MARYLAND
GEOLOGICAL
SURVEY

VOL. I.
1897

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VOLUME ONE

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COMMISSION

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STATE GEOLOGIST

WM. BULLOCK CLARK, ... GEOLOGIST.

PROFESSOR OF GEOLOGY, JOHNS HOPKINS UNIVERSITY.

LETTER OF TRANSMITTAL.

To His Excellency LLOYD LOWNDES,

Governor of the State of Maryland and President of the Geological Survey Commission.

Sir:—I have the honor to present herewith the first volume of the reports of the State Geological Survey. It embraces a preliminary account of the physiography, geology and mineral resources. I trust it may give to the people both within and without the state more complete knowledge of its natural wealth than has been hitherto attainable. I am,

Very respectfully,

WILLIAM BULLOCK CLARK,

State Geologist.

JOHNS HOPKINS UNIVERSITY,
BALTIMORE, *July*, 1897.

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ILLUSTRATIONS.

PREFACE.

The subjects considered in this volume are treated in a preliminary manner and are largely introductory to what will follow in later reports. The volume consists primarily of a summary of past and present knowledge concerning the physical features of Maryland, and embraces an account of the geology, physiography and natural resources of the state. To this is appended a bibliography of all publications relating to these matters. This data will prove of much value to those who are engaged in the study of the geology of the state and will at the same time afford a means of ready reference for those who are desirous of knowing the original sources of information.

In the preparation of this volume grateful recognition is accorded to the many distinguished workers of the past upon the geology of the state, and first and foremost, to the late lamented George Huntington Williams, Professor of Inorganic Geology in the Johns Hopkins University, who did so much in his twelve years of residence in Maryland to unravel the complicated geology of the Piedmont region. Many of his valuable conclusions will find place in this and subsequent volumes.

The *Introduction* to the present volume is given up largely to a discussion of the plan of operation of the present survey, together with a recital of the facts connected with its establishment and organization. It is most important that the citizens of the state should understand at the start the objects of the survey, so that they may obtain the greatest possible advantage from its operations.

The *Historical Sketch* which follows, and which comprises Part II of the report, contains an account of the progress of investigation of the physical features and natural resources of the state. Much of the data relating to colonial days has been furnished the writer by Dr. William Hand Browne, and Dr. Edw. B. Mathews has aided in the preparation of the later chapters. The wide knowledge of Professor

P. R. Uhler, the Provost of Peabody Institute, regarding all lines of scientific research in Maryland, as well as his personal acquaintance with many of the men who were influential in the earlier days, has been of much service to the author.

The *Outline of Present Knowledge of the Physical Features of Maryland*, which follows and which forms Part III of the report, has been compiled from existing data, and is based upon the chapters prepared, for the most part, jointly by the late Professor Williams and the author, for the volume "Maryland, its Resources, Industries and Institutions," which was published by the Board of World's Fair Managers of Maryland in 1893. During the years since this work appeared a reconnaissance survey has been made of the entire state, while certain areas then unknown have been subjected to special study, which admits of a more comprehensive treatment of the subject than was then possible. The later investigations of the writer assisted by Dr. R. M. Bagg, Mr. A. Bibbins and Mr. George B. Shattuck in the Coastal Plain; those of Mr. Arthur Keith and Dr. E. B. Mathews in the Piedmont Plateau; those of Mr. Bailey Willis, Dr. A. C. Spencer and Mr. C. C. O'Harra in the Appalachian Region; and those of Mr. Cleveland Abbe, Jr., upon the physiography of the state, have added much to existing knowledge. The results of this later work will be incorporated in the present chapter, although earlier methods of treatment and even the phraseology will be retained wherever possible. Abstracts have been made directly from the writings of Williams, Willis, Keith, Darton, and others without further recognition than that here given.

The *Bibliography and Cartography of Maryland*, which forms Part IV of the report, and which has been prepared mainly by Dr. E. B. Mathews, has been shared in by all the members of the survey and represents an exhaustive search of all works which might be considered to throw light upon the physical features, including the physiography, geology and mineral resources of the state. The aim during this compilation has been to bring together such papers and maps as will be helpful to workers on the problems presented by the physical features of Maryland. With this aim in view, references have been included which may appear superfluous to the specialist in geology or insufficient to a student of allied subjects. Among those who have aided Dr. Mathews in the preparation of this list are Messrs. Uhler, Bibbins, Spencer and Bagg; while Darton's "Catalogue and Index of Contributions to North American Geology, 1732–1891," Watson's "Bibliography of Virginia," and many lists of works on special subjects have been used in checking the references collected.

The cartographic catalogue, somewhat unusual in this connection, contains most of the original maps and many early or corrected maps which show the gradual recognition and determination of the limits and topographic features of the area of the state. An attempt has been made to give, as far as possible, the size, character and scale of the maps, while those maps giving geological data are indicated. The places where these maps have been found, or the authority on which their titles are based, are indicated by "Peabody," "Williams," etc. Much help in compilation and correction has been gained from Williams' "Maps of the Geology included within the State of Maryland," Phillips' "Cartography of Virginia," "Winsor's Narrative and Critical History, vol. iii," and Marcou's "Catalogue of Geological Maps relative to North and South America."

The *First Report upon Magnetic Work in Maryland*, which comprises Part V of the volume, is made by Dr. L. A. Bauer, who has been conducting this division of the work of the survey. Dr. Bauer was for several years connected with the United States Coast and Geodetic Survey in Washington, and is now the editor of the Journal of Terrestrial Magnetism. The present report gives the results of the determination at a number of points of the so-called magnetic elements, viz., the magnetic declination, the magnetic inclination or dip, and the horizontal component of the earth's magnetic force. These three elements completely determine the direction and intensity of the magnetic force prevailing at the points where observation is made. The results of the work are of great importance to the county surveyors and others who are engaged in determining the boundaries of lands, and for other public matters where the accurate determination of the magnetic points is required. This important work was largely made possible by the kindness of the Secretary of the Treasury, who placed at the disposal of the state the valuable apparatus in the possession of the United States Coast and Geodetic Survey. Further observations will be made from time to time and a second report will be published at a later date.

The co-operation of the Director of the United States Geological Survey, by means of which increased topographic work has been carried on from the first in different portions of the state, has been a most important factor in the operations of the State Geological Survey, and the data furnished has made possible the accurate platting of the geologic boundaries. Direct co-operation along geological lines has at the same time been of much importance to the successful prosecution of the state work.

Attention should also be called to the intelligent and valuable aid which has been given by Mr. A. B. Hoen of A. Hoen & Co., Lithographers, of Baltimore, in the preparation of the lithographic maps which add so much to the attractiveness of the volume.

PART I

INTRODUCTION

ESTABLISHMENT AND PLAN OF OPERATION OF THE SURVEY

BY

WM. BULLOCK CLARK

THE HELIOTYPE PRINTING CO. BOSTON

VIEW OF MODEL OF THE STATE OF MARYLAND.

P.23A

INTRODUCTION.

ESTABLISHMENT OF THE SURVEY.

The state of Maryland, lying midway between the North and South, and stretching as it does from the Atlantic ocean to the crest of the Alleghanies, with the great estuary of the Chesapeake Bay and its tributaries extending far into the land in all directions, possesses many advantages over neighboring commonwealths. There is probably no state of equal size in the Union that has such a variety of natural features in climate, soils and mineral resources, while its central location and numerous natural highways of commerce and trade render this native wealth of the greatest importance to the material prosperity of the people.

It is but natural that the citizens of Maryland should demand the fullest investigation of these factors which the methods of modern science can command. It was in accordance with this idea that a bill was introduced at the last session of the General Assembly calling for a thorough study of the physical features, including the physiography, geology and mineral resources of the state.

The Bill.

The bill by which the survey was established is entitled:

"An Act to establish a State Geological and Economic Survey, and to make provision for the preparation and publication of reports and maps to illustrate the natural resources of the State, together with the necessary investigations preparatory thereto."[1]

Section 1. Be it enacted by the General Assembly of Maryland, That there is hereby established a State Geological and Economic Survey which shall be under the direction of a commission composed of the Governor, the Comptroller, the president of the Johns Hopkins

[1] Laws of Maryland, 1896, Chapter 51.

University and the president of the Maryland Agricultural College, who shall serve without compensation, but shall be reimbursed for actual expenses incurred in the performance of their official duties; and the said commissioners shall have general charge of the survey, and shall appoint as superintendent of the same a geologist of established reputation, and upon his nomination such assistants and employes as they may deem necessary; and they shall also determine the compensation of all persons employed by the survey, and may remove them at pleasure.

Sec. 2. And be it enacted, That the survey shall have for its objects:

(1). An examination of the geological formations of the State, with special reference to their economic products, viz., building-stones, clays, ores and other mineral substances.

(2). An examination and classification of the soils and a study of their adaptability to particular crops.

(3). An examination of the physical features of the State with reference to their practical bearing upon the occupations of the people.

(4). The preparation of special geological and economic maps to illustrate the resources of the State.

(5). The preparation of special reports, with necessary illustrations and maps, which shall embrace both a general and detailed description of the geology and natural resources of the State.

(6). The consideration of such other scientific and economic questions as in the judgment of the commissioners shall be deemed of value to the people of the State.

Sec. 3. And be it enacted, That the commissioners shall cause to be prepared a report to the Legislature before each meeting of the same, showing the progress and condition of the survey, together with such other information as they may deem necessary and useful or as the Legislature may require.

Sec. 4. And be it enacted, That the regular and special reports of the survey, with proper illustrations and maps, shall be printed as the commissioners may direct, and that the reports shall be distributed or sold by the said commissioners as the interests of the State and of science demand, and all moneys obtained by the sale of the reports shall be paid into the State treasury.

SEC. 5. And be it enacted, That all material collected, after having served the purposes of the survey, shall be distributed by the commissioners to the educational institutions in such manner as to be of the greatest advantage to the educational interests of the State; or, if deemed advisable, the whole or a part of such material shall be put on permanent exhibition.

SEC. 6. And be it enacted, That the sum of ten thousand dollars annually, or so much thereof as may be necessary, is hereby appropriated out of any funds of the treasury not otherwise appropriated, for the purpose of carrying out the provisions of this Act.

SEC. 7. And be it further enacted, That this Act shall take effect from the date of its passage.

This bill was introduced in the House upon January 9, 1896, was passed by that body upon February 18, by the Senate upon March 11, and received the signature of the Governor upon March 19.

THE MEETING OF THE COMMISSION.

At the call of the Governor, the Commission met upon March 25th in the Executive Chamber at Annapolis, all the members of the Board being present. The meeting was organized by the election of President Gilman as temporary chairman. The following resolutions were then presented and adopted:

Resolved, 1. That the Board proceed to the election of a President and a Secretary and to the appointment of an Executive Officer, whose duty it shall be to advise with the Geologist, supervise the outlays, and direct such measures as may best fulfill the requirements of the act establishing the survey.

2. That a substantial record-book be procured, in which shall be entered all the actions both of the Board and of the Executive Officer.

3. That a superintendent, to be known as State Geologist, be chosen at once, whose duty it shall be to propose and, with the authority of the Board, to carry out such measures as may be requisite for fulfilling the requirements of the act by which the survey is established.

4. That there shall be no salaried positions, but a moderate *per diem* allowance shall be made for work actually performed in the service of the survey.

5. That the Board shall hold semi-annual meetings, in the months of March and November, prior to and soon after the operations in the field—the meetings to be called by the Governor, at such time and place as he may think best.

6. That it is the sense of the Commission that the Executive Officer be empowered to make draft upon the Comptroller from time to time for such money as the needs of the Commission may demand, the amount to be drawn being limited by the appropriation for any one year.

7. That the Executive Officer be required to see that a detailed account of all expenses is kept and that the same be presented, with proper vouchers for approval, at each of the semi-annual meetings of the Commission, such vouchers being a part of their permanent records.

8. That the offer of the Johns Hopkins University to furnish, free of all charges whatsoever, suitable rooms for the offices of the survey and the use of its collections, maps, and apparatus be accepted, and that the headquarters of the survey, until otherwise ordered, be established at that place.

9. That the State Geologist shall prepare and publish a series of occasional papers for the purpose of keeping the people of the state informed respecting the methods of the survey as it is in progress, and that the first of these reports shall be promptly issued to set forth the organization of the survey, and to show what has hitherto been done for the study of the geology, natural history and resources of Maryland by public or private agencies.

10. That fuller reports upon special topics of importance to the state of Maryland shall be presented as soon as they can be prepared in a satisfactory manner, and that the State Geologist be requested, if he finds it possible, to report in the first place upon building-stones.

