUGHIOGHENY RIVER AT FRIENDSVILLE, MD.
(This table is applicable only from Aug. 18, 1899, to Dec. 31, 1899.)

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	Second feet.	Feet.	Second feet.	Feet.	Second feet.	Feet.	Second feet.	Feet.	Second feet.	Feet.	Second feet.	Feet.	Second feet.
3.0	..	4.0	130	5.0	640	6.0	1600	7.0	2740	8.0	3880	9.0	5020
.1	..	4.1	170	5.1	710	6.1	1714	7.1	2854	8.1	3994	.1	....
.2	..	4.2	210	5.2	785	6.2	1828	7.2	2968	8.2	4108	.2	....
.3	..	4.3	255	5.3	865	6.3	1942	7.3	3082	.3	....	.3	....
.4	..	4.4	300	5.4	955	6.4	2056	7.4	3196	.4	....	.4	....
.5	..	4.5	350	5.5	1050	6.5	2170	7.5	3310	8.5	4450	9.5	5590
3.6	20	4.6	400	5.6	1150	6.6	2284	7.6	3424	.6	....	.6	....
3.7	40	4.7	455	5.7	1260	6.7	2398	7.7	3538	.7	....	.7	....
3.8	65	4.8	515	5.8	1372	6.8	2512	7.8	3652	.8	....	.8	....
3.9	95	4.9	575	5.9	1486	6.9	2626	7.9	3766	.9	....	.9	....

ESTIMATED MONTHLY DISCHARGE OF YOUGHIOGHENY RIVER AT FRIENDSVILLE, MARYLAND.

(Drainage area 295 square miles.)

MONTH.	DISCHARGE IN SECOND-FEET.			TOTAL IN ACRE-FEET.	RUN-OFF.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
1898						
August 17 to 31	1,486	295	517	31,789	....	....
September	385	260	284	16,899	....	....
October	3,766	260	675	41,504	....	....
November	1,942	470	803	47,782	....	....
December.....	3,538	470	1,115	68,559	....	....
The year..	....	....	....	....	....	....
1899.						
January	3,880	710	1,417	87,128	....	....
February	3,766	575	1,579	87,693	....	....
March	4,108	1,150	1,928	118,548	....	....
April	2,626	425	944	56,172	....	....
May	5,590	425	1,430	87,927	....	....
June	2,170	350	821	48,853	....	....
July..........	785	295	378	23,242	....	....
August	520	260	297	18,262	....	....
September	350	245	280	16,661	....	....
October.......	275	245	254	15,618	....	....
November	640	275	362	21,540	....	....
December.....	1,372	320	689	42,365	....	....
The year..	5,590	245	873	624,009	....	....
1900.						
January	1,942	640	1,085	66,714	3.68	4.24
February	2,512	515	1,166	64,756	3.95	4.11
March	2,740	865	1,435	88,235	4.86	5.60
April	1,372	400	734	43,676	2.49	2.78
May	575	300	407	25,025	1.38	1.59
June	2,854	170	701	41,712	2.38	2.65
July..........	1,050	130	327	20,106	1.11	1.28
August	455	130	222	13,650	0.75	0.86
September....	130	65	92	5,474	0.31	0.35
October	255	95	148	9,100	0.50	0.58
November ...	5,590	170	743	44,212	2.52	2.81
December.....	3,310	255	1,014	62,348	3.44	3.96
The year..	5,590	65	673	485,008	2.28	30.81

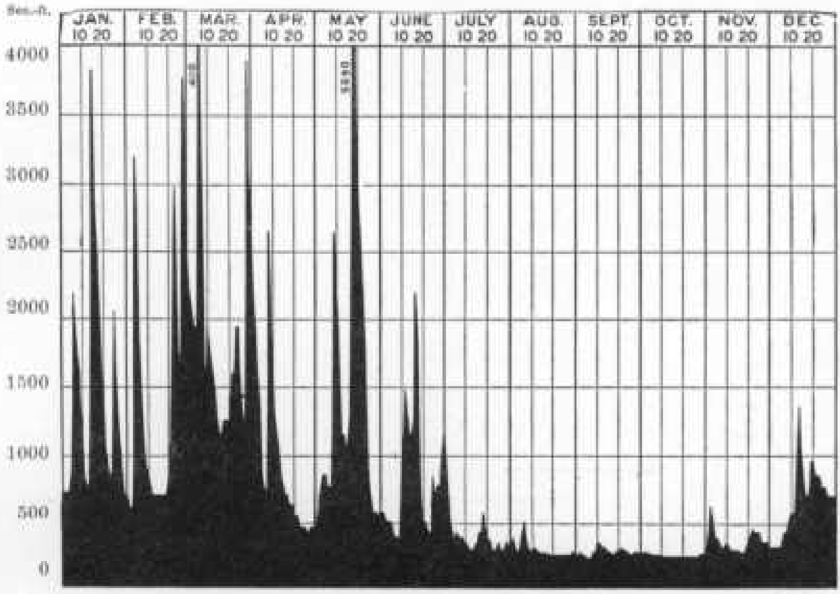


Fig. 11. Diagram showing discharge of the Youghiogheny River at Friendsville for 1899.

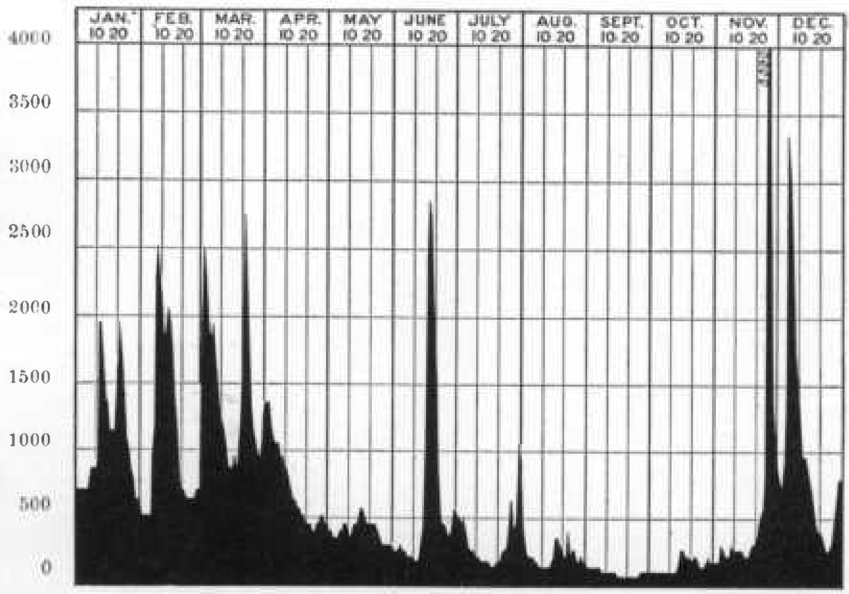


Fig. 12. Diagram showing discharge of the Youghiogheny River at Friendsville for 1900.

THE MAGNETIC DECLINATION IN GARRETT COUNTY

BY

L. A. BAUER

Introductory.

Magnetic observations for the purpose of determining the magnetic declination of the needle, or the "variation of the compass," have been made by the Maryland Geological Survey and the United States Coast and Geodetic Survey at various points within the county or along its boundaries. Additional values were also obtained in connection with the Western Boundary Survey and the Survey of the Garrett-Allegany Line. The values obtained thus far are given in the tables below. For a description of the methods and instruments used, reference must be made to the "First Report upon Magnetic Work in Maryland" (Md. Geol. Survey, vol. i, pt. v, 1898). In the Second Report (Md. Geol. Survey, vol. v, pt. i, 1902), the various values have been collected and reduced to January 1, 1900. The First Report gives likewise an historical account of the phenomena of the compass needle and discusses fully the difficulties encountered by the surveyor on account of the many fluctuations to which the compass needle is subject. Surveyors of the county desiring a copy of these reports should address the State Geologist.

The values in Table I were obtained by L. A. Bauer using United States Coast and Geodetic Survey magnetometer No. 18. The number refers to that given in the Second Report cited above; to this Report, the reader is referred for any additional details.

These observations were made in connection with the survey of the boundary line in the summer of 1898, L. A. Bauer being Chief of Party and W. M. Brown, observer. Mr. Brown's readings taken with the needle of his engineer's transit were reduced to the mean of day and referred to the Coast and Geodetic Survey magnetometer No. 18. See Report on the Boundary Line.

TABLE I.—MAGNETIC DECLINATIONS IN GARRETT COUNTY.

No.	Station.	Latitude.	Longitude.	Magnetic Declination Jan. 1, 1900 West.	Remarks.	
		° ′	° ′	° ′		
72	Fairfax Stono.........	39 11.6	79 29.2	3 16.4	At the Stone.	
72 A	" "	39 11.7	79 29.2	3 12.4	463 feet North Sta. 72.	
73	Camp Fairfax........	39 12.7	79 29.0	3 13.0	Flynn's Farm.	
74	Backbono Mtn........	39 14.1	79 29.2	3 14.0	Michler Mon.	
76	Foley Mtn............	39 20.8	79 30.4	3 22.8	Near Brooksido, W. Va.	
77	Lower Hill	39 21.9	79 29.2	3 23.5	Near L. A. B. Mon.	Western Boundary Lino.
78	Snaggy Mnt...........	39 29.1	79 29.2	3 44.0	Near Michler Mon.	
79	Taylor's Hill	39 30.0	79 30.4	3 38.5	Near Merid. Sta.	
80	Feik Hill, East........	39 34.7	79 29.2	3 47.0	Near Michlor Mon.	
81	" " West. ...	39 33.9	79 30.4	3 47.1	North end of Clearing.	
82	Mason and Dixon Line	39 43.3	79 29.2	3 54.1	273 ft. north Michler Mon.	
70	Corunna..............	39 16.6	79 22.6	3 22.6	M. L., N. Mon., '97 and 1900.	
24 A	Oakland	39 24.5	79 24.5	3 28.8	Merid. L. S., Mon.	
24	"	39 24.6	79 24.6	3 24.2	School Lot.	
95	Swanton......	39 27.0	79 12.3	3 38.3	W. H. Lohr's Garden.	
91	McHenry.............	39 33.4	79 21.2	3 38.0	School Lot.	
92	Accident.......	39 37.6	79 19.0	3 46.5	" "	
94	New Germany.........	39 37.9	79 07.2	4 00.7	Otto's Farm.	
93	Grantsvillo............	39 41.6	79 09.1	4 00.1	School Lot.	