11. That the President of the Board be requested to make known to the head of the U. S. Geological Survey in Washington and to the heads of the Geological Surveys in neighboring states the organization of the State Geological and Economic Survey of Maryland, and to ask their official co-operation.

12. That the State Geologist be directed to make known, in the

name of the Board, that the co-operation of the transportation and express companies is particularly desired in furthering the work of the survey.

13. That this officer be also authorized to say, in the name of the Board, that the friendly aid of the teachers in the higher educational institutions of the state and of other enlightened citizens will be appreciated by the Board and gratefully acknowledged.

Officers of the Survey.

The following permanent officers of the Commission were nominated and elected, viz.: Lloyd Lowndes, Governor of Maryland, President; Daniel C. Gilman, President of the Johns Hopkins University, Executive Officer; R. W. Silvester, President of the Maryland Agricultural College, Secretary. Wm. Bullock Clark, Professor of Geology in the Johns Hopkins University, was chosen State Geologist.

In accordance with the resolutions adopted, the State Geologist proceeded at once to organize the survey. The offices granted by the Johns Hopkins University upon the third floor of its Front Building, on Howard Street, were made ready for occupancy and properly equipped with the apparatus necessary for conducting the operations of the survey. A corps of geologists was at once selected to take up the study of the geology and natural resources of the state along various lines.

PLAN OF OPERATION OF THE SURVEY.

The objects of the Geological Survey of the state, briefly set forth in the act under which the present organization is established, are more fully elaborated in the following pages. It is desirable at the beginning that the citizens of the state should fully understand these objects, in order that they may gain the greatest benefit possible from the operations of the survey. The future work and publications may at times be subject to misinterpretation unless their connection with the general scheme which has been formulated is entirely comprehended.

The plan which has been outlined embraces two general divisions, the first having an *economic*, the second an *educational* object in view. These are so intimately associated with one another, however, that it is impossible to draw a sharp line between them. The investigations must often be the same, or can be carried on contemporaneously, so that the necessary data can be made available for both purposes with little additional expenditure of time or money. Moreover, the survey which pursues one of these lines to the exclusion of the other fails in producing the best and most permanent results for the public interests, and many instances might be cited where such surveys have lost touch with the people by ignoring on the one hand the "practical," and on the other the "scientific" questions involved. It is a mistaken notion that purely scientific investigations must of necessity be impractical. Science is simply the systematic and orderly arrangement of knowledge, and without a scientific foundation practical results of lasting value cannot be obtained. At the same time, the presentation of scientific information without pointing out its practical bearing is of little immediate benefit to the people at large, and can hardly be regarded as appropriate for a state survey report, unless intended ultimately to serve some utilitarian purpose.

The fact must be borne in mind that much preliminary and fundamental work has to be done, the utility of which is not at once apparent to the uninitiated. The publication of such material, rendered necessary as a basis for future investigation, is often liable to misinterpretation, but yet may be of far more lasting value to the state than some superficial statement that is intended to meet a supposed practical need.

Some of the more important lines of work proposed by the State Survey are the following:

The Preparation of Topographic Maps.

The accurate location of geological formations has come to be regarded as a practical necessity for their complete interpretation, and the construction of topographic maps is now a recognized function of all geological surveys. No state in the Union so early recognized the value of topographic work as the state of Maryland, when in 1833 the Legislature of the state passed resolutions relative to a state map and a state geological survey, and the following year passed an act providing for the appointment both of a topographical engineer and a state geologist.

The United States Geological Survey, recognizing the importance of topographic maps, has, since it was established in 1879, been engaged in topographic surveys in different portions of the country, but, on account of the great areas which it has to cover and the necessary division of its work among the several states, is able to do but a small amount in each annually unless the state itself co-operates, or, through its own scientific activity, shows the necessity for increased attention. In the years which have passed since the organization of the U. S. Geological Survey considerable work has already been done within the limits of the state of Maryland, but it was not until the State Survey was organized and showed the necessity of pushing the surveys to completion that the national government has aggressively taken the matter up. As a result the state may confidently expect after a few years to obtain an accurate map of its territory. The completion of this map which will have been brought about through the exigencies of the State Geological Survey and intended primarily for its uses will be of immense advantage to the people of the state for all purposes of internal improvement, since it will afford the necessary information for engineering and military purposes, for the location of railroads, highways, water conduits, and for other public enterprises.

The topographic map will be published in sheets upon the scale of two miles to the inch and will be admirably adapted for the location of the several geological formations of the state, as well as for most other matters of public interest. The elevations will be represented by contour lines, so that the height of any point can be readily determined within a few feet.

The Determination of the Magnetic Conditions.

A thorough study of the magnetic conditions affecting that portion of the earth's crust within the borders of Maryland is also contemplated by the State Geological Survey. A magnetic survey involves the determination at a number of points of the so-called magnetic elements, viz., the magnetic declination, the magnetic inclination or dip, and the horizontal component of the earth's magnetic force. These three elements completely determine the direction and intensity of the magnetic force prevailing at the points of observation. In addition to the far-reaching importance of this work in the future observations and determinations of the great rock masses contained within the state, the results will be of immediate practical benefit to all land surveyors, and from that standpoint alone will more than justify the undertaking.

The importance of magnetic surveys has been recognized for many years, the first survey of this kind having been made in England in 1837. Magnetic surveys have also been made in several of the other European countries, but little systematic investigation in this direction has as yet been undertaken in America. The State Geological Survey intends to make a thorough and systematic magnetic survey of Maryland, and this is to a large extent made possible by the fact that the costly apparatus in the possession of the United States Coast and Geodetic Survey has been placed at the disposal of the state. Already much work has been done in the carrying out of the plan.

In this connection attention should be called to the fact that an act of Assembly was passed at the session of 1870 (Laws of Maryland, Chapter 359) and codified in 1888 (Maryland Code, Article 25), in which it is stated that "it shall be lawful for the county commissioners of each county in the state, if they shall deem it expedient, to cause to be erected on some public spot adjoining the court house of each county two good and substantial stone pillars, 100 feet apart the one from the other, and upon the same true meridian line." Further directions for the establishment of these pillars are given, together with the provisions for their use by the surveyors in each county. As a result of the work already done by the State Geological Survey, combined with the fact that the necessary apparatus is at its disposal, it is now possible for the several counties of the state at a very small outlay to take advantage of this opportunity. Already several of the counties have co-operated with the State Survey in the establishment of meridian lines, and it is hoped that every county will join in carrying out the project which is of such practical importance to the landowners throughout the state.

Collection and Detailed Investigation of the Minerals, Rocks and Fossils.

Both for the preliminary and for the more complete investigation of the mineral resources of the state, a careful study of the different minerals, rocks and fossils is essential. In order that this may be done, a large collection for comparative purposes must be started. It is the plan of the survey to bring together at its headquarters as complete a representation of the minerals, rocks and fossils as is possible; and each will be subjected to a critical examination in the light of modern research, and its bearing upon the interpretation of the geology of the state fully ascertained. The determination and correlation of the several formations are so largely dependent upon the mineralogical character of the rocks and their contained fossils that it becomes a matter of the greatest moment for future economic purposes to fully understand them, although they may not always be of direct practical importance when viewed by themselves. The specimens collected will be carefully labelled and classified as the result of the examinations to which they will be subjected, thus affording the student in geology, the architect, the engineer, or the investor a complete knowledge of the rock formations within the state. It is desirable that the state should make provision for the proper exhibition in some public place of this material after it has been fully studied by the State Survey. At the same time much duplicate material will be brought together which can serve a useful purpose in the various educational institutions of the state, and can also be sent to those persons without the state who are desirous of more intimate knowledge of its geology and mineral resources than can be gathered from published reports.

The Preparation of Geological and Economic Maps.

The platting of the geological data upon maps cannot be satisfactorily undertaken until after detailed investigation has been accorded to the minerals, rocks and fossils, and their distribution and relations deciphered. The collection and critical examination of these materials must, therefore, precede the areal work. After these investigations have been made it is possible to group together those materials of similar age and physical origin in what is known as a geological formation, which may be represented by a single color upon the map. This method of representation is of importance to the searcher after information regarding the mineral wealth of the state, while the descriptive text, explanatory of the geological map, will indicate the various mineral substances which characterize each formation, and will thus be a guide in the development of the various resources of each district. At the same time the futility of attempting to develop mineral products in a formation which has been shown by careful geological investigation to be devoid of them will be at once apparent. Innumerable instances might be cited where great sums have been wasted by a fruitless search after economic substances which might have been entirely obviated if geological maps had been available or had been employed when available.

The ultimate platting of the geological data upon the large scale topographic maps, described in a preceding paragraph, will disclose the relations of the several geological formations to the topography of the state and at the same time will make possible the exact location of the various mineral products. The resulting geological maps will also serve as agricultural maps, since, as will be shown later, each geological formation gives rise to its own particular type of soil.

The Investigation of the Mineral Resources.

A satisfactory description of the various mineral products can be undertaken only after the detailed investigation of the mineralogical characters of the geological formations has been made and their distribution upon the geological map has been platted, at least in a preliminary way. It is the intention of the State Geological Survey, as its work proceeds far enough to give it an insight into the various mineral resources of the state, to treat each subject independently and exhaustively. Among the various materials which will be thus investigated are the building and ornamental stones, lime and cement products, the clays, the sands, the porcelain materials, the marls, the iron ores, the coals, the gold deposits, the soapstone, the mineral paints, the diatomaceous earth (tripoli), the mineral waters and other miscellaneous products.

Building and Decorative Stones.—The state of Maryland is unusually rich in the great variety and excellent quality of its building and decorative stones. At the same time the central location of the state, with several prominent cities and towns, which constantly employ such materials, immediately accessible, renders these products unusually valuable. The State Geological Survey has already devoted much attention to the building and decorative stones, believing that a proper presentation of the subject to the architects, engineers and consumers of such materials will add very largely to the development of the industry, not only by inducing larger investments in quarrying operations, but by increasing the output of those quarries which are now in existence. The decorative stones, particularly, have been brought but little to the attention of architects, although they exist in the state in great variety, many of them equal to the finest foreign and domestic materials elsewhere obtained. Several important building-stones, also, have never been used for more than local purposes and can readily be brought to the attention of outsiders.

Lime and Cement Products.—Many of the geological formations of the Appalachian district of Maryland are characterized by extensive deposits of limestone. Of these the more common varieties are admirably adapted for burning and afford materials suitable for building and fertilizing purposes as well as for flux, while the less common magnesian limestone makes an excellent cement. Although these products are most abundant in the extreme western portion of the state, the more highly crystalline limestones and marbles which occur in many places throughout the Piedmont belt, especially in the northern tier of counties, can also be burned at times to advantage. Many of the calcareous clays in the southern and eastern sections of the state are also well adapted for the manufacture of cement, while some are sufficiently pure to burn for lime. Relatively little has been done toward their development hitherto. It is the intention of the State Geological Survey to give this subject much attention, applying various tests to these widely distributed products, so that the people of the state may know their true value. There is little doubt but that new deposits will be discovered, while other uses will be detected in addition to those which are known to-day.

Clays.—There is perhaps no economic product which more largely abounds in Maryland than clay, the importance of which has never been fully appreciated hitherto. Millions of dollars are invested in the clay industry in some of the states to the north of us, and there is no reason to believe that their clays are in any way superior to ours. The clays of Maryland are adapted to brick-making and pottery; and some are admirable fire clays. The investigation of the properties of the clays has been hitherto very largely left to those who are employed in the clay industry, and yet there is perhaps no product which is more worthy of exhaustive scientific treatment. The clays of Maryland occur chiefly throughout the southern and eastern portions of the state and are found at several different geological horizons; and others of acknowledged superiority are known in the older formations of the western counties. Already there are between one and two hundred plants in operation within the limits of the state, but there is undoubtedly an opportunity for far greater expansion, not only on the part of those already engaged in the business, but on the part of those who are willing to establish new industries. The State Geological Survey has in view a thorough study of the clays of Maryland in the near future.

Sands.—Large deposits of sand, both in unconsolidated form and cemented into sandstone, are found both in the eastern and western portions of the state. Particularly in eastern and southern Maryland, beds of great thickness and wide areal extent are known. At a few points work has already been done upon these materials and there is already some market for the products. These various sand deposits are useful for building and molding and also for glass-making. Their development has only commenced, and it is the intention of the State Geological Survey to look into their properties, and to indicate their quality, quantity and distribution.

Porcelain Materials.—The porcelain materials of Maryland, which comprise flint, feldspar and kaolin, have been relatively little worked, although it seems probable that valuable deposits of these materials may be looked for in many portions of the Piedmont belt. Their manner of occurrence in crystalline rocks is such that close examination is necessary for their accurate location, but the proposed investigation which will be given to the whole crystalline area will undoubtedly develop many new deposits of these materials.