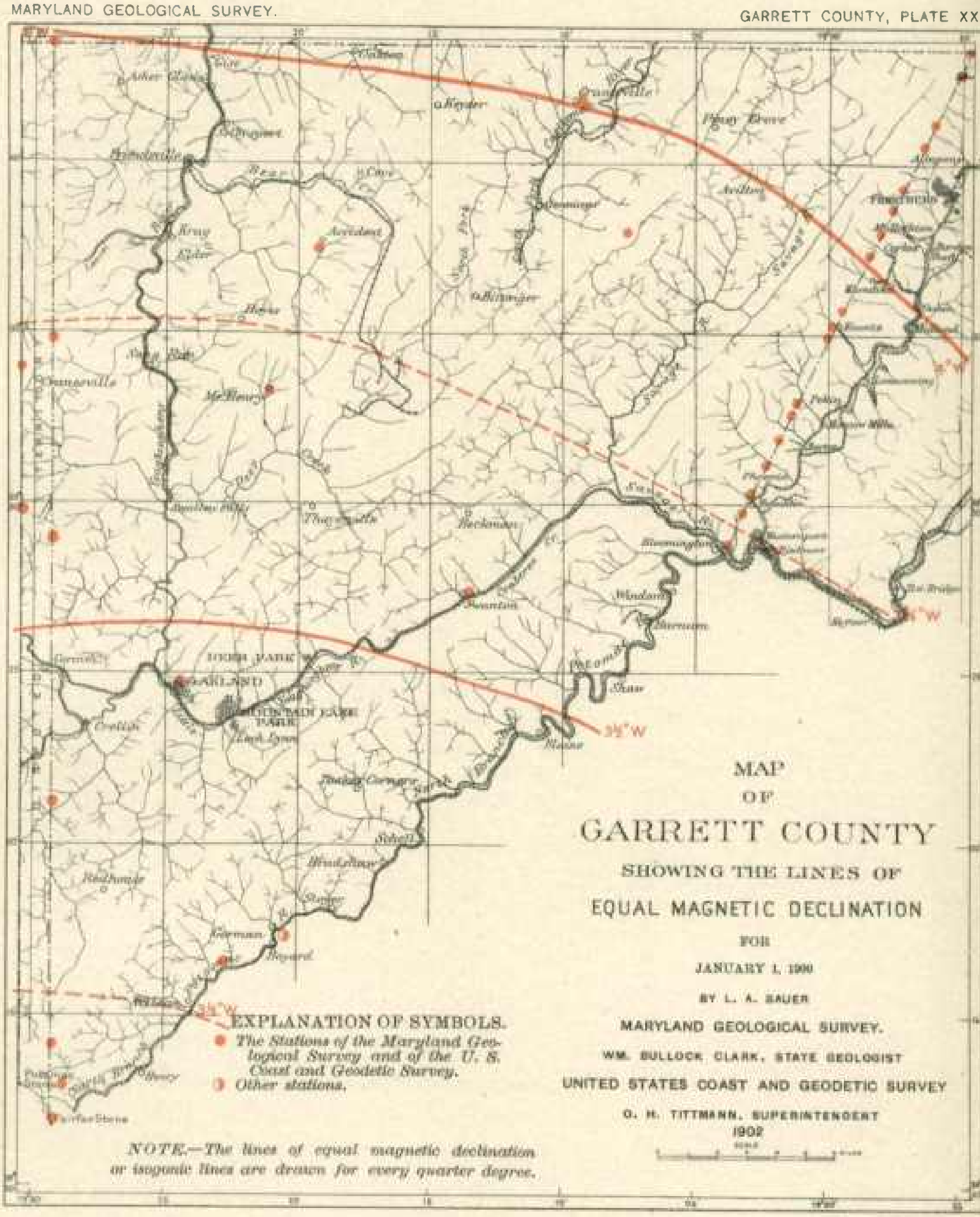
TABLE II.—MAGNETIC DECLINATIONS ALONG BOUNDARY LINE BETWEEN ALLEGANY AND GARRETT COUNTIES, MARYLAND.

No.	Station.	Latitude.	Longitudo.	West Doclination on July 1, 1898.	West Declination on Jan. 1, 1900.
		° ′	° ′	° ′	° ′
1	Mound 1........................	39 43.4	78 54.8	4 07.7	4 12.2
2	" 2	39 42.5	78 55.4	4 06.5	4 11.0
3	Sampson Rock.................	39 42.4	78 55.7	3 58.4	4 02.9
4	Mound 4.......................	39 41.2	78 56.1	4 04.1	4 08.6
5	" 5..........................	39 40.5	78 56.6	4 04.7	4 09.2
6	" 7.........................	39 39.3	78 57.3	3 59.9	4 04.4
7	" 8..........................	39 38.6	78 57.7	3 59.3	4 03.8
8	" 9.....	39 37.9	78 58.2	4 03.4	4 07.9
9	" 10........................	39 37.3	78 58.5	3 57.9	4 02.4
10	" 13	39 35.7	78 59.5	3 53.3	3 57.8
11	" 14...........	39 35.1	78 59.9	3 54.3	3 58.8
12	" 15......................	39 34.7	79 00.1	3 54.6	3 59.1
13	" 18.........................	39 33.0	79 01.2	3 56.4	4 00.9
14	" 19..................	39 32.8	79 01.3	3 55.6	4 00.1
15	" 21.........................	39 31.8	79 01.9	3 51.3	3 55.8
16	" 22...........	39 31.0	79 02.4	3 51.2	3 55.7
17	" 23	39 30.1	79 03.0	3 48.5	3 53.0
18	" 24.........................	39 29.7	79 03.3	3 47.5	3 52.0
19	" 26...........	39 28.8	79 04.0	3 40.1	3 44.6
20	" 27. (Local disturbance)	39 28.8	79 04.0	3 07.1	3 11.6
21	Daniells Δ (In West Virginia)	39 28.0	79 02.7	3 11.1	3 15.6

ON THE ESTABLISHMENT OF THE MERIDIAN LINE AT OAKLAND.[1]

In compliance with the instructions received by the writer from the County Commissioners, through their attorney, Mr. E. H. Sincell,

[1] A MS. copy of this report was forwarded to the County Commissioners on the completion of the work.



A. Hoen & Co. Lith. Baltimore

under the date of July 19, 1897, *a true meridian line was established at the Court House Grounds on July 29-30, 1897.* An act of Assembly passed at the session of 1870[1] and codified in 1882[2] authorizes the County Commissioners to have such a line established at the expense of the county.

To meet the requirements of a surveyor's meridian line as satisfactorily as possible under the conditions prevailing about the Court House, it was decided to place the south meridian stone in the grounds in front of the Court House and the principal north meridian stone in Mr. James R. Bishop's field. In this way a very satisfactory meridian line was obtained.

It was understood that Mr. Bishop would give the County Commissioners a written promise such that the stone monument planted in his field would not be molested; he furthermore permitted Mr. W. McCulloh Brown, who assisted me most ably in the establishment of the line, to enclose the monument by a fence. To meet popular demands, as the distant stone was not visible to the naked eye, a third stone was planted in the meridian line, viz., in the Court House grounds 82.55 feet from the south stone. The surveyor should *set his instrument over the south or "reference" monument and sight on the Bishop or "range" monument.*

The method employed in obtaining the meridian line was that of altazimuth observations on the sun; these observations were made on July 29, the same instruments being used as in the magnetic work of the Maryland Geological Survey.[3] The accuracy aimed at was that the meridian line shall be correct to within one minute and the test observations made after the monuments had been set gave evidence that the desired accuracy had been reached.

The monuments marking the ends of the line are substantial granite posts, $7'' \times 7''$ square and $4\frac{1}{2}$ feet long; they are suitably lettered and were embedded in several courses of concrete and allowed to

[1] Laws of Maryland, 1870, Chapter 359.

[2] Maryland Code, 1888, Vol. I, Art. 25, sections 77–82.

[3] See "First Report on Magnetic Work in Maryland," Maryland Geological Survey, Vol. I, pt. v.

project above the surface about 5 inches. The intermediate stone was prepared by a mason in Oakland and is not quite so substantial as the two principal stones. In the center of each monument is leaded a brass dowel, 1 inch in diameter and 3 inches long. *The line passing through the centers of the crosses cut on these bolts is the true north and south line.*

The magnetic declination (variation of the compass) reduced to its average value for the day (24 hours) was found to be at the *south* or *reference* monument:

Date,	Amount,
July 29 and August 2, 1897.	$3° 23'.0$[1] West.

There is a possibility that there may be a slight local attraction at the south monument, but if so, its effect is very small and can be neglected by the surveyor. [On October 12, 1896, the writer made magnetic observations in the lot back of the new public school (60 paces north of school, 20 paces from east board fence, 16 paces east of oak tree at west fence and 17 paces southwest of large oak tree near north fence) and found the value of the magnetic declination to be $3° 14'.5$. This value referred to August 2, 1897, would be $3° 17'$. A very heavy magnetic disturbance occurred on October 12, and although the values found on this day were corrected with the aid of the observations made at the Washington Magnetic Observatory, it is nevertheless quite possible that the correction applied was not entirely correct.]

The annual change of the magnetic declination or variation of the compass may be taken to be at the present time as:

$3'$ (three minutes) increase.

The table below shows how the magnetic declination has changed between the years 1750-1900 at a station referred to the south meridian stone in the Court House grounds.

[1] On June 5, 1899 the writer found the value, using same instrument as before, $3° 25'.7$. Mr. W. McCulloh Brown obtained the following values with his transit needle as standardized with the Coast and Geodetic Survey magnetometer, June 24, 1898, $3° 24'.4$, Jan. 13, 1899, $3° 22'.2$ and on June 13, 1899, $3° 19'.8$. The value given in Table I utilizes all these values.

Year.	Needle pointed.	Year.	Needle pointed.	Year.	Needle pointed.
1750	1°22′W	1800	1°19′E	1850	0°08′W
55	1 00 W	05	1 21 E	55	0 26 W
60	0 41 W	10	1 22 E	60	0 45 W
65	0 22 W	15	1 21 E	65	1 05 W
70	0 00	20	1 19 E	70	1 26 W
75	0 20 E	25	1 09 E	75	1 47 W
80	0 39 E	30	0 56 E	80	2 08 W
85	0 53 E	35	0 40 E	85	2 29 W
90	1 04 E	40	0 25 E	90	2 50 W
95	1 13 E	45	0 08 E	95	3 11 W
1800	1 19 E	1850	0 08 W	1900	3 30 W

With the aid of these figures the surveyor can readily ascertain the amount of change of the needle between any two dates. It should be emphasized, however, that when applying the quantities thus found in the re-running of old lines, the surveyor should not forget that the table cannot attempt to give the correction to be allowed on account of the error of the compass used in the original survey.