Marls.—The marl deposits of Maryland have been worked from time to time for nearly a century. They received the attention of the First Geological Survey and of the subsequent State Agricultural Chemists, and since then analyses have been made from time to time by the chemist of the Agricultural Experiment Station. It is desirable that this work should be continued and that the location and extent of these marl beds, which cover so wide an area in eastern and southern Maryland, should be fully determined. It is particularly important that the agricultural interests of the counties where these natural fertilizers abound should realize the value of their own resources.

Iron Ores.—The iron ores of Maryland have from the earliest times been a source of great profit to the state of Maryland. The earliest blast furnace was built within the limits of the state, and local ores since early colonial days have been smelted both in Maryland and adjacent states. On account of the discovery of larger and more easily worked deposits in other portions of the country, the iron industry in Maryland has in later years suffered a considerable decline, but notwithstanding these facts extensive deposits are still known to exist, and the carbonate ores are to-day worked with profit. The State Geological Survey has in view the location and study of these deposits with the view of bringing them to the attention of the people.

Coals.—The coal deposits of Maryland have perhaps been more fully explored and extensively worked than any other of our mineral resources. In Allegany county, especially, the coal operators are well informed as the result of private enterprise, regarding their coal seams, but in Garrett county little has yet been done toward the development of this industry, and it is the intention of the State Geological Survey at an early date to take up a systematic investigation of the coal-bearing beds of this portion of the state. Already enough has been learned in the preliminary examination of the area to convince the members of the survey that extensive deposits of coal exist there.

Gold Deposits.—There is undoubtedly a considerable volume of gold scattered through the crystalline rocks of the Piedmont portion of Maryland, but it has not hitherto been found in sufficient quantities at any one point to give assurance of its being worked with profit by present methods. It is not at all improbable, however, as the various processes are improved, that the gold deposits of Maryland will come to have much value, and it is certainly desirable that the character and distribution of these gold ores should be fully studied by the State Geological Survey. Such investigations are to-day being accorded the gold deposits of the adjacent states where the outlook can be considered to be little better than in Maryland.

Soapstone.—Soapstone quarries have been opened from time to time in the northern portion of the Piedmont area, and it is desirable that the distribution of this material should be carefully determined. Larger and more readily worked deposits may be discovered in the careful investigation of the crystalline rocks, which will tend to very largely develop this important industry. It is the intention of the State Geological Survey to consider this matter as its work proceeds.

Mineral Paints.—Mineral paints in several varieties have been obtained in various portions of Maryland, and are to-day being worked to some extent in the region between Baltimore and Washington. These mineral paints are found in the old crystalline and in the recent sedimentary rocks. It is probable that further investigations will reveal other deposits and that this industry may receive much aid from the work of the survey.

Diatomaceous Earth (Tripoli).—The deposits of diatomaceous earth, sometimes known as infusorial earth or tripoli, extend as a thick bed across the eastern and southern counties of Maryland and have been worked with profit at several points in the latter area. As the work of the State Geological Survey proceeds, the extent of these deposits will be carefully located, so that further development of them may be anticipated.

Mineral Waters.—Mineral waters in considerable variety issue at many points from the Maryland rocks. The great diversity in the geological formations and their different chemical composition have an intimate relationship to the varying character of these waters. It will be one of the objects of the State Geological Survey to investigate the mineral waters and to call the attention of the people at large to their occurrence and value.

Miscellaneous Products.—There are many miscellaneous mineral products in Maryland which are not known to-day to occur in sufficiently large quantities to be advantageously worked, although many of them have in the past been of economic value. Among these products may be mentioned copper, chrome, lead and zinc ores, asbestos, mica, amber and graphite, while traces of other substances, including manganese and antimony, have been observed. It is not improbable that as investigations proceed larger deposits of these substances may be detected which may come to have considerable commercial importance to the state. The geological formations of Maryland will be subjected to careful examination by the State Survey, and everything that appears to have a possible economic value will be fully looked into, with the anticipation that still other products of commercial utility may be detected.

Detailed Study of and Report upon County Resources.

There are many advantages to be found in considering the resources of each county collectively. In the first place the work can be done in much more detail than would be desirable when considering each product as a whole in its general distribution throughout the state, while the bringing together of the several resources of a small division like that of the county would show, as would not be possible by any other method, the natural wealth of a specified district. The physiographic and climatic conditions of each county will be considered in the accounts which will be prepared as well as the geology and mineral resources, so that the reports when finished will afford a complete statement of the natural advantages of each county, and will not only be of value to the residents, but likewise to those who are looking for homes in the state. These reports will be accompanied by large scale topographic maps which will show at a glance by the colors and symbols introduced all of the natural resources of the county. This method of treatment has been pursued in some of the other states with excellent results, and has many practical advantages in a state like Maryland over the publication of section sheets which ignore the county lines.

The Special Investigation of Road Materials.

There is perhaps no subject to-day which is more demanding the attention of enlightened commonwealths than the proper construction of roads. Much consideration has been given this subject by experts, who have found that if the money now expended annually by the several states was properly applied, a system of permanently good roads could be gradually constructed in place of the temporary makeshifts now in vogue. The importance of proper highways to all classes of citizens cannot be too forcibly dwelt upon, but this is neither the time nor the place to go into the discussion of this important question. It is desirable, however, that attention should be called to the fact that good roads can only be built with proper materials, and that it is most essential that the various rock formations within the state should be studied with a view to their use in this direction. Although some rocks may be shown to be better than others, questions of transportation have to be considered, and in each section it is necessary to discover the most available local materials. After the various rocks have been tested by well-known methods and their availability determined, it is then important to show their distribution so that the road commissioners of each county may know where to obtain them with the least expenditure of time and money. There are few ways in which the Geological Survey can be of more direct service to the state than in giving advice regarding the proper materials for road construction, and it is the intention of the State Geologist to give this subject his careful attention as the work of the survey proceeds.

The Investigation of the Origin and Nature of the Soils.

The intimate relations which exist between geology and agriculture have come to be recognized in late years by those who are investigating the subject of soils and their formation. The character of a soil is determined by the underlying geological formation, since the soil itself is but the disintegrated surface of the subjacent rocks mingled with varying proportions of vegetable humus. The limits of a geological formation become then the limits of a particular type of soil, so that a geological map is at the same time an agricultural map. The latest investigations of soils show that their difference is dependent not so much upon their chemical composition as upon the physical arrangement of their particles, so that a study of the character of the rocks from which they come is of much significance. It is the intention of the State Geological Survey, by co-operation with the Maryland Agricultural College and the U. S. Department of Agriculture, to investigate the origin and the nature of the soils of Maryland from a geological standpoint, believing that such a classification of the soils will be of great benefit to the agricultural interests of the state, and will at the same time show to those who desire to settle in our midst the characteristic features of our arable land.

The Investigation of Artesian Well Prospects.

A very close relation exists between the water-bearing horizons of the state and the geological formations, and it is of much importance to the people that the most reliable information possible should be available upon this subject. A careful study and measurement of the thickness of the several geological formations throughout the eastern and southern portions of the state will readily afford data upon which estimates may be made of the depth at which water may be anticipated. In the more highly folded and crushed crystalline rocks of the Piedmont belt between Baltimore and the Frederick valley less accurate information can be given, but even here the geological relations often give indications of the depth of deep-seated water. Farther to the west, in the Appalachian district of the state, the geological relations are again much more distinct. The value of pure water is a matter which does not require discussion, and is to-day recognized by every community of importance within the state. It is therefore desirable, both from a sanitary and from an economic standpoint, to know the conditions under which water may be expected and the depth and character of the material of the water-bearing zone. Although it is not always possible to give exact information upon these points on account of the varying conditions beneath the surface, yet the advice which the State Geological Survey will be able to give the people upon this subject after its work has further advanced will be one of the most important services which it can render to the state.

The Determination of the Water Power.

Maryland possesses much undeveloped water power in its larger rivers and creeks, and as yet but little has been done toward its determination. In co-operation with the State Weather Service and the U. S. Geological Survey, water-gauges have been placed on the more important streams for the purpose of ascertaining the normal volume and fluctuation of their waters. These facts, which can be readily obtained with little expenditure of time or money, should be accessible to the public. It is the intention of the State Geological Survey to have this data tabulated, so that those who are seeking sites for new industries, or are desirous of using the water power for electrical purposes, may have a reliable source of information.

The Study of the Physiographic Features of the State.

The origin of our mountains and our river valleys depends upon the geological structure of the state, and has influenced the occupations of the people to so large an extent that it is desirable that attention should be called to this subject. It is the plan of the State Geological Survey to trace out the history of the development of the mountain chains, valleys and plains in connection with the study of the areal geology. To those seeking a home amongst us such features are of much importance, and it is desirable that they should be presented in a thoroughly systematic manner accompanied by graphic illustrations.

The Collection of Statistical Information.

Special forms have been prepared by the Survey which are submitted to the proprietors of each industry in the state that has to do with the natural resources. Questions are asked in these forms regarding the amount and value of the materials produced, in order that a complete tabulated statement may be prepared from time to time showing the development of the various industries. This information, which is intended for incorporation in the economic reports of the survey, will be held strictly confidential, so far as it relates to the private business of any company or individual, but will be used in making up the state and county totals. If only one or two plants are found in a single county the returns will be grouped so that there can be no possible disclosure of the private affairs of any industry. Such information is annually sought by the U. S. Geological Survey for publication in the "Mineral Industries of the United States," and it is desirable that the industries of Maryland should be adequately represented. Many private individuals also desire to know the actual commercial value of our economic products, and complete records of this data should always be available. Furthermore such information is valuable to our own citizens in showing the status of those enterprises which are based upon our mineral wealth. The State Survey particularly requests the co-operation of the various industries of the state in order that the best possible showing may be made annually of our products.

The Preparation of Final Reports.

After all the investigations outlined in the previous pages have been made, it will then be possible to publish a final and general report concerning the physical features of Maryland, in which the physiography, geology and mineral resources will be comprehensively treated. Such a statement regarding our natural wealth, in which constant references shall be given to the special reports earlier published, will be of inestimable value in presenting both to our own citizens and those of other portions of the country not only the developed but the undeveloped wealth in the rocks of the state, while at the same time it will show the character of the state, in its varied physiography and climate, as a place of residence. Such a treatment of the physical resources of Maryland, in which both the surface and underground conditions are considered, will indicate not only to the people of the state the special advantages of each district, but will be sure to invite the investment of capital by outsiders and at the same time induce immigration.

In addition to the distinctly economic importance of such reports, their educational significance should not be lost sight of. They will be of great value for the instruction of the people of the state in all matters relating to their physical surroundings, and in a simplified form could be made suitable for school purposes. If the people of the state should desire it, an elementary treatise could be written, which would be well adapted for purposes of public instruction. This could be prepared without any added expenditure, excepting that involved in the printing. It is most desirable that the youth of Maryland should grow up with a knowledge of the country in which they live and be able to interpret intelligently the physical features of the state, the mountains and valleys, the rocks and minerals and the economic products which are so accessible to them. It is greatly to be desired, when such large sums are annually devoted to the purposes of public instruction, that a means so valuable for training the powers of observation should not be totally ignored. Although this is not the primary object for which the survey is established, yet the results in this line, without added expense to the state, could be made of great practical benefit to succeeding generations.

PART II

HISTORICAL SKETCH

EMBRACING AN ACCOUNT OF THE

PROGRESS OF INVESTIGATION CONCERNING THE PHYSICAL FEATURES AND NATURAL RESOURCES OF MARYLAND

BY

WM. BULLOCK CLARK

HISTORICAL SKETCH

EMBRACING AN ACCOUNT OF THE

PROGRESS OF INVESTIGATION CONCERNING THE PHYSICAL FEATURES AND NATURAL RESOURCES OF MARYLAND.

Information acquired during Colonial Days regarding the Physical Features and Natural Resources of the State.

The Chesapeake Bay was probably known to some extent to the Spaniards early in the 16th century, as there is good evidence that a special expedition was sent to the region many years before the English attempted to establish themselves in any part of the American continent. An account of this expedition is to be found in a book[1] published at Madrid in 1723.

Although the Chesapeake Bay was doubtless thus early entered by Spanish explorers, the first account of the physical characteristics of the Maryland area was given by Captain John Smith,[2] who, in an open boat with a few companions, began an exploration of the Chesapeake Bay and its numerous tributaries in the year 1608. During the two trips which he made into the upper portion of the Chesapeake during the summer of that year, the shores of the Bay were surveyed as far as the Susquehanna river. The harbor of Baltimore was probably entered and the Potomac river was ascended as far as the falls above Georgetown. The intervening portions of the country were also explored, and the map which Captain Smith prepared shows with remarkable correctness the outlines of the regions which he visited.