To reduce an observation of the magnetic declination to the mean value for the day of 24 hours, apply the quantities given in the table below with the sign as affixed:

Month.	6 A. M.	7	8	9	10	11	Noon	1	2	3	4	5	6 P. M.
	′	′	′	′	′	′	′	′	′	′	′	′	′
January	−0.1	+0.2	+1.0	+2.1	+2.4	+1.2	−1.1	−2.5	−2.6	−2.1	−1.3	−0.2	+0.2
February	+0.6	+0.7	+1.5	+1.9	+1.4	−0.1	−1.5	−2.1	−2.5	−2.0	−1.2	−0.8	−0.4
March	+1.2	+2.0	+3.0	+2.8	+1.6	−0.6	−2.5	−3.4	−3.7	−3.3	−2.3	−1.2	−0.5
April	+2.5	+3.1	+3.4	+2.6	+0.8	−2.1	−4.0	−4.1	−4.2	−3.6	−2.3	−1.2	−0.2
May	+3.0	+3.8	+3.9	+2.6	+0.1	−2.4	−4.0	−5.0	−4.5	−3.6	−2.3	−0.9	+0.1
June	+2.9	+4.4	+4.4	+3.3	+1.1	−2.0	−3.6	−4.5	−4.5	−3.8	−2.6	−1.2	−0.2
July	+3.1	+4.6	+4.9	+3.9	+1.8	−1.2	−3.4	−4.4	−4.7	−4.2	−2.8	−1.3	−0.3
August	+2.9	+4.9	+5.4	+3.7	+0.4	−2.8	−4.7	−5.1	−4.9	−3.7	−1.9	−0.6	+0.3
September	+1.8	+2.8	+3.4	+2.5	+0.3	−2.7	−4.4	−4.6	−4.2	−4.0	−1.4	−0.3	−0.1
October	+0.5	+1.6	+3.1	+2.8	+1.4	−1.0	−2.7	−3.3	−3.4	−2.4	−1.3	−0.4	−0.4
November	+0.5	+1.2	+1.7	+1.8	+1.1	−0.5	−2.[illegible]	−2.7	−2.6	−1.8	−1.0	−0.2	+0.2
December	+0.2	+0.3	+0.8	+1.8	+1.8	0.0	−1.6	−2.4	−2.3	−1.8	−1.1	−0.3	+0.1

ANGLE.

The angle between the true meridian line and the tip of spire of Presbyterian Church is, at the south meridian stone:

63° 14′.8 W. of N.

The latitude of the Court House may be taken to be 39° 24′.5 and the longitude 79° 24′.5 W. of Greenwich or 2° 24′ W. of Washington. To obtain true local mean time, or solar time, subtract from Eastern or Standard time, 17 minutes and 38 seconds.

Description of Stations.

WESTERN BOUNDARY OF MARYLAND, STATIONS OF 1897, ALONG THE "FAIRFAX" MERIDIAN LINE.

72 and 72A. FAIRFAX STONE.—This stone was the initial point of the Michler survey of the Western Boundary Line and is situated at one of the head springs of the North Branch of the Potomac river. The original Fairfax Stone planted in 1745 has disappeared since the Michler survey (1859) and instead is a monument about three to four feet high, which Lieut. Michler stated he placed directly behind the Fairfax Stone and used as a pier for his instrument. The magnetic observations were made partly a few feet north of the stone but mainly, however, at a point 463 feet north (72A).

73. CAMP FAIRFAX.—Near the barn on Mr. Patrick Flynn's farm situated east of the Michler line and between the Fairfax and the Backbone monuments.

74. BACKBONE MOUNTAIN.—On the summit of the Backbone or Big Savage Mountain near the Michler monument, a monument built of dressed stones and about 4 feet high. The precise point was about 11 feet south of the monument, which is about 15,000 feet north of the Fairfax Stone and approximately 3323 feet above sea-level.

77. LOWER HILL.—A few feet north of stone with a copper bolt in it, projecting about a foot above the ground, the stone having been planted by L. A. Bauer in 1897 to mark his meridian line. A few feet east is a pile of stones placed by Lieut. Michler in 1859.

78. SNAGGY MOUNTAIN.—The magnetic station is marked by a hole drilled in a rock 78.85 feet nearly north of Michler monument.

80. FEIK HILL.—The magnetic station was 30 feet a little west of north from the Michler monument.

82. MASON AND DIXON.—The magnetic observations were made at a point in the field 273 feet north of the Michler monument, which marks the intersection of the Michler meridian line with the Pennsylvania or Mason and Dixon line.

WESTERN BOUNDARY OF MARYLAND, STATIONS OF 1897, ALONG THE "POTOMAC" MERIDIAN LINE.

76. FOLEY MOUNTAIN.—Near Brookside, W. Va. The station is on the top of the mountain in the clearing for the meridian line 22.05 feet, 35° 01′.2 west of north from L. A. Bauer's meridian station.

79. TAYLOR'S HILL.—The magnetic station is 51.3 feet north-northwest of meridian station.

81. FEIK HILL.—North of a large flat rock at north end of clearing for the meridian line.

STATIONS IN THE INTERIOR OF COUNTY.

70. CORUNNA, 1897 and 1900.—On Mr. W. McCulloh Brown's estate near Bayard. Precise point was over the North monument of the meridian line established by L. A. Bauer in 1897.

24. OAKLAND, 1896.—In the lot back of new public school, 60 paces north of latter, 20 paces from east board fence, 16 paces east of oak tree along west fence and 17 paces southwest of large oak tree near north fence.

24A. OAKLAND, 1897.—In the court-house yard over the South monument of the meridian line established by L. A. Bauer in 1897.

95. SWANTON, 1899.—In the southeast corner of garden in front of Mr. W. H. Lohr's frame dwelling used as a boarding-house. Precise point is marked by a nail in a stake driven in an old stump.

91. MCHENRY, 1899.—Over red sandstone rock in lot south of frame schoolhouse, directly north of Mr. Brison Welsh's house. The point is marked by a ½-inch hole drilled in the rock 57.7 feet from southwest corner of schoolhouse and 66.8 feet from southeast corner.

92. ACCIDENT, 1899.—In the south corner of school lot opposite Bellevue Hotel. Marked by a stake which is 62.9 feet from east corner of frame schoolhouse and 93.7 feet from west corner.

94. NEW GERMANY, 1897.—On Mr. J. C. Otto's farm; in the meadow about 300 feet east of house and about 25 yards east of garden. Precise point is marked by a ½-inch hole drilled in large flat sandstone sticking out of the ground. There is another stone about 10 feet west.

93. GRANTSVILLE, 1899.—Near the west corner of schoolhouse lot, opposite Farmers' Hotel. Marked by a cherry stake, 2 x 2 inches square; with brass screw in the top, and having a pine stake driven alongside as a wedge. This stake is 69.25 feet from east corner of schoolhouse and 32.8 feet from second locust tree east of gate of entrance to school.

STATIONS ALONG BOUNDARY LINE BETWEEN GARRETT AND ALLEGANY COUNTIES.

1. Mound on Mason and Dixon line. "On the summit of Big Backbone or Savage Mountain, where that mountain is crossed by Mason's and Dixon's line." Reached by mountain road from Mount Savage railroad station. A more roundabout way, but a better road, is from Frostburg by way of Finzell postoffice. The gate-house of the Standard Oil Pipe Line is about 50 yards to the north of the mound. The mound, consisting of stone entirely, was built between two rocky ledges. No hole could be dug, as the precise point was in the crevice of a large, deeply embedded sandstone rock. The subsurface marks are two iron expansion bolts[1] in this rock, one of the bolts being 9 inches to the east of the precise point, and the other 9 inches to the west. The precise subsurface point is therefore midway between the crosses on the bolts. The crevice was enlarged sufficiently so that the surface stone (a rough sandstone 3 feet high and about 70 inches

[1] These bolts wedge tight in driving; the head is one inch square, and they are ½ inch in diameter and 2½ inches long.

square) could be wedged into the lower rock. Around this stone was thrown up a substantial mound consisting, in the absence of earth, of large and small stones. A half-inch hole in the top of the stone marks the precise point. In order that this stone might be replaced easily in case it should be thrown out of position in some manner, two good solid sandstone rocks jutting out of the ground along the line were marked by iron expansion bolts placed in true line. The first bolt is 15.18 feet back of hole in stone; the second, 22.84 feet in front of it (toward mouth of Savage river). Besides this a bolt was placed forward in line in sandstone rock 154¾ feet.

2. Mound on Mount Savage fire-clay hill. About 500 feet from second dump on fire-clay incline plane. Most easily reached from Mount Savage or from Finzell. Marking stone is 3½ feet high and 8 x 10 inches square, with a hole in top marking precise center. Mound, trench, subsurface stone as prescribed. Pitch pine tree 18 inches in diameter stands about 9 feet north of mound.

3. Mound on Piney Hill, better known as Cranberry Hill. About 300 feet east of mountain road known as Cranberry road, running north from National Road to fire-clay mine. The subsurface stone is about 5 inches thick with center marked on it; on this was placed a stone 2½ feet high and 5 x 10 inches square with hole in top. Mound and trench around the stone as usual.

4. Mound on Roaring Hill. About ¾ mile north of National Road, where old toll-gate formerly was, not far from house occupied at present by John Workman. A subsurface stone (with center), mound and trench as usual. The upper stone is 2 feet long and 5 x 12 inches square, the longer dimension being along the line. A drill hole started in top of stone marks precise point.

5. Mound on National Road. 1½ mile from Frostburg, on south side of pike and about 56 feet west of iron columns marking site of old toll-gate. The principal stone is dressed, of white marble, 3 feet long and 6 x 6 inches square, with corners rounded off to prevent chipping. A ¼-inch hole in top marks precise point, and the top of stone is lettered as follows:

$$\boxed{\begin{array}{c}\text{Md. G. S.}\\ \text{—}\\ \text{1898}\end{array}}$$

On the east side of stone is the letter *A* and on the west side *G*. The monument rests on a flat rock (the subsurface mark) and is set in a mixture of broken stone and hydraulic cement. The usual mound and trench surround the monument.

6. Mound on hill south of National Road. About ¾ of a mile south of pike, between two runs, on level piece of cleared ground near an old road and near Frostburg pipe-line for water supply, and not many feet west of artesian well. The upper rock is 2½ feet long and about 6 inches square on top. A drill hole started in top marks center. Subsurface stone, mound (9 feet in diameter) and trench as usual.

7. Mound near old Braddock road, on hill north of Winebrenner Run, 1½ mile north of Midlothian. The mound is about 50 yards north of the Braddock road. The upper stone is about 3 feet long, 8 inches square, rudely dressed and with center marked in top. Subsurface mark, mound and trench as prescribed.

8. Mound on hill south of Winebrenner Run, ¾ of a mile northwest of Midlothian. On the face of hill sloping toward N. E. upon lower part of spur, about half-way to top of hill and near an old log road, one quarter of a mile south of Benjamin Filer's house, which is in sight. The upper stone is 2.2 feet long and 8 inches square on top with center marked. Subsurface stone, mound and trench as usual.

9. Mound on hill north of Staub Run. About ¾ of a mile northwest of Carlos, on farm belonging to William Filer. In the woods, about 100 yards south of rail fence at brow of hill, where miner's path intersects fence. This path leads down to road coming out at Carlos. The upper stone is a red sandstone, about 5 inches thick and about 2½ feet long, with hole drilled in top. Subsurface stone, mound, trench. Mound had to consist chiefly of stone.

10. First mound on hill south of Staub Run. About ¾ of a mile west of Carlos. Take road as far as William Filer's house, then follow miner's path to mine opening about ½ mile, then bear to the right to cutting. The hill belongs to the Consolidation Coal Company.

11. Second mound on hill south of Staub Run. About 268 paces south of first mound. The two mounds were placed so near to each other so as to give intervisible points to the north and south. From north mound, mounds 9, 7, 4 and 1 are visible (or can be made so), and from south mound No. 12 can be seen.

12. Mound on north side of Koontz Hill. South of Wrights Run and reached from either Lonaconing, Midland or Ocean. A road passes within 20 yards of the mound and continues northward on down the hill to Ocean, or southward past Cutter's barn down the hill to Lonaconing. Not a very good looking stone, but a substantial one, forms the principal stone. The mound consists chiefly of stone.

13. Mound on south side of Koontz Hill. About 2 miles northwest of Lonaconing. On the south side of lane leading to the west of gate to Cutter's barn and house, and 70 yards from the gate. The farm belongs to the New Central Coal Co., and is rented by Barney Cutter, whose brother, Henry, is at present living on the place. The precise point is marked by a cross cut in stone, 3½ feet long and about 7 x 7 inches square. In center of cross was drilled a ⅛-inch hole. From this mound, mound No. 15 can be seen by planting a pole on top of it.

14. Mound on Pea Ridge road. On the north side of the road leading from Lonaconing to Pea Ridge, about 1½ mile from Lonaconing. Center stone is about 13 inches square and about 3½ feet long, resting about 2 feet in the ground. Precise point was marked with a pick in center of stone. No subsurface mark. Mound about 1½ foot high and 6 feet in diameter, consisting of earth and stone thrown up against center stone.

15. Mound on hill west of Lonaconing. On property of Maryland Coal

Company; near fence on west side of meadow south of house occupied by Mr. Weir, who is the present tenant of the farm. Precise point is marked by a cross and ¼-inch hole in center of top of central stone of mound. Subsurface stone, mound and trench as usual. From this mound are visible several points in the line as far south as Franklin Hill.

16. Mound on Detmold Hill. On the west end and on the highest point of the hill. Reached by Miller road running from Detmold to Grantsville, within about ¼ of a mile to the west of mound. Mound is built on an undisturbed, solid stone with subsurface mark on it, and around a smooth, upright stone, 3 feet long and 6 x 9 inches on top.

17. Mound near Miller Road. South of Detmold Hill, between Laurel Run and Miller road, which runs from Georges Creek road to Grantsville; one rod north of road and about ¼ of a mile from Robert Green's farm. The precise point is marked by a hole in the central stone, which is 3 feet long and 8 x 10 inches on top. Subsurface mark, mound, trench.

18. Stone on North Pickell Hill. About ¼ mile to the north of next mound (No. 19). No mound was built, but simply a stone 2 feet long and 4 x 14 inches on top was set in the ground and stones firmly packed around it. The stone is north of a road to meadow on hill. Coal mines are on fire on this hill.

19. Mound on South Pickell Hill. Reached from Barton by taking county road to Grantsville, or also from Moscow, mound being about 2 miles west of latter point. Constructed in the usual manner. Precise point is a cross cut in top of central stone.

20. Mound on Bartlett Road. On county road leading from Barton to Grantsville, about 1½ rod north of road, on land owned by Wm. Sommerville. Constructed in the prescribed manner.

21. Mound on Swanton Hill. Reached from Barton by a very steep road to top of hill. Mound is about 40 paces north of barbed-wire fence dividing the American Coal Co. property from that of the Swanton Coal Co. The precise location can be pointed out by Peter Shaw, who lives on top of hill. The central stone of the mound has a cross cut in the top and the letters *A* and *G* rudely cut in the sides. Franklin Hill mound (No. 24) can be seen from this point; also No. 15.

22. Mound on Phoenix Hill. Reached from Morrison switch by taking Phoenix Hill road. It is on the summit in a meadow owned by the Davis Coal and Coke Co. and leased by John Lannon. Built in the usual manner.

23. Monument on county road south of Phoenix Hill. Reached from Franklin railroad station. On the north side of the road. A good, substantial stone firmly set in the ground and smaller stones packed around it. The mound is about three rods east of U. P. Gannon's house.

24. Mound on north side of Franklin road. On the highest point of the hill reached by the line. About 50 feet to the south the hill breaks off very abruptly and only a short distance beyond the tramway curves around the hill to the west. The central stone is about 2½ feet long and about 12 inches square. A cross cut in the top marks the precise point. Subsurface stone, mound and trench.

25. Mound on south side of Franklin Hill. About 20 yards north of

county road where it crosses bridge over the Davis coal mine plane. The subsurface mark is a cross cut in a sandstone about 1½ foot long, 8 inches wide and 10 inches thick, lying with the longer dimension at right angles to the line. On this solid stone rests a dressed marble post 2½ feet long and 6 inches square. Around the stone is a mound 8 feet in diameter, consisting of earth and stone; a trench encircles the mound. The stone is lettered on top:

Md. G. S.
1898

On the west side is the letter *G* and on the east side *A*. The precise center is marked by a half-inch hole drilled in the top of the stone.

26. Mound at mouth of the Savage. On the south side of the road leading to Bloomington about 100 feet above the Savage river. The central stone is a dressed marble post, 2½ feet long and 6 inches square, marked and lettered as in the case of No. 24.

27. Bolt in rock at mouth of Savage river. Set with plaster of Paris in a good, firm rock close to the river. Bolt is ¾ inch in diameter; head about 1¼ inch round. For references and distances to other marks at the mouth of the Savage, see Report on the Survey of the Boundary-line between Allegany and Garrett Counties, page 33.

THE FORESTS OF GARRETT COUNTY

BY

H. M. CURRAN

WITH AN INTRODUCTION BY GEORGE B. SUDWORTH

INTRODUCTION.

The following report on the "Forests of Garrett County" is made under the direction of the Bureau of Forestry, in cooperation with the Maryland Geological Survey. For the history of this cooperation and a statement of the special purposes of these forest investigations, the reader is referred to the reports on the "Forests of Allegany County,"[1] and the "Forests of Cecil County."[2]

Mr. H. M. Curran, Agent in the Bureau of Forestry, Division of Forest Investigation, has prepared the present report, which is based on a careful personal study of the forest conditions of the county. He was assisted in making valuation surveys of the several types of forest by Messrs. J. E. Keach, A. O. Waha, and F. R. Miller. Credit is due, also, to Mr. John Foley, of the Division of Forest Management, for the very excellent photographs from which the half-tone illustrations for this report were made.

A very important feature of Mr. Curran's report is the development of the fact that Garrett county still possesses considerable timber, and that, with fire protection and regulated cutting, the forests of the county can be expected to yield a steady supply of timber, which is greatly needed for the development of local mines and other industries. As a means of securing a constant supply of timber and also of increasing and preserving the natural beauty of the region, the recommendation that the state acquire as rapidly as possible, as

[1] Md. Geol. Survey, Allegany County, 1900, p. 263.

[2] Md. Geol. Survey, Cecil County, 1902, p. 295.

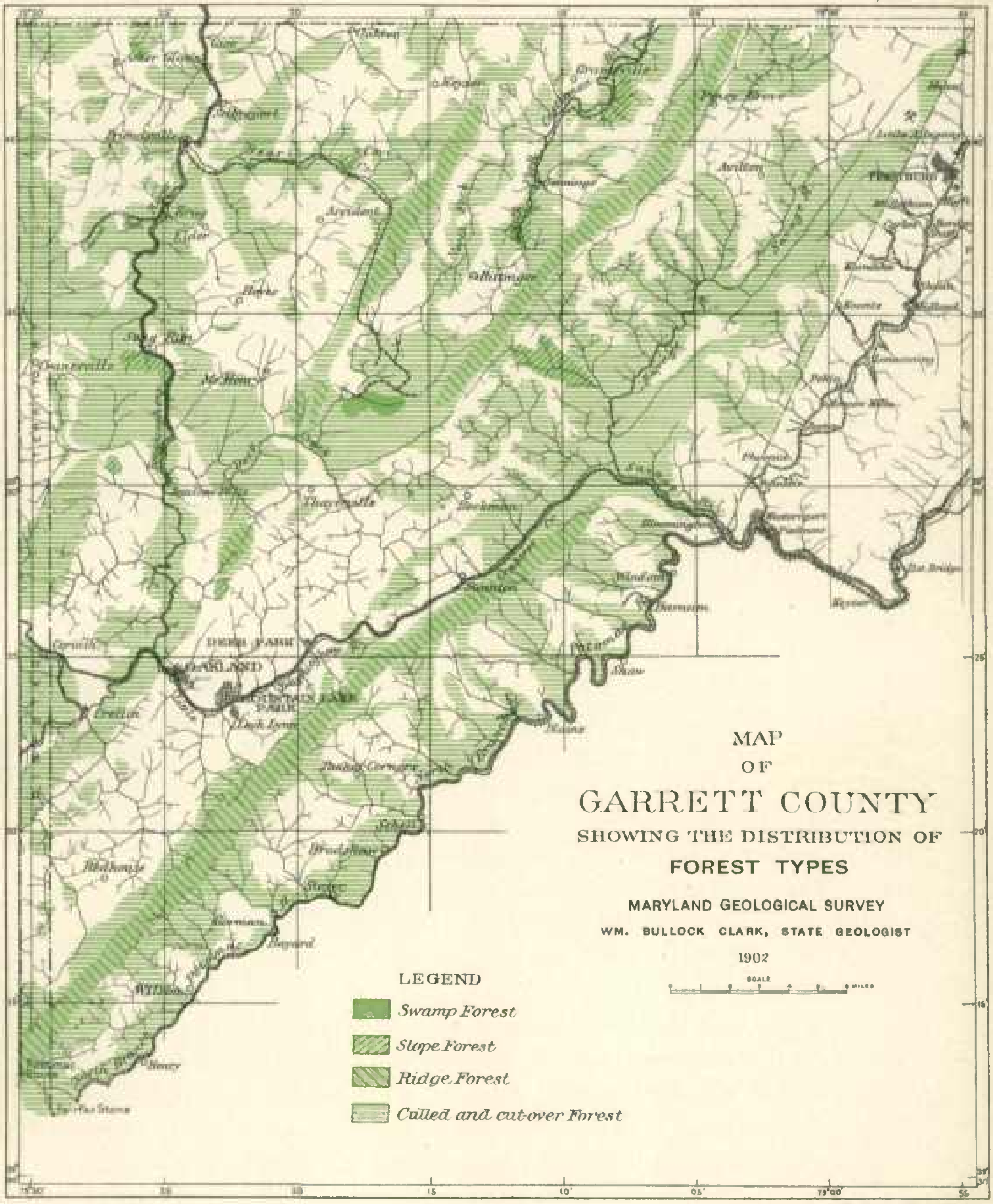
much non-agricultural land as is available for the establishment of a forest reserve, is worthy of serious consideration. In the same manner that the adoption of a national forest policy is necessary and is becoming more and more possible, it is the duty and to the interest of every forest-bearing state to give support to the general movement and at the same time to determine a policy for the fullest development and the best management of its forest resources. Garrett county has a large area of rough, untillable mountain land suitable only for forest growth. It is believed that this land should be concentrated in a state forest reserve.