[1] Ensayo Cronologico para la Historia de la Florida por Don Gabreil de Cardenas y Cano.

[2] The Generall Historie of Virginia, London, 1624. See Bibliography.

During his first voyage, following the eastern shore of the Chesapeake into the southern limits of the state, Captain Smith describes the land as low and bordered with marshes; then crossing to the western shore of the bay he compared the country to that which he had left in the following words:

"Finding this Easterne shore, shallow broken Isles, and for the mostpart without fresh water, we passed by the straits of *Limbo*[1] for the Westerne shore; so broad is the bay here, we could scarce perceiue the great high clifts on the other side: by them we Anchored that night and called them *Riccards Cliftes*.[2] 30 leagues we sayled more Northwards not finding any inhabitants, leaving all the Eastern shore, lowe Islandes, but ouergrowne with wood, as all the Coast beyond them so farre as wee could see; the Westerne shore by which we sayled we found all along well watered, but very mountanous and barren, the vallies very fertill, but extreame thicke of small wood so well as trees, and much frequented with wolues, Beares, Deere, and other wild beasts. We passed many shallow creekes, but the first we found Navigable for a ship, we called *Bolus*,[3] for that the clay in many places vnder the clifts by the high water marke, did grow vp in red and white knots as gum out of trees; and in some places so participated together as though they were all of one nature, excepting the coulour, the rest of the earth on both sides being hard sandy grauell, which made vs thinke it *bole-armoniack* and *terre sigillata*."

Returning thence southward, the Potomac river was entered, the high bluffs of which are compared with those which were observed on tho bay shore.

Upon the second voyage which took place later in the summer of the same year the head of the Chesapeake Bay was visited and many of the physical characteristics of the region were observed.

Very little further knowledge was gained in regard to the physical features of Maryland until the arrival of the first permanent settlers in 1634; before their departure Lord Baltimore[4] in his instructions told them to look out for proper places for making salt and saltpeter and to search for iron and for other ores. In his narrative of the voyage written during that year by Father White[5] to his religious superiors at Rome many interesting facts regarding the physiography of southern Maryland may be found. Father White's description of

[1] Now called Hooper's Straits.
[2] Now called Calvert Cliffs.
[3] Now called the Patapsco river.
[4] Calvert Papers, I, p. 140.
[5] Relatio Itineris in Marylandiam, 1634.

the lower valley of the Potomac and the shores of St. Mary's county possesses much of interest to the student of early travel.

Perhaps the most important publication regarding the physical features of Maryland that appeared in early colonial days is "A Relation of Maryland," which was published in 1635. In this most interesting pamphlet a description of the climate and physiography of those sections of Maryland which had been explored up to that time is given. The narrative states that—

> "The Countrey is generally plaine and even, and yet hath some pritty small hills and risings; It's full of Rivers and Creekes and hath store of Springs and small Brookes:"
>
> "The Mineralls have not yet beene much searched after, yet there is discovered Iron Oare; and Earth fitt to make Allum, *Terra lemnia*, and a red soile like Bolearmonicke, with sundry other sorts of Mineralls, which wee have not yet beene able to make any tryall of.
>
> "The soile generally is very rich, like that which is about *Cheesewecke* neere *London*, where it is worth 20. shillings an Acre yeerely to Tillage in the Common-fields, and very many places, you shall have two foote of blacke rich mould, wherein you shall scarce find a stone, it is like a sifted Garden-mould, and is so rich that if it be not first planted with *Indian* corne, *Tobacco*, Hempe, or some such thing that may take off the ranknesse thereof, it will not be fit for any *English* graine; and under that, there is found good loame, whereof wee have made as good bricke as any in *England;* there is great store of Marish ground also, that with good husbandry, will make as rich Medow, as any in the world: There is store of Marle, both blue, and white, and in many places, excellent clay for pots, and tyles; and to conclude, there is nothing that can be reasonably expected in a place lying in the latitude which this doth, but you shall either find it here to grow naturally: or Industry, and good husbandry will produce it."

Another interesting work of this period is an atlas published in 1635 by Johannem and Wilhelm Bleau, in which the authors indicate the northeast-southwest trend of the mountains and the gorges which the rivers cut through them. There is also a description of the prominent rivers flowing to the Chesapeake. It is evident, however, that the information is largely based upon Captain John Smith's account of his explorations, which have been already described.

With the increase in number of colonists and the gradual settlement of the country, wider knowledge was gained regarding the physical features of Maryland; new industries were opened up and the older ones still further extended, so that before the close of the seventeenth century Maryland became one of the most progressive of the colonies in the development of her natural resources.

Brickmaking was undoubtedly an important industry throughout this period, and much corroborative evidence has been found in the early records regarding this subject. In the Maryland Archives for 1637 and 1638 it is reported that a brickmaker sat in the Assembly, and a letter from S. Cornwalleys[1] to Lord Baltimore the latter year states that he is building a house with cellar and chimneys of brick. In 1652 there is a record of an agreement[2] of a brickmaker to make thirty-six thousand "Good Sound well Burn'd Bricks" in consideration of three hundred acres of land on the Patuxent river.

These and other references show that brickmaking was a common industry in early colonial days, and that the popular belief that bricks were brought to America in large numbers for ordinary building purposes is not well founded. A study of the ancient records and bills of lading fails to afford a single authentic case of the importation of brick, and it seems highly probable that the use of the term "English brick" refers rather to the prevailing shape of the brick than to the locality from which it came. Accounts show that many of the early churches[3] of Maryland were constructed of this material as well as the more pretentious residences.

The iron ore deposits of the Coastal Plain were also developed during this period. In 1648 mention was made of the fact that pig iron was worth £12 per ton, and that the facilities with which iron could be mined and the cheapness at which fuel could be obtained on the numerous watercourses enabled those engaged in its manufacture to earn high wages. This fact doubtless attracted many to the shores of the Patapsco, stimulated speculation in lands and exerted some influence upon the location of the future city of Baltimore. In 1681 an act was passed imposing a duty on the export of iron.

The most important of the early maps of Maryland was made during the decade succeeding 1660 for Lord Baltimore by Augustin

[1] Calvert Papers, I, p. 174.

[2] Md. Archives, Provincial Court, 1649-1657, p. 267.

[3] Helen West Ridgely, "The Old Brick Churches of Maryland." New York, 1894.

Herman[1] and first published in 1670. Herman was a remarkable character. Born at Prague, he was educated as an engineer, and came from Holland to New Amsterdam with the Dutch. Peter Stuyvesant sent him south to help settle a boundary dispute, and he arrived in Maryland in 1660. He was so pleased with this country that he determined to remain here, and proposed to Lord Baltimore to make for him a new map of his domains in return for a large tract of land at the head of the bay in Cecil county. This offer was accepted, and Herman named his estate Bohemia Manor, in honor of his birthplace. Herman's map was engraved by Faithorne and published in London in four folio sheets. Its title is "Virginia and Maryland as it is planted and inhabited this present year 1670; surveyed and exactly drawne by Augustine Herman, Bohemiensis." It contains a fine portrait of Herman. Its scale is 12 English miles to the inch. It names eight Maryland counties as well as the rivers "Sassquahana," "Bush," "Gunpowder," "Patapsko," "Seavorn," "Patuxen," and "Patowmeck." The idea then prevalent that the Appalachians formed the central ridge of the American continent finds expression on Herman's map as follows:

"These mightly high and great Mountaines trenching N. E. and S. W. and W. S. W. is supposed to be the very middle Ridg of Northern America and the only naturall cause of the fiercenes and extreame stormy cold winds that comes N. W. from thence all over this Continent and makes frost. And as Indians report from the other side westward doe the Rivers take their originall issuing out into the west sea, especially first discovered a very great River called the Black Mincquaas River out of which above the Susquehana Fort. . . .

"Certain it is that as the Spaniard is possessed of great Store of Meneralls at the other side of these mountaines the same Treasures they may in process of time afford also to us here on this side when occupyed which is Recomended to Posterity to Remember."

[1] Further information regarding Herman may be found in the N. Y. Geneal. and Biog. Record, vol. ix, 1878, p. 52; N. Y. Historical Collections, vol. xviii; "Ancient Families of Bohemia Manor," by C. P. Mallery, Del. Hist. Soc., 1888; "A Maryland Manor," by J. G. Wilson, Md. Hist. Soc. (Fund Publication, 30), 1890. The Maryland Historical Society also possesses the MS. journal of Herman on the "First Foundation and Seating of Bohemia Manor," 1660.

This description of Herman and the references are taken from Williams' "Maps of the Territory included within the State of Maryland," etc.

During the 18th century the natural resources of Maryland were still further explored and many important industries established, Maryland ranking among the very foremost of the colonies in the production of iron and copper.[1] The Assembly of 1719 passed an act for the encouragement of iron manufacture, in which it is stated "that there are very great conveniences for carrying on of iron works within this province, which have not hitherto been embraced for want of proper encouragement to some first-class undertakers." To encourage the erection of furnaces and forges the laborers employed therein were to be exempted from all levies and taxes.

One of the most important factors in the development of the iron industry was the organization in 1722 of the Principio Company, which in that year commenced the erection of a furnace in Cecil county near the mouth of Principio creek. This company was composed of English gentlemen of wealth who were familiar with iron manufacture in the old country. At an early date in the history of this enterprise, probably 1725, Augustine and Lawrence Washington, the father and half-brother of the future President of the United States, became interested in this company, which soon outranked all others in America in the manufacture of pig and bar iron, being the proprietor of three furnaces and two forges in Maryland and one furnace in Virginia.

Many other companies were organized for the working of the iron deposits prior to the Revolution. A Baltimore company, which was incorporated in 1723, built a furnace at the mouth of Gwynn's Falls. A blast furnace in Harford county was built about 1760. In 1761 the Governor and Council of Maryland reported to the Commissioners of the Board of Trade and Plantations in England that there were eighteen furnaces and ten forges in the state, which made 2,500 tons of pig iron per year.

Just prior to the beginning of the Revolution several furnaces were built in central Maryland, among them being the Catoctin furnace in Frederick county. Bishop says that during the Revolu-

[1] Description taken largely from chapters by W. and R. B. Keyser in "Maryland, its Resources," etc., 1893.

tionary War there were seventeen or eighteen forges in operation in Maryland in addition to the furnaces and other iron works. These furnaces and forges were built mostly on the tributaries of Chesapeake Bay. They were all of the same type, using charcoal for fuel with cold blast and applying the power of the blow cylinder by water wheels. Some of these furnaces, especially the Catoctin furnace, furnished guns and projectiles for the Continental army.

During these years attempts were also made to discover and develop other mineral products. In a letter from Philemon Lloyd to Lord Baltimore and co-partners in 1722 the writer speaks of the discovery of copper ore and other minerals. A report made by the Governor and Council to the Board of Trade of London in 1748 states among other things that "there are in the Province great shews of copper in many places, but of the several attempts that have been made to discover veins of that metal none has yet been made that quitted cost." It was probably shortly after this that a party of English miners opened the Liberty and Mineral Hill mines. They built a small smelting furnace on the Deer Park tract of land near the latter mine where they smelted the ores, and must have produced considerable quantity of copper, as shown by the large amount of rich slags and residue left at the furnace, which nearly a century later were hauled to Baltimore and profitably reworked. Operations at these mines ceased for a time with the opening of the Revolution.

In various letters to Lord Baltimore during the period above described, references are made to the natural resources of the state and accounts are given of the different types of rock, of the condition of the soils, and of the general character of the country, based particularly on more extended explorations of the central and western portions of the colony. Before the opening of the Revolution there was already a wide acquaintance with the broader features of the physiography and mineral products of Maryland.

The determination of the boundary line between Maryland and Pennsylvania was the object of one of the most famous surveys made in this country and one which added much to the existing knowledge regarding the physical features of the state. After numerous controversies a deed was finally executed between the heirs of Wm. Penn and Lord Baltimore in 1732, stipulating that their boundary line should be drawn across the peninsula of Maryland from Cape Henlopen (wrongly located by the Penns 15 miles too far south!) and from its central point a meridian should be followed to a circle drawn with a twelve mile radius about New Castle, Del. From the tangent point this meridian was to be followed to a parallel of latitude fifteen miles south of the southern boundary of Philadelphia, and this parallel was to be the E. W. boundary between the two colonies. To this deed was attached a small map with the boundaries indicated in red, known as "Lord Baltimore's Map." This map was printed by Franklin.