While the general advice given in the present report for the care of woodlands is not intended to take the place of a detailed forest working plan, nevertheless, observance of this advice will go far to improve the present condition of Garrett county forests. It is hoped, also, that the present report will pave the way for a more detailed study of Garrett county forest lands and stimulate the owners of both large and small woodlots to apply the principles of practical forestry.

General Conditions.

Garrett, as has been described in the preceding pages, is the largest and most western of the counties of Maryland. Within its roughly triangular shape, it has an area of 680 square miles, or 435,200 acres. The northern boundary of the county is formed by Pennsylvania, the southern by the Potomac river, and the western by West Virginia. Allegany county lies to the east of Garrett. The dividing line is straight and extends in a southwesterly direction from the crest of Savage Mountain at the Mason and Dixon Line, to the confluence of the Savage and Potomac rivers. The only irregular boundary of Garrett county is the southern, where the county line follows the windings of the Potomac river.

The most marked topographic features of the county are four high, flat-topped mountain ridges, which extend from Pennsylvania into the county in a southwesterly direction. The two central ridges which are known as Negro and Meadow mountains, converge near Thayerville, whence they extend southwestward in a single but less distinct



A. Hoen & Co. Lith. Baltimore.

P. 304 B

ridge of which Roman Nose is the highest peak. The eastern and longest ridge extends entirely across the county and bears the names of Savage and Backbone mountains. Savage river breaks through this ridge in the eastern part of the county, the northern portion of the ridge being known as Big Savage Mountain and the southern as Great Backbone Mountain. Winding Ridge, which is the fourth and most western, extends parallel to Negro Mountain from the Pennsylvania line to a point near Sang Run. Here its distinct ridge-like character is lost in an irregular group of peaks and table-land on both sides of the Youghiogheny river. These four main ridges have a general elevation above sea-level of from 2500 to 3400 feet. They often rise abruptly to elevations above the river beds of from 1000 to 1800 feet. The river channels through the mountains are deep, narrow ravines, with sides so steep and strewn with boulders as to be difficult of ascent.

The agricultural valleys between the ridges and along the streams have a general elevation of 2500 feet above sea-level. They are seldom more than 500 feet below the crests of the highest ridges and are usually 500 to 1000 feet above the river beds.

Garrett county is well drained. The streams start on the high mountain slopes and flow rapidly to the rivers below. The principal streams of the county are, the Youghiogheny, Potomac, Savage, and Castleman rivers. The Youghiogheny and Castleman rivers unite in Pennsylvania and join the Monongahela. Their waters, through the Ohio and Mississippi, finally reach the Gulf of Mexico. The Savage and Potomac rivers unite and send their waters to Chesapeake Bay.

The rivers are from thirty to one hundred feet in width, and their beds are usually filled with a mass of rounded stones and boulders.

The depth of water varies with the width of the stream and the season of the year, from a few inches to three or four feet. The boulders in the stream beds make navigation of any kind impossible. It is therefore necessary to remove the timber along the streams by means of railroads following the watercourses.

The area of Garrett county is 435,200 acres. The agricultural valleys include forty-six per cent of this, or 199,900 acres. It is not probable that the farming areas of the county will be materially increased in the future, as the best lands are now occupied, and many areas once cultivated are being abandoned on account of their poor soil. The tilled lands often extend up from the valleys over the foot-hills and high on the ridges themselves. The soils of the valleys are deep and vary from a clay to sandy loam. The soil of the higher slopes is shallow and rocky, but fertile, producing good grain crops.

Forest Lands.

Fifty-four per cent, or 235,200 acres, of Garrett county is wooded. Of this wooded area, 210,200 acres are cut-over or culled forest lands, and 25,100 acres are in virgin forests.

CUT AND CULLED FORESTS.

These areas are found in all parts of the county and include the principal types of timber discussed later. The best or all of the timber on these lands has been taken. The present growth varies from low brush of Mountain Laurel and Barren Oak to mature forests from which only the best material has been removed. The largest portion of the culled and cut-over lands bears a sprout growth of oaks and chestnut, 5 to 30 feet high. Scattered singly or in groups through these sprout forests are old defective or inferior trees left by the lumbermen. The soil of these forest lands varies, but is mainly poor, shallow, and rocky, unsuited to agriculture other than pasture. The map (Plate XXI) shows the area and distribution of these lands with reference to the agricultural lands and virgin forests.

VIRGIN FORESTS.

The present area of the virgin forests of the county is 25,100 acres. The timber is, however, rapidly disappearing. The local mills cut annually from 1000 to 3000 acres. The acreage of these forests may be divided among three types, as follows:

Type.	Acres.
Ridge Timber	20,220
Slope Timber	4,193
Swamp Timber	733
Total	25,146

At present the greater part of the lumbering is in the Slope and Swamp forests, but unless the ridge timber is also cut, most of the mills will be idle in a few years.

The character of the virgin forests may be best understood by a study of them by types. The distribution of the types is shown on the map (Plate XXI).

Ridge Timber.

This forest type occupies the benches and broken, rocky crests (see Plate IX, Fig. 6 and Plate XXV, Fig. 1) of Backbone, Meadow, and Negro mountains. It is essentially a chestnut forest. The soils upon which it occurs are shallow and sandy, or very rocky. The acreage of this forest (20,220) is four times the combined acreage of the other two types. Commercially it is the least important of the three. This is due to the inferior character of the Ridge Timber. The trees have short trunks, and are often stunted in exposed situations. The Chestnut, which is the principal commercial tree of the type, is usually defective. The trunks are first injured by repeated fires, and finally rendered unfit for lumber by the entrance of fungi and insects. The defectiveness of the Ridge Timber is the principal reason for such large areas remaining unlumbered. It is probable that, with the exhaustion of the timber of the Slope and Swamp forests, and the development of the mining interests of the county, the Ridge Timber will be lumbered and thus added to the cut and culled area of the county. The character of this type, in which Chestnut predominates, is shown in Table No. 1, on following page.

Slope Timber.

The Slope Timber is commercially the most important of the three types. It contains the largest number of species, and, with one exception (Table No. 6), the heaviest growth of timber. The composition of the slope forest varies between two extremes. On the steep slopes above the Youghiogheny river it is often pure Hemlock, and in the richer coves almost pure White Oak. Between these extremes we have slopes upon which Hemlock and hardwoods mingle, while on other slopes Chestnut predominates, there being but little Hemlock or White Oak present.

TABLE NO. 1.

Average of 33 acres.

Trees 12 inches and over in diameter breast-high.

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high. Inches.	Average stand per acre. (Doyle Rule.) Board Feet.
Chestnut	29.45	47.34	18.6	10,034.59
Red Oak	12.47	20.04	17.9	2,170.28
White Oak	6.68	10.73	18.1	1,582.23
Chestnut Oak	4.00	6.43	16.7	843.19
Red Maple	3.30	5.34	16.6	914.40
Sweet Birch	2.42	3.88	15.8	331.31
Hemlock	.18	.29	24.4	149.25
Basswood	.15	.24	15.5	18.09
Beech	.06	.09	15.1	9.57
White Pine				
Spruce				
Sugar Maple				
Yellow Birch				
Other species	3.50	5.62	14.1	354.03
Average of all species	62.21	100.00	17.5	16,406.94

NOTE.—"Other species" include the occasional and inferior trees occurring with the merchantable species.

The Slope Timber may be divided into the following sub-types, which are determined by the abundance of the principal species:

Sub type.	Acres.
Chestnut	2,290
Hemlock and hardwoods	1,280
White Oak	480
Hemlock	143
Total	4,193

CHESTNUT.—This sub-type is found in two bodies, one on the Youghiogheny river, near Sang Run, the other on Monroe Run, a tributary of Savage river. These bodies occupy steep slopes above the streams and represent the best hardwood growth of the county. The following table shows the composition of these forests:

FIG. 1.—HEMLOCK AND HARDWOODS, NEAR BEVANSVILLE.

FIG. 2.—WHITE OAK AND HEMLOCK, NEAR BEVANSVILLE.

FORESTS OF GARRETT COUNTY.

TABLE NO. 2.

SUB-TYPE: CHESTNUT.

Average of 15 acres.

Trees 12 inches and over in diameter breast-high.

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high	Average stand per acre. (Doyle Rule.)
			Inches.	Board Feet.
Chestnut	22.29	36.06	19.7	8,906.09
Sugar Maple	12.68	20.51	18.2	4,355.25
Red Oak	5.66	9.16	22.9	2,571.90
Basswood	5.41	8.75	16.6	851.06
Yellow Birch	2.47	3.99	15.6	344.63
Sweet Birch	2.07	3.34	16.5	331.36
Beech	1.75	2.83	16.4	366.69
White Oak	1.55	2.51	23.5	988.37
Chestnut Oak	.14	.23	19.4	29.12
Hemlock				
White Pine				
Spruce				
Red Maple				
Other species	7.80	12.62	15.2	946.93
Average of all species	61.82	100.00	18.6	19,691.39

WHITE OAK.—There are only three small bodies of this sub-type in the county, and the preservation of this timber is accounted for by the fact that the owners do not wish to sell. White Oak was one of the first timbers cut in the county and is still eagerly sought. The best of this oak is found in coves, or on moist, gentle slopes along streams. The soil which it occupies is usually deep, and makes good farming land. With the removal of this timber and the clearing of the land, it is hardly probable that there will ever be a second growth of pure White Oak in the county. The character of the White Oak stands is shown in Table No. 3, on following page.

HEMLOOK AND HARDWOODS.—The forests of this sub-type were once quite extensive, occupying the gradual slopes along the rivers and other streams. Recent lumbering operations have rapidly reduced these areas. There are three small tracts in the county, two on Castleman river and one on Bear Creek. The Castleman tracts are being lumbered, while the Bear Creek tract remains uncut. The largest operations in the county have had for their principal object the removal of Hemlock. Extensive stands on the Youghiogheny river, Bear Creek, and Cherry Creek have been recently cut. Except in the recent cuttings on Castleman river, fire has followed lumbering, killing the reproduction and small trees left by loggers. In many places the fire has been so severe as to completely destroy all vegetation on the area; the abundant humus, and even the top layers of the soil have also been burned. No reproduction of Hemlock can be expected on these areas. The probability of a future stand of this species in the county is practically destroyed, unless artificial planting is done. (See Plate XXIII, Fig. 1.)

TABLE NO. 3.

SUB-TYPE: WHITE OAK.

Average of 25 acres.

Trees 12 inches and over in diameter breast-high.

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high. Inches.	Average stand per acre. (Doyle Rule.) Board Feet.
White Oak	46.80	81.12	17.7	10,110.08
Chestnut	6.20	10.75	18.7	2,134.72
Red Oak	2.32	4.03	17.4	448.00
Red Maple	1.32	2.29	15.4	271.44
Chestnut Oak	.64	1.11	18.6	169.08
White Pine	.12	.21	15.3	29.84
Sweet Birch	.08	.14	16.1	11.88
Hemlock				
Spruce				
Sugar Maple				
Yellow Birch				
Beech				
Basswood				
Other species	.20	.35	14.7	22.16
Average of all species	57.68	100.00	17.6	13,197.20

The principal hardwood of this sub-type is Sugar Maple. The sugar groves of the county are small areas of the type from which the Hemlock and all hardwoods, except the Maple, have been removed. These sugar orchards are neither numerous nor extensive except in the Castleman valley. The farmers show but little interest in the maple sugar industry or in the orchards; the old trees are often defective and there are many dead trees throughout the groves. Nothing is being done to improve old groves or to produce new ones, and as the lumbering operations are taking the principal areas containing Sugar Maple, the future production of sugar and syrup will probably be small.

The character of the stand of this sub-type is shown in the following table:

TABLE NO. 4.

SUB-TYPE: HEMLOCK AND HARDWOODS.

Average of 29 acres.

Trees 12 inches and over in diameter breast-high.

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high. Inches.	Average stand per acre. (Doyle Rule.) Board Feet.
Hemlock	23.37	32.14	18.8	9,194.55
Sugar Maple	20.57	28.29	18.5	7,209.05
Beech	7.72	10.62	14.9	1,177.04
Basswood	5.54	7.62	17.1	707.60
Yellow Birch	4.34	5.97	17.7	801.45
White Oak	2.58	3.55	24.6	1,583.28
Chestnut	2.21	3.04	19.1	823.87
Red Oak	1.89	2.59	21.1	665.96
Sweet Birch	1.62	2.23	17.6	330.80
Chestnut Oak	.15	.21	22.9	76.84
White Pine				
Spruce				
Red Maple				
Other species	2.72	3.74	17.1	603.70
Average of all species	72.71	100.00	18.3	23,374.14

HEMLOCK.—The last stand of practically pure Hemlock is found on the Youghiogheny river near Muddy Creek. This, with the exception of the White Pine of the Swamp Timber, is the heaviest stand in the county. The trees are large and grow on steep, rocky slopes above the river. A dense thicket of laurel covers the ground under the trees and adds to the difficulty of lumbering. However, the cost of logging on this tract has not prevented the lumbermen from attempting the removal of the timber. A railroad is being built along the foot of this slope and with its completion logging will commence. (See Plate IX, Fig. 2.)

The character of the stand is shown in the following table:

TABLE NO. 5.

SUB-TYPE: HEMLOCK.

Average of 25 acres.

Trees 12 inches and over in diameter breast-high.

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high.	Average stand. per acre. (Doyle Rule.)
			Inches.	Board Feet.
Hemlock	54.72	86.04	20.0	27,483.41
Yellow Birch	4.20	6.60	16.2	681.92
Sugar Maple	1.56	2.45	19.8	673.16
Beech	1.00	1.58	14.9	154.56
Basswood	.76	1.18	17.2	149.28
Red Maple	.40	.64	14.8	74.12
White Oak	.20	.33	22.4	84.92
White Pine	.16	.25	21.0	77.88
Sweet Birch	.12	.19	13.1	9.52
Chestnut	.08	.12	13.0	8.00
Red Oak	.04	.06	17.0	7.00
Chestnut Oak				
Spruce				
Other species	.36	.56	16.3	62.52
Average of all species	63.60	100.00	19.6	29,466.29

Swamp Timber.

This is the last of the three principal types of virgin forest. The other two, Ridge Timber and Slope Timber, have each a much larger acreage than this. The Swamp Timber has fewer species than any of the types of forest, and yet contains the most valuable timber of all. The principal species are Spruce and White Pine, with a varying amount of Hemlock. The areas occupied by this type surround and extend into the swamps and sedge-covered tracts along the streams, known as Glades and mountain meadows. The wetter portions of these areas are covered with herbaceous plants and alder brush, and the drier portions are heavily wooded. The timber growth is mainly Spruce, with occasional groups of excellent White Pine. The last of this Swamp Timber is found in the depressions between Negro and Meadow mountains at the head of Cherry Creek. It is being

FIG. 1.—HEMLOCK AND HARDWOODS, CASTLEMAN RIVER.

FIG. 2.—RIDGE TIMBER. EFFECT OF FIRES ON CHESTNUT, BACKBONE MOUNTAIN.

FORESTS OF GARRETT COUNTY.

rapidly lumbered, and will be removed within two years. (See Plate XVIII, Figs. 1, 2.)

Two sub-types of the Swamp Timber are distinguishable; the first has White Pine as the predominant species, and the second, Spruce.

White Pine.—White Pine was once quite a common tree along the streams and rivers of Garrett county, and was one of the first timbers removed. It reached the best development and grew in almost pure stands on the moist level lands surrounding the swamps and mountain meadows. The areas occupied by this growth were never more than a few acres in extent, and the number of such areas was small. As a scattered tree along the streams and mountain slopes it was fairly common and reached large sizes. The reproduction of this pine is fairly abundant, considering the numbers of old trees and the treatment it has received. Young seedlings are found throughout the county and are making a good growth. (See Plate XVIII, Fig. 12.) The last group of pure White Pine in the county was cut recently.

The following table is the result of the measurement of three acres of this sub-type:

TABLE NO. 6.

Sub-type White Pine.

Average of 3 acres.

Trees 12 inches and over in diameter breast-high.

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high. Inches.	Average stand per acre. (Doyle Rule.) Board Feet.
White Pine	40.30	55.76	25.9	33,473.6
Hemlock	11.66	16.13	20.6	7,285.3
Red Maple	7.66	10.60	14.6	1,898.9
Spruce	7.65	10.57	16.0	1,369.3
Yellow Birch	4.00	5.53	15.4	533.0
Chestnut	.33	.47	17.0	79.3
White Oak	.33	.47	18.0	71.6
Red Oak	.33	.47	12.0	16.6
Basswood				
Sweet Birch				
Beech				
Sugar Maple				
Chestnut Oak				
Other species				
Average of all species	72.26	100.00	22.1	44,727.6

SPRUCE.—The winter of 1902 will probably see the last large stand of Spruce in the county removed. It is at the head of Cherry Creek, between Negro and Meadow mountains. The best of the Spruce occurs on the level or gradually sloping land surrounding the swamps. As the land rises, and becomes drier, oak and other hardwoods prevail. The stand of Spruce is good; the trees have grown rapidly, are tall, and the trunks are clean. In all respects it seems well adapted to this locality, and but for the fact that the lands upon which it grows are valuable for agriculture, it would seem wise to encourage the growth of Spruce. The reproduction here is fair, and except for the fires which follow logging, would insure a good second growth.

Spruce, like White Pine, sometimes occurs as one of the lesser components of the moist slope forests. On Backbone Mountain, near the West Virginia line, it occurs with Hemlock in considerable abundance, but is being rapidly removed.

The following table is from measurements taken in the stand of Spruce at the head of Cherry Creek:

TABLE NO. 7.

SUB-TYPE: SPRUCE.

Average of 20 acres.

Trees 12 inches and over in diameter breast-high.

Species.	Average number of trees per acre.	Percentage of each species.	Average diameter breast-high. Inches.	Average stand per acre. (Doyle Rule.) Board Feet.
Spruce	41.10	63.81	17.0	13,341.75
Hemlock	15.40	23.91	21.7	10,097.15
Yellow Birch	4.50	6.99	16.4	708.40
Red Maple	1.50	2.33	17.6	474.55
Beech	1.05	1.63	15.8	191.60
Sugar Maple	.50	.77	20.2	236.40
White Pine	.20	.31	19.1	69.25
Basswood				
Sweet Birch				
Red Oak				
Chestnut Oak				
White Oak				
Chestnut				
Other species	.15	.25	19.9	43.70
Average of all species	64.40	100.00	18.1	25,162.80

The Stand.

The figures for the present stand of timber in Garrett county were obtained by multiplying the acreage of each forest type by the average acre yield obtained from measurements of typical areas within the type. In the table no allowance is made for defective timber. The Ridge Timber has been excluded from the merchantable class on account of its general defectiveness.

The following tables show the present stand of virgin timber by types and the merchantable stand by types and species:

TABLE NO. 8.

TOTAL STAND.

Type. Sub-type.	Area. Acres.	Average stand per acre. Board Feet.	Total stand. Board Feet.
RIDGE TIMBER.			
Chestnut	20,220	16,406	331,729,000
SLOPE TIMBER.			
Chestnut	2,290	19,691	45,092,000
White Oak	480	13,197	6,334,000
Hemlock and hardwoods	1,280	23,375	29,920,000
Hemlock	143	29,467	4,213,000
SWAMP TIMBER.			
Spruce	730	25,163	18,368,000
White Pine	3	44,728	134,000
Total	25,146	17,330	435,790,000

TABLE NO. 9.

MERCHANTABLE STAND.

Type. Sub-type.	Area. Acres.	Average stand per acre. Board Feet.	Total stand. Board Feet.
SLOPE TIMBER.			
Chestnut	2,290	18,744	42,923,000
White Oak	480	13,175	6,324,000
Hemlock and Hardwoods	1,280	22,771	29,146,000
Hemlock	143	29,404	4,204,000
SWAMP TIMBER.			
Spruce	730	25,119	18,336,000
White Pine	3	44,728	134,000
Total	4,926	20,517	101,067,000

TABLE NO. 10.

MERCHANTABLE STAND.

Species.	Total Stand. Board Feet.
Hemlock	23,092,000
Chestnut	22,475,000
Sugar Maple	19,469,000
Spruce	9,745,000
White Oak	9,154,000
Red Oak	6,958,000
Basswood	3,132,000
Beech	2,509,000
Yellow Birch	2,432,000
Sweet Birch	1,188,000
Red Maple	491,000
Chestnut Oak	246,000
White Pine	176,000
Total	101,067,000

FOREST TREES.

Composition of Forests.

The forests of Garrett county, like those of Allegany county adjoining on the east, are rich in species. The following list includes most of the trees found in Allegany county[1] and has, in addition, a few trees not found there:

Conifers.

White Pine	*Pinus strobus.*
Pitch Pine	*Pinus rigida.*
Tamarack	*Larix laricina.*
Black Spruce	*Picea mariana.*
Red Spruce	*Picea rubens.*
Hemlock	*Tsuga canadensis.*

Hardwoods.

Butternut	*Juglans cinerea.*
Black Walnut	*Juglans nigra.*
Bitternut Hickory	*Hicoria minima.*
Shagbark Hickory	*Hicoria ovata.*
Mockernut Hickory	*Hicoria alba.*
Pignut Hickory	*Hicoria glabra.*

[1] See "The Forests of Allegany County," by Geo. B. Sudworth. Allegany County Report. Maryland Geological Survey, 1900.

FIG. 1.—VIRGIN FOREST NEAR GRANTSVILLE.

FIG. 2.—CULLED FOREST NEAR GRANTSVILLE.

FORESTS OF GARRETT COUNTY.