After twenty-eight years of further controversy, a second and final deed was executed in 1760. In 1763 the Penns and Lord Baltimore secured the services of two London surveyors, Mason and Dixon, who, between November 15, 1763, and September 29, 1767, continued the survey as far west as Dunkard's Creek, within 36 miles of its western limit. Here they were stopped by the Indians. The bounding parallel was fixed by this survey as N. 39° 43′ 26″, instead of 40°, as was stated in Lord Baltimore's original patent of 1632. Mason and Dixon's map, with the final award of the Joint Commission and with their report on parchment, is in the Maryland Historical Society's library.[1]

Early Geological Investigations in the Period between the Revolution and the Organization of the First State Geological Survey.

This period witnessed the gradual development of the modern science of geology. At first the methods were crude, but already some years before the organization of the first survey of the state,

[1] For the history of the Mason and Dixon Survey, with the controversies which led to it, see J. Dunlop, "Mem. on the Controversy between W. Penn and Lord Baltimore," Penn. Hist. Soc., Mem. 1, 1826; "History of the Mason and Dixon Line," by J. H. B. Latrobe, address before Pa. Hist. Soc., 1854, Philadelphia, 1855; "Mason and Dixon's Line—A History," by James Veech, Pittsburg, 1857.

This description is taken from Williams' "Maps of the Territory included within the State of Maryland," etc.

geology had come to take a leading position among the sciences. It was only during the last decade of this period that anything like modern methods of classification and of cartographic representation of geological formations came to be generally adopted, yet during these years much was done in the elucidation of the geology of Maryland.

The first observations upon the geology of Maryland during this early period were made by Thomas Jefferson and published in his "Notes on Virginia." These notes, in which the author "speculates on the geology of the state at Harper's Ferry," were written in 1782 and a few copies published in French, the preface to the final publication of 1832 bearing the date of February, 1787.

In 1807 Joseph Scott published in Philadelphia "A Geographical description of the states of Maryland and Delaware," in which an account is given of the natural features of the state, together with a brief summary of Maryland's resources as then known.

About this time several papers relating to Maryland geology were read before the American Philosophical Society of Philadelphia and subsequently printed in its Transactions, among them being contributions by B. H. Latrobe,[1] S. Godon,[2] and Wm. Maclure.[3] The latter publication, entitled "Observations on the Geology of the United States explanatory of a geological map," contains broad generalizations regarding the geology of the country, in which we have the first attempt at a correlation of American formations with those of Europe, the Wernerian classification being adopted.

In 1810 Dr. H. H. Hayden presented a "Mineralogical and Geological Description of the Country Surrounding Baltimore," in which an area extending about nine miles from the city and including the region of the Bare Hills, is considered.

In 1814 Robert Gilmor, Jr., published "A Descriptive Catalogue of Minerals occurring in the vicinity of Baltimore, arranged according to the distribution méthodique of Hauy,"[4] in which he enumerates forty-three minerals found within a distance of 12 miles of the city.

[1] Vol. vi, 1809, pp. 283-293.
[2] Vol. vi, 1809, pp. 319-323.
[3] Vol. vi, 1809, pp. 411-428.
[4] Bruce Min. Jour., vol. i, 1814, pp. 221-232.

Mr. S. L. Mitchill in "A detailed Narrative of the Earthquakes of 1811, 1812 and 1813"[1] describes the phenomena and narrates his observations in Maryland. He suggests that the effects probably did not extend northeast of the state line.

In 1817 William Maclure published his classical work on "Observations on the Geology of the United States of America, with some remarks on the effect produced on the nature and fertility of soils by the decomposition of the different classes of rocks." In this book the limits and character of the geological formations of Maryland are described in a broad way.

Samuel L. Mitchill, in a volume dealing with "Cuvier's Essay on the Theory of the Earth. To which are now added Observations on the Geology of North America," and published in New York in 1818, has numerous references to Maryland geology, especially in the vicinity of Harper's Ferry, on the eastern shore and in the area about Washington. The book contains three figures of an elephant's tooth from Maryland.

Elias Cornelius,[2] in an article published in the American Journal of Science in 1819, refers to the Potomac marble. The same volume contains a letter to the editor from Dr. Hayden upon "Red Pyroxene Augite."

In 1820 Dr. Hayden published in Baltimore a most interesting volume, entitled "Geological Essays; or an Inquiry into some of the Geological Phenomena to be found in various parts of America and elsewhere," in which numerous Maryland localities are cited, especially in the vicinity of Baltimore, in support of the theories which he advanced. Among other interesting facts he mentions the finding of numerous mastodon teeth in Maryland.

The following year Mr. G. Troost[3] announced the discovery of amber on the Magothy river, Anne Arundel county. In this article are found descriptive notes regarding its geological occurrence and the associated minerals and fossils.

[1] Trans. Lit. and Phil. Soc., N. Y., vol. i, 1815, pp. 284-307.
[2] Vol. i, pp. 214-226.
[3] Amer. Jour. Sci., vol. iii, 1821, pp. 8-15.

A work of some importance in its day was "An elementary treatise on Mineralogy and Geology," which was published by Parker Cleaveland in 1822 and in which frequent references are found to Maryland minerals. Maclure's map of the United States is reproduced in the volume.

One of the most important contributions to the stratigraphy of the Coastal Plain which had up to that time appeared, was made by Professor John Finch in a "Geological Essay on the Tertiary Formations in America," in the American Journal of Science and Arts for 1824.[1] This was the first attempt at a correlation of the deposits of the Coastal Plain on scientific grounds, and although thus early in the history of the subject, minute comparisons, which are always unsatisfactory, were made, yet the knowledge of the Maryland Tertiary formations was materially advanced. In this article Professor Finch objects to Maclure's use of the term "alluvium" and shows that the formations so called are "contemporaneous with the newer Secondary and Tertiary formations" of other parts of the world.

During the same year Thomas Say of Philadelphia presented "An Account of some of the Fossil Shells of Maryland," in which he describes and figures many new species, although he draws few geological inferences from the organic remains examined.

Another contribution of some moment is "An Account of the Examination and Surveys, with Remarks and Documents Relative to the Projected Chesapeake and Ohio, and Lake Erie Canals," which was published by James Shriver in Baltimore in 1824. This pamphlet includes remarks on the minerals and rocks of the area traversed.

In Robinson's "Catalogue of American Minerals, with their localities," published in Boston in 1825, several pages are devoted to Maryland minerals.

"The shell marl region of the eastern parts of Virginia and Maryland"[2] was discussed by James Pearce in the American Journal of Science for 1826, the now historic locality of Marlboro being described.

[1] Vol. vii, pp. 31-43.

[2] Vol. xi, pp. 54-59.

A very interesting contribution to the history of the development of artesian waters is an article entitled "Notice of some recent experiences in boring for fresh water, and of a pamphlet on that subject,"[1] in which the sections passed through at points in Washington and Baltimore are described.

In 1827 Dr. Samuel G. Morton of Philadelphia commenced his investigations upon the fossiliferous strata of the Coastal Plain, and throughout the remainder of this period made many important contributions to the paleontology of the deposits, the articles being found chiefly in the Journal of the Academy of Natural Sciences of Philadelphia and in the American Journal of Science for those years.

The publication of an article by Dr. T. A. Conrad of Philadelphia "On the Geology and Organic Remains of a part of the Peninsula of Maryland" in 1830 marks the beginning of a new epoch in the study of Maryland geology. Unlike his predecessors, Conrad from the first applied the paleontological evidence he possessed to an interpretation of the stratigraphy; and, although many of his conclusions were erroneous, still the knowledge of the geology of the Coastal Plain was very materially advanced by the methods which he introduced. During this and subsequent years Conrad added largely to the knowledge of the Tertiary faunas of Maryland and Virginia.

During 1830 Philip T. Tyson published his "Notice of some Localities of Minerals in the counties of Baltimore and Harford, Md."[2] in the American Journal of Science and Arts. Maryland is indebted to many important contributions from his pen from this time forward.

In a letter written in November, 1831, to the editor of the American Journal of Science, S. W. Pomeroy contributes "Remarks on the Coal Region between Cumberland and Pittsburgh, and on the Topography, Scenery, etc., of that portion of the Alleghany Mts."[3] The same year Edmund Ruffin published "An Essay on Calcareous manures," which subsequently passed through three editions. This volume contains a general discussion of the marls of the Coastal Plain and the author refers to localities in Maryland.

[1] Amer. Jour. Sci., vol. xii, 1827, pp. 136-143.

[2] Vol. xviii, pp. 78-84.

[3] Amer. Jour. Sci., vol. xxi, 1832, pp. 342-347.

The close of the period prior to the organization of the First Geological Survey of Maryland found much interest developed in the study of the geology of the state and at this early day considerable knowledge had been already gained regarding the geological deposits.

The Work of the First State Geological Survey and the Investigations carried on under Private Auspices during the same Period.

the first state geological survey, 1834–41.

The decade 1830-40 was a period of great importance in the development of official geological surveys. Before the close of the decade nearly every one of the eastern and some of the central states as well had officially inaugurated geological work. With three exceptions, viz., North Carolina, Massachusetts and Tennessee, Maryland was the first state to establish an official survey. To Maryland, however, belongs the credit of first fully recognizing the importance of a topographical map as a basis for a proper representation of the geology of the state, and we find the General Assembly both in 1833 and 1834 making provision both for a Topographical Engineer and a State Geologist.

The inception of the first geological survey of Maryland dates from 1833, when resolutions relative to a state map and geological survey were passed by the General Assembly of the state upon the 6th and 16th of March.[1] Memorials had been presented to the Legislature recommending the survey, including one from the Maryland Academy of Scienee and Literature.

The original resolution provided for the appointment of both an engineer and a geologist, but the latter office was stricken out at the time the first resolution was passed. It was incorporated in a second

[1] The General Assembly of Maryland was petitioned by Fielding Lucas, Jr., in 1831 to grant money to prepare a more correct geographical map of the state upon which were to be laid down the prominent features of its geology. This petition was not granted, and the bill presented at the same session was rejected. Several earlier attempts, looking to the same result, had been defeated.

resolution, however, which was passed ten days later. The resolutions are as follows:

Resolution relative to the State Map.[1]

Resolved by the General Assembly of Maryland, That the Governor and Council be, and they are hereby authorized to appoint a competent Engineer, whose duty it shall be to examine and collect all the information, plats and reports of surveys, for Canals or Rail Roads, or other public works, which have been made by or under the authority of this State, or any company incorporated by the State, or under the authority of the corporation of Baltimore; and the said Engineer shall make and report to the Governor and Council, before the next session of the General Assembly, a plan and drawing for a complete map of Maryland, and such portions of adjacent States as may be necessary to show the position of Maryland, in reference to the great valleys and streams in her immediate vicinity, the practicable routes for plans of internal improvement; and the said Engineer shall make further examinations and surveys as shall be requisite, for the purpose of exhibiting the prominent geographical and topographical features of the country; and also to collect such statistical information as will be useful, and is generally exhibited on modern improved maps; and the Governor and Council shall allow such reasonable compensation for the services to be rendered, under this resolution, as in their judgment may be just and reasonable.

Resolution relative to a Geological Survey.[2]

Resolved by the General Assembly of Maryland, That the Governor and Council be, and they are hereby authorized to appoint an assistant to the Engineer to be appointed on the subject of a State Map, whose duty it shall be to act in conjunction with said Engineer, and the said assistant shall make the necessary geological researches, and report to the Governor and Council before the next session of the General Assembly, upon the expediency, and probable cost of a Geological Survey of the State; and the Governor and Council shall allow such compensation for the services to be rendered under this resolution, as in their judgment they may deem just and proper.

In accordance with these resolutions the Governor of Maryland appointed J. H. Alexander, Engineer, and J. T. Ducatel, Geologist. They together visited each county, gaining much geographical and geological information concerning the state, which they presented in a joint report to the General Assembly the following year. That report was referred to the Committee on Internal Improvement, to

[1] Laws of Maryland, 1832, Resolution No. 48, passed March 6, 1833.
[2] Laws of Maryland, 1832, Resolution No. 61, passed March 16.

whom it appears to have been satisfactory, as their chairman reported "an act to provide for making a new and complete map and a geological survey of this state." This act was passed on the 25th of February, 1834, and is in full as follows:

An Act to provide for making a new and complete Map and Geological Survey of this State.[1]

Section 1. *Be it enacted by the General Assembly of Maryland,* That the Governor and Council be and they are hereby authorized and required annually hereafter to appoint and commission a person of talents, integrity and suitable scientific attainments as topographical engineer for the State of Maryland; also to appoint and commission in like manner a competent and suitable person as geologist for the State of Maryland, and the said officers shall each receive in consideration of the faithful performance of their respective duties, an annual salary of two thousand dollars, to be paid as the salaries of the other civil officers of the state are or may be directed to be paid.