White Willow	*Salix alba.*
Aspen	*Populus tremuloides.*
Large-tooth Aspen	*Populus grandidentata.*
Yellow Birch	*Betula lutea.*
Sweet Birch	*Betula lenta.*
Hornbeam	*Ostrya virginiana.*
Blue Beech	*Carpinus caroliniana.*
Beech	*Fagus atropunicea.*
Chestnut	*Castanea dentata.*
White Oak	*Quercus alba.*
Chestnut Oak	*Quercus prinus.*
Red Oak	*Quercus rubra.*
Scarlet Oak	*Quercus coccinea.*
Yellow Oak	*Quercus velutina.*
Barren Oak	*Quercus pumila.*
Slippery Elm	*Ulmus pubescens.*
White Elm	*Ulmus americana.*
Red Mulberry	*Morus rubra.*
Cucumber-tree	*Magnolia acuminata.*
Tulip-tree	*Liriodendron tulipifera.*
Papaw	*Asimina triloba.*
Sassafras	*Sassafras sassafras.*
Witch Hazel	*Hamamelis virginiana.*
Sycamore	*Platanus occidentalis.*
Sweet Crab	*Pyrus coronaria.*
Mountain Ash	*Pyrus americana.*
Serviceberry	*Amelanchier canadensis.*
Scarlet Haw	*Crataegus coccinea.*
Black Cherry	*Prunus serotina.*
Redbud	*Cercis canadensis.*
Locust	*Robinia pseudacacia.*
Staghorn Sumach	*Rhus hirta.*
Dwarf Sumach	*Rhus copallina.*
Mountain Maple	*Acer spicatum.*
Striped Maple	*Acer pennsylvanicum.*
Sugar Maple	*Acer saccharum.*
Red Maple	*Acer rubrum.*
Basswood	*Tilia americana.*
Angelica-tree	*Aralia spinosa.*
Flowering Dogwood	*Cornus florida.*
Blue Dogwood	*Cornus alternifolia.*
Black Gum	*Nyssa sylvatica.*
Great Rhododendron	*Rhododendron maximum.*
Persimmon	*Diospyros virginiana.*
Black Ash	*Fraxinus nigra.*
White Ash	*Fraxinus americana.*
Red Ash	*Fraxinus pennsylvanica.*
Sheepberry	*Viburnum lentago.*

Distribution of Forest Trees.

The trees of the county may be divided into two groups, the merchantable and the unmerchantable. The first group includes all trees reaching a suitable size for timber and furnishing material for manufacture. The second group includes the remaining smaller trees of the county, their principal use being as props, charcoal, or cordwood.

Merchantable Species.—This group includes the six conifers found in the county and 38 of the hardwoods. The trees that occur in measurable quantities (as shown in the preceding tables) and furnish the bulk of the merchantable timber are: White Pine, Black Spruce, Red Spruce, Hemlock, Yellow Birch, Sweet Birch, Beech, Chestnut, White Oak, Chestnut Oak, Red Oak, Sugar Maple, Red Maple, and Basswood.

The common trees of the upper slopes and ridges are: Chestnut, Red Oak, White Oak (Plate XXII, Fig. 2), Chestnut Oak, and Sweet Birch (Plate IX, Fig. 1), on the lower slopes and along the streams, Hemlock (Plate XXII, Fig. 2), Basswood, Beech, Sugar Maple, and Yellow Birch predominate, while in the swamps and mountain meadow lands Red and Black Spruce, White Pine and Red Maple are common.

Of the better class of timber trees occurring in the county, but not in measurable quantities, Black Walnut, the hickories, the elms, Cucumber-tree, Tulip-tree, and White Ash are found on the richer slopes and along the streams; Red and Black Ash and Black Cherry in the mountain meadow lands; and on the ridges and drier upper slopes Yellow Oak, Scarlet Oak and Black Locust. The latter occurs as a seedling growth following fire on cut-over lands.

A third class of merchantable trees of lesser importance (partly due to their poor development here) includes Pitch Pine, Tamarack, Butternut, White Willow, Aspen, Large-tooth Aspen, Sycamore, Flowering Dogwood, Black Gum, and Persimmon. With these may also be included Red Mulberry, Sassafras, Hornbeam, and Blue Beech, which are of slight importance and are used only by farmers and woodsmen for special purposes.

The Pitch Pine is a low, knotty tree of the cut and burned ridges, valueless as a commercial timber. The Tamarack is found only in the swamps in small quantities and poorly developed. The Sycamore occurs only on the larger streams and seldom reaches a large size. The other trees are more widely distributed and have a fair development.

Unmerchantable Species.—The trees of this group include seventeen species, and all are hardwoods. They are small trees, or in many localities merely shrubs. The common trees of the group found on the ridges and dry slopes are Barren Oak, Mountain Ash, the Sumachs, Angelica-tree, and Mountain Laurel; along the streams Papaw, Witch Hazel, Sweet Crab, Serviceberry, Scarlet Haw, Redbud, and Blue Dogwood occur; the Striped and Mountain maples are found on the steep river slopes and the Rhododendron and Sheepberry in the swamps.

The dense undergrowth and thickets in many parts of the county are formed by trees of this group. The Mountain Laurel and Rhododendron often make almost impenetrable thickets in the swamps and along streams. On the ridges and dry slopes the Barren Oak and Mountain Laurel have frequently taken complete possession of the ground after fire and form low, dense thickets. The Sweet Crab and Scarlet Haw also form thickets from 10 to 20 feet high in the moist level glade land along streams.

LUMBERING.

Garrett county has lumbering interests second to none in the state. Their rapid growth in the past few years is due to the activity of the mills cutting Hemlock. Three large mills are at work in the county, one is building (Plate XXVI, Fig. 2), and there is prospect of another. One of the mills has finished cutting its Garrett county holdings and brings logs from West Virginia. Two West Virginia companies secure part of their material from the slopes of Backbone Mountain. These large mills cut the hard and soft wood with the Hemlock, and thus lengthen their operations. Unless the mills acquire and cut the defective ridge forests, they will have to be closed within the next ten years.

The present annual cut of the mills of the county is about 25 million feet. The small portable mills, of which there are a number in the county, cut less than one-fifth of this annual output. The bulk of the lumber cut is Hemlock, while Spruce, White Pine, Chestnut, Oak, Maple, Beech, and Basswood furnish the remainder. The principal manufactured product is lumber and with it large quantities of lath, shingles and barrels are produced.

The object of the large companies is to cut and market as rapidly as possible all material on their tracts. The mills are located on streams and the logs are brought from the woods over logging railroads. In one case the haul is over 15 miles. The mills are connected with the Baltimore and Ohio Railroad by means of spurs and load their product for shipment direct from the yards.

The small mills do not run steadily and the quality of lumber produced is generally poor. Their cut is mainly hardwood and is, in many instances, from culled forest or small isolated bodies of fair timber. The logs are brought to the mills by teams and the manufactured lumber is hauled by wagons to shipping points. A few small mills are making soft-wood shingles, but find it difficult to obtain material for a continuous run.

The present unconservative methods of lumbering in the county are rapidly denuding the best timber lands. No attempt is being made to insure a future supply. The cut is as close as possible, and includes all material that can be marketed. Little care is exercised to prevent fires after lumbering and the greater part of the slashings are burnt over. The fires have been so severe in places as to completely kill all timber and other growth left on the land. This is especially noticeable on the Spruce and Hemlock slashings.

FOREST FIRES.

The future of Garrett county as a lumber producing region is not bright. This is due to the severe lumbering and to the prevalence of forest fires in the county. The problem of protecting the cut-over and culled forest lands is here, as in all the principal lumber regions of the United States, one of paramount importance. No single prob-

FIG. 1.—RIDGE TIMBER, CHESTNUT AND OAK, BACKBONE MOUNTAIN.

FIG. 2.—CUT AND CULLED FOREST, HEMLOCK LANDS, CASTLEMAN RIVER.

FORESTS OF GARRETT COUNTY.

lem confronting timber production in the county outranks this. Fires in the forest are usually the result of carelessness. In sections where logging companies employ locomotives, fires from carelessness are very common. The condition of the cut-over lands on the Youghiogheny river, Bear Creek, and Cherry Creek is a good illustration of the indifference of the lumber companies of the county to damage by fire. Thousands of young Spruce and much good material cut and skidded were destroyed or injured by fire last year in the cutting between Negro and Meadow mountains. Fires on the ridge have rendered the trees there defective and in places even the humus and thin layers of soil over the rock have been destroyed. A similar damage is also noticeable on the Hemlock cuttings along the Youghiogheny river and Bear Creek. Large areas of culled Chestnut and Oak lands in all parts of the county have been burned over and thrifty young sprouts and seedlings were killed and in many cases the stumps also. Repeated fires in some sections have completely destroyed the valuable trees, especially on the ridges where the burns are now waste tracts covered with only a low growth of Barren Oak, Mountain Laurel, and scattered patches of scrubby Pitch Pine.

Through neglect and indifference one of the county's chief sources of revenue is rapidly disappearing. Its growing industries will be seriously crippled if some action is not taken to prevent the cutting off of the local supply of wood materials.

USES OF WOOD.

The wood of Garrett county reaches the market in two forms, either as a manufactured product or as a raw material. The manufactured products are, lumber (including plank and square or dimension stuff), shingles, lath, barrels, and excelsior. The raw material marketed includes pulpwood, mining timbers, spars, railroad ties, fencing material, fuel and tanbark. In value and amount the manufactured products exceed the raw material.

Lumber.—Most of the timber cut in the county goes to the mills and is sawn into boards, plank, or dimension stuff. The combined daily cut of the mills averages about 100,000 feet, board measure.

The coniferous lumber comes from Hemlock, Spruce, and White Pine. Oak and Maple furnish most of the hardwood lumber, while smaller amounts of Beech, Birch, and Basswood are manufactured.

LATH, SHINGLES, BARRELS AND EXCELSIOR.—Some of the large lumber mills also manufacture lath and shingles from their softwood slabs, while a few small mills in the county make nothing but shingles. The annual output of the shingle mills is small compared with the lumber produced and the run of the mills is irregular owing to the scarcity of suitable material.

A barrel factory operated in connection with one of the large mills uses all of the good White Oak on the company's tract.

A small mill at Blaine is engaged exclusively in the manufacture of excelsior. Small but entire logs are used.

PULPWOOD.—The trees commonly used for pulpwood are Spruce, Basswood, Cucumber-tree and Tulip-tree. There is, however, no extensive cutting in the county for pulpwood alone. Only small inferior trees and tops reach the pulp mills. Softwood slabs from the saw-mills are sometimes used for certain grades of pulp. The annual cut of pulpwood varies and is never large. The nearest market for this material is at Luke, Allegany county, on the Potomac river.

MINING TIMBERS.—The demand for these materials is a growing one and of considerable importance. The mines of the Georges Creek valley in Allegany county and those surrounding Piedmont are the principal users of mine timbers. Savage Mountain is being stripped of its timber to furnish these mines. Any sound tree six inches in diameter may be used for props. The culled forests and other sproutlands yield a fair amount of prop timber. Further growth of the mining interests of the county will probably create a large demand for mine props and lagging, so that in the future the production of this timber is likely to be an industry of great importance to the county.