Sec. 2. *And be it enacted,* That it shall be the duty of the engineer to be appointed as aforesaid, to proceed with all due and reasonable diligence and care to collect the necessary information and make all the necessary surveys and locations to enable him to make a perfect and complete map of the state according to the plan and drawing prepared and submitted to the Executive of the state by J. H. Alexander, Esq., under and in pursuance of a resolution of the General Assembly, passed at the December session, eighteen hundred and thirty-five, and the said engineer shall, as soon as conveniently he can, make perfect and complete the said map.

Sec. 3. *And be it enacted,* That it shall be the duty of the geologist to be appointed as aforesaid, to make a complete and minute geological survey of the whole state, commencing with that portion which belongs to the tertiary order of geological formations, and with the southern division thereof, and progressing regularly with the course of the waters of the Potomac and Chesapeake through that region, and thence through the other subdivisions of the state, with as much expedition and despatch as may be consistent with minuteness and accuracy, and he shall prepare and lay before the Legislature at the commencement of every session a detailed account of all remarkable discoveries made and the progress ot the work.

Sec. 4. *And be it enacted,* That it shall further be the duty ot the geologist of the state, at those seasons not suited to the active prosecution of the geological survey, to analyze and ascertain the qualities and properties of all specimens of mineral substances or soils left at his office or residence for that purpose by any citizen of the state, and taken from any portion of the territory of the state.

Sec. 5. *And be it enacted,* That it shall be the duty of the topographical engineer to indicate upon the new map of the state the localities of valuable mineral deposits already known, or which may in the progress of

[1] Laws of Maryland, 1833, Chapter 138, passed Feb. 25, 1834.

the geological survey be discovered, and as far as conveniently may be, to indicate also, by reference to marginal notes or otherwise, their several natures, qualities and values, and for this purpose the geologist of the state shall keep him regularly advised of all important discoveries which he may make, and the material facts in relation thereto; and the said engineer shall report to the Legislature at the commencement of every session the progress he shall have made during the preceding year in the work assigned to him.

Sec. 6. *And be it enacted*, That for the purpose of facilitating and expediting the completion of the said map and geological survey of the state, the Governor and Council be and they are hereby authorized to allow and pay the accounts of said officers, for necessary contingent expenses, other than personal; so far as they may deem said accounts just, equitable and proper, to an amount not exceeding one thousand dollars in any one year.

Sec. 7. *And be it enacted*, That the officers to be appointed under and by virtue of this act, shall be subject to the orders of the Executive of the state, to make any surveys for canals, rail roads, or other works of internal improvement which the Legislature at any time direct to be made; *Provided nevertheless*, That this act shall expire at the termination of the next session of the General Assembly, unless the same shall be re-enacted by the next Legislature of this state.

During the first year of the survey the Topographical Engineer was hindered from carrying on his work upon the map of the state by the section of the bill which rendered it necessary for him to execute "a survey for canals, railroads or other works of internal improvement which the Legislature may at any time direct to be made," he having been ordered to co-operate immediately after his appointment with an engineer from Virginia and commissioners from Delaware in the location of a canal on the Atlantic borders of Worcester county. He however succeeded in perfecting a plan for extensive co-operation with Mr. Hassler, the Chief of the U. S. Coast and Geodetic Survey, in the conduct of the topographic survey of Maryland. "The object of the Topographical Engineer," as stated in an historical sketch prepared by Ducatel in 1839, "was to obtain the superintendence of Mr. Hassler in order to secure a guarantee of accuracy in the measurement of base lines and the determination of main points for future operations. He was by this arrangement, too, to be put in possession of tried instruments; and the work of course is to be completed with more despatch and at less expense than if left to be prosecuted with such means alone as he could otherwise command."

The Geologist, on the other hand, was enabled to begin his investigations at once upon his appointment. He proceeded as soon as the season would permit to the eastern shore of Maryland, where he made a survey of Talbot, Caroline and Queen Anne's counties, and later in the season crossed to southern Maryland, where he surveyed the shore of the Potomac in Prince George's and Charles counties. Much attention was devoted to the marl deposits of the area visited.

"An act to provide for the completion of the new map and geological survey of this state" having been passed by the General Assembly in March, 1835, the investigations of the survey were continued uninterruptedly. The State Geologist revisited the eastern shore and made geological examinations of Dorchester, Somerset and Worcester counties, and later of St. Mary's county, a full account of which is given in the report for the year. This report also contains the first announcement of the existence of greensand marl or "Jersey marl" (Cretaceous) in Kent and Cecil counties.

The Topographical Engineer was compelled during the season of 1835 to continue his surveys in connection with various plans for further internal improvements, so that his time was again interfered with in the preparation of the new map of the state. In addition to several maps which were prepared for special surveys, he, however, completed a topographical map of Dorchester, Somerset and Worcester counties on the scale of 1:211200 with 4-foot contour lines, and a similar topographic map of St. Mary's, Charles and part of Prince George's counties on the scale of 1:200000 with 10-foot contour lines. Both of these maps had geological data placed upon them and were published in the report of the State Geologist.

The State Geologist during 1836 completed the survey of Calvert county and extended his observations into Anne Arundel, Prince George's and St. Mary's counties, where he likewise announced the discovery of extensive deposits of marl. A special visit was made to Allegany county, and in his report for the year an account is given of the Frostburg basin with its coal and iron deposits.

The Topographical Engineer during the year 1836 was repeatedly engaged in the conduct of special surveys which had been authorized by distinct resolutions of the Legislature, so that he was still further retarded in the prosecution of his work upon the state map. Among the maps prepared and published by the Engineer in his annual report, however, is a detailed map of the Frostburg region and another of northern Frederick county as the basis for a proposed railroad from Frederick to the Pennsylvania line. A topographical map of Calvert county with part of Anne Arundel, upon which the State Geologist entered much geological information, was also published in the same report.

Impressed with the impossibility of prosecuting the topographical survey under existing conditions, Mr. Alexander, in a letter to the Governor, recommended a postponement of the work upon the new map of Maryland until it could be undertaken in connection with the U. S. Coast and Geodetic Survey in accordance with the plan of cooperation which had been earlier effected with Professor Hassler. Mr. Alexander still continued, however, to prepare special maps for the reports of the State Geologist between 1837 and 1840, and also compiled an admirable topographical map of the state upon the scale of 1:200000, with 50-foot contour lines to the east, and 100-foot contour lines to the west of the Monocacy river. This map was never published in full size, but two manuscript copies, beautifully executed by Alexander himself, were prepared. One of these was deposited in Annapolis, where the author of this chapter has up to the present time sought in vain for it; the other is in the possession of Mr. J. J. Alexander of Baltimore, the son of the Topographical Engineer. The boundaries of the geological formations were indicated upon these maps as well as the localities for the following useful mineral products, viz.: "iron, chrome, copper ores; alum clay and pyrite; potter's clay; soapstone and stone paint; granite, syenite and gneiss; marble, hydraulic limestone; slate, sandstone, coal." The date of this map is not stated, but it was probably completed shortly prior to 1840. This map of Alexander's was so much the best extant during the Civil War that soon after the 19th of April, 1861, General Scott ordered

Mr. Bates of the U. S. Coast and Geodetic Survey to have an exact tracing made of it. This was accordingly done in Mr. Alexander's house and the tracing taken to Washington, where it is now to be seen in the archives of the Chief of Engineers of the U. S. Army.

During the year 1837 the State Geologist completed the survey of Kent, Cecil and Montgomery counties. An account of his investigations was published in the report of that year, accompanied by topographic maps, which were prepared by Mr. Alexander, and upon which the leading matters of geological interest were noted. Map A of this report, including Kent and Cecil counties, is upon the scale of 1:150000, and Map B, including Montgomery county, is upon the scale of 1:120000.

The State Geologist occupied his time during 1838 in a survey of Harford county, and the report for that year contains a statement regarding its mineral resources, together with a general outline of the geology of both Harford and Baltimore counties, with some remarks on their agricultural condition. To this report the State Geologist appended a treatise on lime-burning, as the result of a thorough study of the subject. This article is accompanied by diagrams of limekilns.

During 1839 Mr. Ducatel completed his investigations of Frederick and Carroll counties, and prepared an account of their resources and agricultural condition for his report of the operations of that year. This pamphlet also contains a history of the work of the topographical and geological surveys of the state up to that time, with a most interesting account of the conditions under which the work had been prosecuted.

During 1840 the operations of the State Geologist were confined largely to Washington and Allegany (including Garrett) counties. Chapters are devoted to the physical geography, geology and mineral resources of this portion of the state, and the report is accompanied by a topographic map of the area on the scale of 1:400000, with a "geological profile of the Cumberland and National Roads." Additional plates give a "Sectional profile of the ore beds worked at Lonaconing" and also a "Section near the centre of the Georges

Creek Basin." This pamphlet constituted the last report of the State Geologist, although the office was not abolished until February, 1842.

The Topographical Engineer, who had not made any reports between the years 1837 and 1840, presented in 1841 a brief statement regarding the "Trigonometrical survey for the new map of Maryland," in which he urges the taking up of the plan of co-operation with the U. S. Coast and Geodetic Survey which had been earlier arranged, but which had been up to this time hindered because the national bureau had been largely concerned with surveys to the north of Maryland. The general extension of these surveys to the borders of the state made it possible for the first time to enter into active co-operation, and the advantages of this are set forth in this report. The abolition of the office of Engineer at the same time with that of Geologist in February, 1842,[1] put an end, however, to further operations.

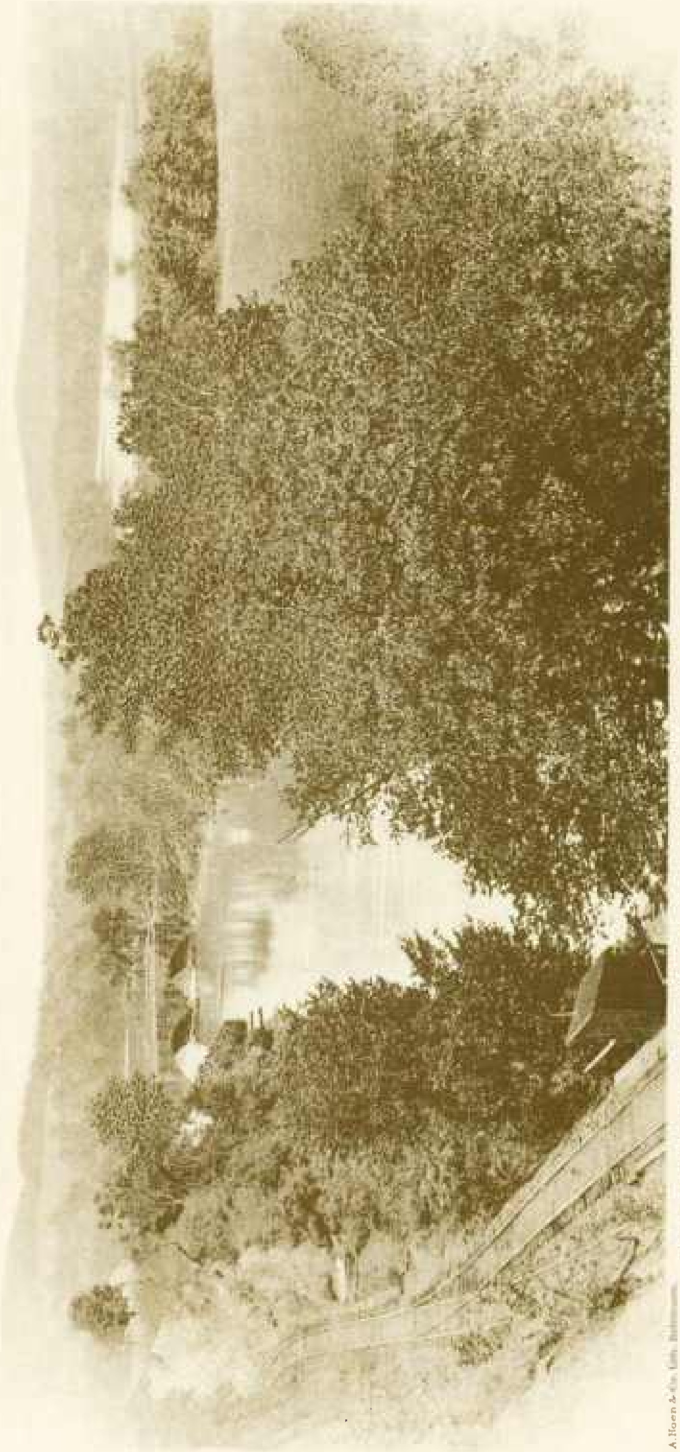
INVESTIGATIONS MADE UNDER OTHER AUSPICES.

Considerable activity was manifested in the investigation of Maryland geology by others during the years that the official state survey was in operation. Dr. H. H. Hayden,[2] who had already contributed much to local geology, prepared a description of the Bare Hills near Baltimore in which various mineral localities are described and indicated upon the map which accompanied this article.

During the same year Messrs. Isaac Lea and S. G. Morton[3] discussed the Tertiary and Cretaceous deposits, the latter tracing the extension of the greensand beds from New Jersey across Delaware into Maryland.

An important article by W. E. A. Aikin, entitled "Some notices of the Geology of the Country between Baltimore and the Ohio River, with a section illustrating the superposition of the rocks," was published in the American Journal of Science in 1834.[4] This article contained the most complete description of the geology of central and western Maryland that had been published up to that time.

[1] Laws of Maryland, 1841, Chapter 153, passed Feb. 24, 1842.
[2] Amer. Jour. Sci., vol. xxiv, 1833, pp. 349-360, map.
[3] Amer. Jour. Sci., vol. xxiii, 1833, pp. 288-294; vol. xxiv, 1833, pp. 128-132.
[4] Vol. xxvi, pp. 219-232, plate.



A. Hoen & Co. Lith. Baltimore.

THE POTOMAC RIVER AT WILLIAMSPORT, ON THE WESTERN MARYLAND R. R.

Valuable contributions by Conrad [1] appeared during 1834 and 1835 in which the character and position of the Eocene deposits are described.

The publication of Dr. Morton's "Synopsis of the organic remains of the Cretaceous group of the United States," in which was added an appendix regarding the Tertiary fossils of North America, occurred in 1834. Numerous Maryland forms are referred to.

An interesting section was presented by R. C. Taylor in the Transactions of the Geological Society of Pennsylvania in 1835,[2] in which the relations of some of the rocks of central Maryland in the vicinity of Harper's Ferry are described.

Much interest was manifested in the investigations of the Georges Creek basin during this period, the first company having been formed in 1836 to develop the coal and iron properties. In addition to the work of the State Geologist, before described, a pamphlet was prepared by James C. Booth [3] upon the coal lands of a portion of the Georges Creek basin, and in the two succeeding years further contributions were made by Philip T. Tyson [4] and D. V. Douglas.[5] Tyson [6] also prepared at this time "A descriptive Catalogue of the principal minerals of the State of Maryland."

During the latter years of the existence of the State Survey, Dr. Conrad made further contributions to the Tertiary geology and paleontology of Maryland, describing numerous fossils from the Calvert Cliffs. Correlations were also made of the Eocene deposits of Upper Marlboro, Fort Washington and other localities.

After the organization of the Maryland Geological Survey the neighboring states of Virginia, Pennsylvania and Delaware followed the same course, the survey of Virginia being organized in 1835 under

[1] Jour. Acad. Nat. Sci., Phila., vol. vii, 1834, pp. 116-157; Trans. Penn. Geol. Soc., vol. i, 1835, pp. 335-341, pl. xiii; Amer. Jour. Sci., vol. xxviii, 1835, pp. 104-111, 280-282.

[2] Vol. i, pp. 314-325 (with colored sections).

[3] Report of the Examination and survey of the Coal lands, etc., belonging to the Boston Purchase, near Cumberland, in the State of Maryland. New York, 1836. 18 pp.

[4] Trans. Md. Acad. Sci. and Lit., vol. i, 1837, pp. 92-98. Plate.

[5] Report on the Coal and Iron Formation of Frostburg, etc., 1838.

[6] Trans. Md. Acad. Sci. and Lit., vol. i, 1837, pp. 102-117.

W. B. Rogers, that of Pennsylvania in 1836 under H. D. Rogers, and that of Delaware in 1839 under J. C. Booth. The investigations carried on by these surveys along the borders of Maryland were of much importance in deciphering the geological structure of the formations of Maryland as well. The work of the Rogers particularly, to the north and south of Maryland, had an important bearing upon the development of knowledge regarding the geology of the state of Maryland, and the results of their work are still frequently employed by those seeking information regarding the geological structure of our own state.

An Account of both Private and Official Investigations conducted after the termination of the First State Geological Survey to the Outbreak of the Civil War.

INVESTIGATIONS CONDUCTED UNDER OTHER THAN STATE AUSPICES.

The termination of the first geological survey was followed by a period of little activity in geological work. From time to time investigations were made, under private auspices, of special phases of Maryland geology, but little systematic work was undertaken. The most marked exception to this general rule is seen in the continued work of Dr. T. A. Conrad, who pursued his investigations upon the Tertiary deposits of the country, and almost yearly contributed articles in which both the Eocene and Neocene faunas of Maryland received greater or less attention. The publications of Dr. Conrad during this period are perhaps the most important contributions that were made to Maryland geology.

The visit of Charles Lyell to America during the early portion of this period had an important influence upon the development of knowledge regarding the geology of the country. Although his observations extended over a wide area from New Jersey to the Gulf, his conclusions were nevertheless of much value to each region, especially in the Coastal Plain. On account of his wide knowledge of the Cretaceous and Tertiary in other portions of the globe, he succeeded in explaining many points hitherto imperfectly understood in

American stratigraphy. Several contributions were made to scientific journals as the result of his investigation. In his volume of travels in America, which was published in 1845, he gives also an account of his observations among the Carboniferous rocks of the Cumberland-Frostburg area and a list of the fossil plants which he found. In this volume there is a geological map of the United States in which the geology of Maryland is given upon a very small scale. The fossil plants collected by Mr. Lyell were described and figured by Mr. Bunbury in the Quarterly Journal of the Geological Society of London.[1]

The discovery of microscopic forms in the Tertiary deposits of Maryland and Virginia began to attract attention at this period and articles were contributed by J. W. Bailey[2] and C. G. Ehrenberg[3] upon the subject.

The exhaustive investigations of Professor James Hall of Albany, N. Y., upon the Paleozoic fossils of that state led him early to the study of similar material in adjacent states. In connection with this work large collections of Paleozoic fossils from western Maryland were obtained and descriptions and figures of numerous species from Cumberland and vicinity appeared already in Volume 1 of the Paleontology of the State of New York, which was published in 1847.

The discovery of gold in Montgomery county in 1849 and its exhibition that year before the American Philosophical Society led to several descriptions[4] of the deposits in scientific publications.

During the second decade of this period Professor H. D. Rogers, the State Geologist of Pennsylvania, conducted investigations along the borders of that state that were of much value in determining the classification and distribution of the geological formations represented in central and western Maryland. The final report of this survey appeared in 1858 and is still an important source of information.

[1] Vol. ii, 1846, pp. 82-91.

[2] Amer. Jour. Sci., vol. xlvi, 1844, pp. 137-141; ibid. vol. xlviii, 1845, pp. 321-343; ibid. 2 ser., vol. vii, 1849, p. 437; ibid. 2 ser., vol. xi, 1851, pp. 85-86.

[3] Bericht. d. k. Akad. Wiss., Berlin, 1844, pp. 57-97.

[4] Proc. Amer. Assoc. Adv. Sci., vol. iv, 1851, pp. 20-22; Proc. Amer. Phil. Soc., vol. v, 1854, p. 85.

INVESTIGATIONS CONDUCTED BY THE STATE AGRICULTURAL CHEMISTS, 1848–1862.

By an act[1] of Assembly passed in March, 1848, the Governor of the state was authorized to appoint a State Agricultural Chemist, whose duty it was "to analyze specimens of every variety of soil of the county in which he shall be that may be brought to him or that he may find to exist, and also to examine, and if necessary analyze, specimens of every kind of marl or other mineral or vegetable deposits that may come to his knowledge," and also "to deliver one public lecture after having given timely notice in each election district in each county and then to deliver a course of public lectures at each county town."

Dr. James Higgins was appointed the first State Agricultural Chemist, his term of office extending from 1848 to 1858, when he was succeeded by Mr. Philip T. Tyson, who continued in office until the repeal of the act in 1862.[2]

The work of Dr. Higgins possessed little of scientific interest. He published six reports between the years 1850-58, in which numerous analyses of soils, marls and other substances are found, but the work was intended to be of more immediately practical than scientific value.

Mr. Tyson was deeply interested in the geological problems connected with his work as State Agricultural Chemist, and in his first report, published in 1860, prepared a geological map of the state on the scale of 12 miles to an inch, that was by far the most complete representation of Maryland's geology that had been attempted up to that time. It was the first detailed geological map of the entire state. More fully perhaps than any one else at that period, he recognized the fact that geological investigations were essential to any proper interpretation of the soils of the state, and accordingly did much to classify and describe the several geological formations. He says:

> In the present day there are perhaps few who will refuse their assent to the proposition, that the character of the industrial operations of every

[1] Laws of Maryland, 1847, Chap. 249, Maryland Code, 1860, Art. 17.

[2] Laws of Maryland, 1861-62, Chapter 73, passed Feb. 19, 1862.

country, depends for the most part upon its geological constitution, modified, of course by climate.

It is equally certain that, in connection with climate, the geological structure and mineral components of any region, determine the character and the fertility of its soils.

From what is now known of the origin and characters of soils, we must conclude that the very foundation of any intelligent and practical application of science to agriculture in any region, must consist of a thorough investigation of its geological and mineral constitution.

A survey of this kind for our state should have for its object the determination of the chemical, physical and other characters of each kind of rock, bed of clay, sand, marl, or other mineral deposit within our borders.

They should be minutely described, and their position and extent be accurately shown on a map, and sections upon a large scale. We should make ourselves acquainted with the properties of every mineral that can be usefully applied to the soil, and also, with those that may promote industrial operations within our limits. These last should by no means be overlooked, because of their importance in adding to the demand for the products of the farm.

These views led Mr. Tyson to the preparation of a geological map "to aid in forming a correct idea of the agricultural and other industrial capabilities of our state." The base map for the geology was executed by Mr. August Faul upon data secured from various sources, chiefly from that of the manuscript map of Mr. J. H. Alexander, which has been described in a previous chapter.

"The First Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, January, 1860," contains several chapters dealing with the general principles of mineralogy and geology, including a classification of rocks and their geographical distribution in Maryland. Much attention is given to the limestones and marls, and their value for agricultural purposes. Much of the report deals with the soils and the various natural and artificial fertilizers which may be used for their improvement. This report closes with an appendix in which the mineral resources of Maryland are briefly described.

"The Second Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, January, 1862," again dwells upon the importance of geological work in connection with an agricultural survey. In this second report much more attention is devoted to the mineral resources of the state, their local occurrences being more fully described.

Sketch of the History of the Maryland Academy of Sciences.[1]

The first successful efforts to organize an association in Maryland for the promotion of science were made in the year 1822, although the actual beginning of the present academy does not antedate 1855. Sundry associations had been previously contemplated and some had actually gone into operation, but they soon disappeared after an ephemeral existence. The Maryland Academy of Science and Literature was opened in 1822 under more favorable auspices. A large number of persons presented themselves who were willing to advance the objects of such an organization and in a short time the Academy found itself in possession of an extensive collection of minerals and an herbarium, the nucleus of a cabinet around which new materials might daily accumulate.

A strong appeal was then addressed to members of the learned professions in Baltimore and throughout the state which was in some measure responded to. The number of contributing members became sufficiently large to justify the steps of procuring an apartment where the meetings of the Academy could be regularly held. After various removals a location was finally secured in a spacious hall where the collections increased from year to year until an unfortunate fire in 1835 consumed the entire property of the Academy, including many valuable scientific books.

Not discouraged by this calamity, members of the Academy in 1836, acting under a charter obtained in the year 1826, determined to reorganize the society and place it upon a basis of permanent prosperity. Large numbers of books and specimens were again collected and commodious apartments were secured. Five sections were established to facilitate investigation along special lines—Section 1, Mathematics, Astronomy and Physics; Section 2, Chemistry; Section 3, Mineralogy and Geology, including Physical Geography; Section 4, Zoology; Section 5, Botany. In 1837 a volume of Transactions was

[1] This sketch is mainly compiled from a chapter prepared in 1888 by Professor Philip R. Uhler, President of the Maryland Academy of Sciences, and from the Introduction to the Transactions of the Maryland Academy of Science and Literature, published in 1837.

published containing among other articles "Outlines of the Physical Geography of Maryland embracing its principal Geological features," by J. T. Ducatel, the State Geologist; "A description of the Frostburg Coal formation of Allegany County, Maryland, with an account of its geological position," by Philip T. Tyson; and "A descriptive Catalogue of the principal Minerals of the State of Maryland," by the same author.