SPARS.—Spruce is the only timber in the county used for spars. Formerly in cutting a tract of Spruce the spars were the first material removed, as only the very best of the trees could be used. The spar industry, however, is practically at an end. The last body of Spruce fit for this purpose is being cut now, and the land from which the timber is being taken will probably be used for agriculture, so that it is not likely that a second crop of Spruce will be grown.

TIES.—The timber used for ties is mainly of small size, or of inferior quality. The logging and coal roads use most of the ties cut. Hemlock, Beech, Birch, and Maple are used by the logging roads, while a better class of ties are cut from White Oak, Chestnut Oak, and Chestnut for the Baltimore and Ohio Railroad. The cutting is done by farmers or small contractors during the winter or other dull seasons. The ridge and culled forests furnish most of this timber.

FENCING MATERIAL.—Farmers readily obtain plenty of good fencing material from the large areas of culled or virgin forests surrounding the agricultural valleys. Second growth Oak, Chestnut and Locust may be had on many of the culled areas, while the ridge forests furnish plenty of Oak and Chestnut for this use. Chestnut is preferred for rails, while White Oak, Chestnut Oak, and Locust are used for posts.

FUEL.—The use of wood for fuel is probably less in Garrett than in any other county in the state. Coal is very cheap and many farmers dig a supply on their lands. Coal is commonly used for all heating purposes and even for burning lime. This general use of coal for all domestic fuel makes it impossible to dispose of the waste hardwood tops left left by lumbermen. Thousands of cords of good Oak, Chestnut, and other hardwoods are left to rot in the woods, and this large amount of slash always adds to the fire danger. The future will probably see but little increase in the demand for fuel, and unless some industry using small and inferior material is introduced, the fullest utilization of the hardwood cut is impossible. Charcoal kilns, acid factories, and tool handle or spool mills, would be able to use the wood now going to waste in the county.

TANBARK.—All of the Hemlock and Chestnut Oak bark peeled in the county finds a ready market at the tanneries of neighboring counties. The nearest market is just across the Potomac in West Virginia. While the amount of Chestnut and Oak bark produced is small, the lumber companies annually peel large quantities of Hemlock bark from the timber cut on their tracts.

The following table will give an idea of the yield of bark per acre of the types producing Hemlock. The present stand for the county is also shown:

TABLE NO. 11.

HEMLOCK BARK.

Trees 12 inches and over in diameter breast-high.

Sub-type.	Area.	Average Stand per acre.		Total yield.	
	Acres.	Cubic Feet.	Cords.[1]	Cubic Feet.	Cords.
Hemlock	143	853.86	9.49	122,102	1,357
Hemlock and hardwoods	1,280	312.27	3.47	399,706	4,442
Spruce	730	287.86	3.20	210,138	2,336
White Pine	3	176.45	1.96	529	6
Total	2,156	339.73	3.77	732,475	8,141

FUTURE PROTECTION AND UTILIZATION.

Thus far only the present condition of Garrett county forests and the present crop and its removal have been considered. With the removal of the original stand of timber the owner of forest land usually ceases to consider a further yield. It is believed that this conception of a lumbered forest as a "dry well" is largely responsible for the poor condition of Garrett county forests. Fires are allowed to sweep across cut-over lands, killing sprouts and seedlings because the owner does not fully realize the amount of damage done. Therefore, if he endeavors to prevent fires on his lands it is chiefly because his fences, grain crops, or buildings are in danger, or he fears a law-suit, should the fire spread to a neighbor's land. As long as this view is held by forest owners the principles of practical forestry will never be seriously considered.

Possible Timber Production.

That the cut-over lands are, in most instances, capable of producing a never-failing amount of timber if properly managed is readily seen. If a given tract of land has in the past produced a forest and has not

[1] A cord of piled bark equals 90 cubic feet.

FIG. I.—HEMLOCK LOGS ON SKIDWAY, CASTLEMAN RIVER.

FIG. 2.—NEW SAW MILL, CASTLEMAN RIVER.

FORESTS OF GARRETT COUNTY.

been subjected to fire which may destroy its capacity to support, or delay the establishment of, tree growth, it is reasonable to suppose that it will again produce forest trees. The belief of the farmer in the crop-producing power of his land leads him to continue to plow, plant and cultivate a crop. The forester's belief in the continued productiveness of soil leads him to start and tend a crop of trees, using methods different from the farmer's methods only in the length of time needed to mature the crop. The axe, instead of the hand or hoe, is used in thinning and weeding, and the saw and wedge, instead of the scythe and reaper, at the harvest. The difference is in degree rather than in kind.

Management of Forest Lands.

If it is admitted that the lumbered areas are capable of again supporting tree growth, we have but to start a new crop (in many cases it is already started) and care for it until maturity in order to harvest a second crop. With care this process may be carried on from generation to generation and the land need never be idle.

The thought, however, of tending a crop that takes from thirty to sixty years to mature is one that seldom appeals to private individuals. The farmer gets returns from his crop in a few months, the orchardist in from five to ten years, while the forester seldom harvests a crop under thirty years. Although this may keep many from planting trees for timber, it need not prevent owners of forest lands with timber well along toward maturity from caring for and improving their growing crops. The small holder should never allow his forest to be completely cut over, if he is unwilling to wait a long period for the second crop. It is best for him to practice a selection system in which a certain amount of material is marketed every year and the cutting so regulated as to improve the condition of the remaining trees. For instance, if a farmer owns 100 acres of young Oak and Chestnut in a dense stand, thirty to forty feet high, he may remove some of the trees that will make posts, rails, or ties; these trees should be selected from different places in the stand not be taken from one spot. Single trees of suitable size which are crowding others may be removed, giving the remaining trees a better chance to grow. If there is a sale for cordwood, mine props, or small material, the crooked, decayed, least desirable species, or injured trees may be removed, leaving the thrifty, straight, and more merchantable kinds for future cuttings. By following this method forests that are now full of broken, decayed, and stunted trees and undesirable species may later become woods of only steadily growing merchantable trees, with tall, clean stems. This improvement can be made with but little cost to the owner, and in many cases the thinnings will yield a revenue. If in the farmer's lifetime the remaining crop does not mature, he still has had abundant material for home use and for sale year by year, and the forest, worth perhaps $400 when he began to care for it, will when he dies have 200 to 400 trees per acre that will cut two ties per tree, and the crop at ten cents per tie will be worth $40 to $80 per acre. Instead of leaving to his children $400 worth of inferior woodland, he leaves them $4000 to $6000 of merchantable tie timber, which they may sell or further improve by caring for the trees until they reach larger timber sizes. In this calculation taxes may be disregarded, as the farmer seldom sells his wood land, but pays the taxes year after year on land producing poor timber crops, or none at all.

Fire Damage.

If a farmer decides to systematically improve his woodlands, considering them as an interest bearing investment, he should protect his forest crop. The greatest danger to which Garrett county forests are subjected is fire. The damage due to fire is never fully realized by the majority of forest owners, unless mature timber is killed outright. But every light surface fire running through the woods injures the growing crop. The fallen leaves are essential to the best development of the trees, for by their decomposition they return food material to the soil, form soil over rocky places, and prevent the evaporation of soil moisture by acting as a close covering or mulch in periods of little rain. Surface fires burn the leaves and in very dry seasons the partially decomposed leaves and twigs also that constitute the upper layers of the soil, and, in rocky places, the only soil. Besides this damage, seedlings up to a few feet high are killed by surface fires, and, as in many cases, these are the trees which should furnish a new crop when the older ones are removed, the damage is a very serious one. Often the litter of leaves, branches and fallen trees is so great as to enable surface fires to injure the boles of the larger trees; the bark is killed on one side, decay enters, and later the whole tree becomes worthless from the spread of rot in the stem. Where sprout lands are burned, the damage is often even greater than in the older forest. Here the sprouts are killed, putting back the growth five or ten years, and often the stumps and young seedlings among them are destroyed, and the future stand, instead of being a dense one of Chestnut and Oak, is an open one or a low thicket of Mountain Laurel and Barren Oak. Repeated fires, especially on rocky, shallow ridge soils, destroy every vestige of tree growth, burn the humus from the soil, and leave the land in such a condition that for years it refuses to produce a forest cover.

Fire Protection.

To produce the best wood crops fire must be kept from forest lands. This is best done in the case of woodlands of a few hundred acres by surrounding the timbered area, if possible, with a belt of cleared land to prevent fires from reaching it from adjoining woods. By keeping the roads and trails through the woods free from brush and weeds and by cutting and burning along them once a year it is possible to confine surface fires started within the forest to small tracts, and to back-fire if necessary to check fires with much headway. After these precautions are taken, watchfulness during the dry season when fires are most prevalent will reduce the fire danger to a minimum. With the danger from fire removed, the wood crop of Garrett county is practically assured.

Care of the Forest Crop.

Besides fire protection, the amount of time and care spent by the owner on a forest property must be determined by his object in growing trees. If he desire simply cordwood or fencing, but little care will be needed beyond the removal of trees that are crowding and stunting the main crop. Work in the forest should be done gradually, as the material cut can be utilized and at a season of the year, as in winter, when farm work is light.

If the farmer desires better material from his woodlands than cordwood more care and attention will be necessary. To produce ties or lumber careful thinnings must be made and only those species allowed to reach maturity which yield such materials. The stem should be tall and free of limbs, necessitating a thick stand in youth to kill the lower limbs. As the trees mature thinnings must be made to induce a good diameter growth. A little thought and care on the part of the small forest owner will result in a much improved forest crop.[1]

The treatment of larger tracts not held in connection with farm lands or other revenue producing areas, as mines or quarries, should be similar to that for woodlots. The necessary annual expenditure for protection and taxes on large tracts of land, from which, owing to their burnt and cut-over condition no return can be expected for a long period of years, is the greatest drawback to this form of investment. For this reason large lumber firms and individual owners usually dispose of the better portions of their cut-over lands to adjoining property owners. The unsalable portions are neglected and often revert to the state through unpaid taxes.

Michigan, Pennsylvania and New York have found it wise to purchase and set aside as forest reserves large areas of these abandoned lands. The object of the reservation is to preserve the beauty of certain regions, furnish breeding grounds for game, prevent erosion and floods, and to furnish the wood consuming industries of the state

[1] If a more detailed plan of management is desired for the woodlot, the Bureau of Forestry, U. S. Department of Agriculture, is prepared to supply such a working plan, the terms of arrangement for which are outlined in Circular 21. The Bureau also offers tree planting plans, the terms of which are set forth in Circular 22. Copies of these circulars can be had by applying to the Bureau of Forestry, Washington, D. C.

with the necessary materials. The state rather than an individual can afford to hold and protect large areas of forest land from which no immediate revenue is obtained because of the indirect as well as the direct benefits derived. Pleasure resorts, game preserves, and protected watersheds are benefits for which the state is or should be willing to pay, while the individual is interested chiefly in the direct money returns from his investment.

INDEX

P

Q

R

ERRATUM.

p. 106, line 13, for *fauna*, read *flora*.

MARYLAND
GEOLOGICAL
SURVEY

GARRETT
COUNTY