The Academy of Science and Literature continued its existence but a few years, after this, however and prior to the abandonment of the State Survey in 1841, came to an end, its collections and books being divided among the members. For more than a decade after this the state was without an official academy.

The present Maryland Academy of Sciences dates from May, 1855, when several members of the Maryland Historieal Soeiety formed a Committee on Natural History by act of that Society and met fortnightly in one of its small rooms until the close of the year 1862. On the 22d of February, 1863, a meeting was held at the house of Mr. Philip T. Tyson in Baltimore, when the Maryland Academy of Sciences was organized by the adoption of a constitution and the election of Mr. Tyson as its first president. In 1867 an act of incorporation was asked from the General Assembly of Maryland, which was granted on the 15th of March of the same year.

The Academy's collections of natural history specimens and of books accumulated rapidly as the result of the enthusiastic labors of its members, who included some of the most prominent professional men of Baltimore. The more aetive of these members grouped themselves into sections, each of which took charge of one or more subjects of investigation. Reports were made upon the more conspicuous or attractive specimens secured, and the interest of the society was continually kept awake by the fresh objects thus brought to its consideration.

It finally became apparent that a proper building would have to be constructed to accommodate the growing needs of the Academy, and accordingly in 1873 the lease of a lot of ground on Mulberry Street was secured from the University of Maryland, and subscriptions to the building fund were solicited from the citizens of Baltimore with the result that a suitable building was constructed and made ready for occupancy early in 1875. In this new building it was decided to restrict objects placed on exhibition to such as belonged particularly to the state of Maryland. Courses of free lectures, illustrated by specimens from the collections, were given in the hall both by the members and by professors of the Johns Hopkins University. Field meetings were also held on alternate clear Saturdays during the summer or early autumn, and these were usually presided over by an officer or prominent member of the Academy. Among the most conspicuous of the leaders in these excursions was Mr. Philip T. Tyson, who being a good geologist, mineralogist and chemist was every ready to make intelligent remarks upon the structure and peculiarities of the region visited. Many of the other members of the society assisted in leading these excursions and did much to explain the geology, physical geography and natural history of the areas visited.

Persons from other states visited the museum of the Academy and were often assisted to obtain information about the natural history objects which had excited their interest at home.

In 1883 the city of Baltimore passed an act to extend Cathedral Street, and the building of the Academy being in the way of this improvement, it became necessary to abandon it. The collections were moved to other quarters, many of them being sent to the New Orleans Cotton Exposition in 1884, where, through the carelessness of those into whose custody they were placed, they were permanently lost. Finally the balance of the Academy's collection was given to the Johns Hopkins University.

The Academy upon relinquishing its public museum decided to publish the manuscript material which had been accumulating for many years, and in 1888 began the publication of its first volume of "Transactions," which were completed in 1895. This volume contains several important contributions by Professor Philip R. Uhler, the present President of the Academy, in which the Tertiary and Cretaceous formations of eastern and southern Maryland are described.

In 1892 the large building at the corner of Franklin and Cathedral

Streets, which had been recently vacated by the Maryland Club, was presented, through the generosity of Mr. Enoch Pratt, to the Academy. In the halls of this large edifice extensive collections which illustrate the natural resources of the state are being brought together at the present time under the direction of Professor Uhler and his co-laborers.

The Establishment and Work of the Maryland Agricultural College and Agricultural Experiment Station.[1]

The intimate relationship which exists between the soils of a region and the underlying rocks from which they are derived has been already pointed out in an earlier chapter. It is important therefore that something should be said regarding the agencies which have been active in their study and development in more recent years.

The student of agriculture necessarily comes in touch at many points with the same problems that the geologist has to deal with, and much can be accomplished as a result of their co-operation for the agricultural needs of the community. More and more the classification of soil types is coming to be recognized as resting upon the geological discrimination of the underlying formations.

The Maryland Agricultural College and Agricultural Experiment Station have been most efficient factors in the investigation of our soils, and their relations to the development of knowledge regarding the physical features of the state of Maryland will be briefly considered in the following pages.

THE MARYLAND AGRICULTURAL COLLEGE.

The Maryland Agricultural was the second technical agricultural college established in the United States. It owes its inception to the wisdom and energy of a party of Maryland gentlemen who, recognizing the great advantage to agriculture and to the state of suitable provision for scientific training for the sons of farmers, petitioned the Legislature in 1856 for an act of incorporation of an agricultural college.

The petition was met by an act of the General Assembly of Mary-

[1] Information furnished by President R. W. Silvester.

land, dated March 6th, 1856, which contained the following general provisions for the establishment of a college of agriculture and a model farm: That as soon as two thousand shares of stock, of the value of $25 a share, should be subscribed for the purpose, the subscribers should be incorporated into a company to be known as The Maryland Agricultural College. The direction of the corporation was to be placed in the hands of twenty-two trustees, to be selected from the stockholders, which trustees should purchase land and cause the necessary buildings to be erected, should select a president and faculty, and generally control and direct the affairs of the institution. The express purpose of the college was defined to be: "To instruct the youthful student in those arts and sciences indispensable to successful agricultural pursuit."

The corner-stone of the first college building was laid on August 24th, 1857, at its present site in Prince George's county. While the building was still in process of construction, work was begun upon the farm, looking to its preparation for the experimental work required by the charter to be conducted upon it. The building was completed in the following year, and the College was formally opened in October, 1859. Each trustee was empowered to designate students for admission from his own county. Students were to be required to perform practical farm work. The College thus began its career auspiciously.

Three years after its opening—in 1862—the Congress of the United States passed the first act providing for the endowment of agricultural colleges. The fact is worthy of being emphasized here that Maryland did not wait for Federal aid in the establishment of such an institution, but before the passage of the act of 1862, by the generosity and public spirit of her private citizens, and the wisdom and foresight of her Legislature, had established and put into practical operation a college whose primary object was to develop her agricultural interests by training young men in those departments of science "which should fit them for the successful pursuit of agriculture." Thus the Maryland Agricultural College is not, strictly speaking, a "Land-grant College" in its origin, but rather a beneficiary of the land grant of 1862.

In 1865 the hard times and unsettled state of affairs in Maryland, consequent upon the Civil War, rendered it necessary for the College to apply to the state for aid. The state came to the assistance of the College, becoming part owner of the land and property of the corporation, binding itself to an annual appropriation for its support and thus securing the right of representation on the Board of Control. Since that time several changes have been made in the composition of the Board. At present it is constituted as follows: the Governor of the state is ex-officio President of the Board; the other state officers who are ex-officio members are the Comptroller, the Treasurer, the Attorney-General, the President of the Senate and the Speaker of the House of Delegates. Besides this representation, the Governor appoints six visitors, and the stockholders elect five.

In 1887 Congress passed a second important act in aid of the agricultural interests of the country, appropriating $15,000 a year to each state for the establishment and maintenance of an agricultural experiment station. The Maryland station was located on the College farm, and was made a separate department of the College. In 1892 the board of trustees so far separated it from the College as to put it under a special director, who is directly responsible to the Board.

Again, in 1892, the Federal Government showed its disposition to favor the colleges of agriculture and the mechanic arts. By the act of that year a sum of $15,000, to be increased by $1000 each year until the sum of $25,000 was reached, was granted to each state to be applied to the further equipment and support of the agricultural and mechanical colleges. Maryland, as was the case in all the states in which there is a considerable negro population, in order to comply with the terms of the act of Congress, divided this fund between the State Agricultural College and a somewhat similar institution for the education of negroes. This college is located at Princess Anne, on the eastern shore of Maryland.

During the years since the Maryland Agricultural College has been started, it has done much to foster a study of the natural wealth which the state contains in its soils, both by training young men as agriculturalists to a higher realization of the agricultural needs of the community and by the researches which have been carried on by the members of the staff upon Maryland agricultural topics. In this connection may be mentioned the establishment by an act of Legislature, in 1896, of a Department of Farmers' Institutes at the College and Station. The work of this department is fairly under way, and in the 24 meetings which have been held during the past winter in various parts of the state, most gratifying success has been met with. By the organization of this department the College has greatly increased its sphere of usefulness to the farmers of the state, for whose benefit it was especially created.

THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

The Experiment Station of Maryland was called into existence as a result of an act passed by the 49th Congress and approved March 2, 1887. This act appropriated $15,000 annually to each state for research work in agricultural and kindred subjects. The act did not directly carry an appropriation, so it did not become operative until the 50th Congress made the necessary provision by an act approved March 6th, that the Maryland Agricultural College should be the beneficiary of this fund. The experiment station by this act became a department of the College, and this connection of the College with the Station is a matter of no little advantage to both institutions. As above mentioned, it was so far separated from the College in 1892 as to be placed under a special director, who is immediately responsible to the board of trustees.

The work of the Agricultural Experiment Station is defined by the second section of the act, which is as follows:

"Sect. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and waters; the chemical composition of manures, natural or artificial, with experiments designated to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States, as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective states or territories."

The principal lines of work now being conducted are as follows:

The agricultural department conducts culture experiments, variety tests, fertilizer tests, tests of fungicides for rot, and scab of sweet and Irish potatoes.

The chemical department conducts digestion experiments, feeding experiments (cows, steers, pigs and horses), dairy experiments, special fertilizer tests with phosphoric acid, lime, potash and nitrogen and tobacco tests and general laboratory work.

The horticultural department conducts variety tests upon fruits, small fruits and vegetables.

The entomological department conducts the determination of the character and extent of insect ravages and of insecticides.

The soils department conducts physical examinations and classifications and geological classifications.

PUBLICATIONS OF THE MARYLAND AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 1, June, 1888.—History, Organization and Work of the Station.
Bulletin No. 2, Sept., 1888.—Cutting Seed Potatoes for Planting. Appendix, with information about the Station.
Bulletin No. 3, Dec., 1888.—Fodder-Corn and Fodder-Cane. Appendix, about taking and sending samples.
Bulletin No. 4, March, 1889.—Experiment Orchard.
Bulletin No. 5, June, 1889.—Experiment Orchard.
Bulletin No. 6, September, 1889.—Commercial Fertilizers.
Bulletin No. 7, Dec., 1889.—Farm Manures.
Bulletin No. 8, March, 1890.—Some Feeding Trials.
Bulletin No. 9, June, 1890.—Strawberries.
Bulletin No. 10, Sept., 1890.—Wheat.
Bulletin No. 11, Dec., 1890.—Tomatoes.
Bulletin No. 12, March, 1891.—Pig Feeding.
Bulletin No. 13, June, 1891.—Strawberries.

Bulletin No. 14, Sept., 1891.—Wheat.
Bulletin No. 15, Dec., 1891.—Experimental Vineyard.
Bulletin No. 16, March, 1892.—Wheat Insects.
Bulletin No. 17, June, 1892.—Strawberries and Seed Potatoes.
Bulletin No. 18, Oct., 1892.—Sweet Potatoes.
Bulletin No. 19, Dec., 1892.—Tomatoes.
Bulletin No. 20, March, 1893.—The Composition and Digestibility of the different parts of Corn Fodder.
Bulletin No. 21, June, 1893.—The Soils of Maryland.
Bulletin No. 22, Sept., 1893.—Steer Feeding, a well-balanced vs. a poorly-balanced ration.
Bulletin No. 23, Dec., 1893.—Injurious Insects of Maryland.
Bulletin No. 24, Feb., 1894.—Composition of Commercial Fertilizers sold in this State.
Bulletin No. 25, March, 1894.—Agricultural and Horticultural Departments. Corn, Potatoes, Tomatoes, Strawberries, Grapes, etc.
Bulletin No. 26, June, 1894.—Tobacco.
Bulletin No. 27, Aug., 1894.—Composition of Commercial Fertilizers sold in this State.
Bulletin No. 28, Sept., 1894.—Experiments with Wheat and Barley.
Bulletin No. 29, Dec., 1894.—Further Investigations on the Soils of Maryland.
Bulletin No. 30, Jan., 1895.—Composition of Commercial Fertilizers sold in this State.
Bulletin No. 31, March, 1895.—Potato Experiments.
Bulletin No. 32, April, 1895.—The San José Scale.
Bulletin No. 33, April, 1895.—Horticultural and Agricultural Departments, Small Fruits, Vegetables and Field Corn.
Bulletin No. 34, July, 1895.—Composition of Commercial Fertilizers sold in this State.
Bulletin No. 35, Sept., 1895.—Wheat, Barley, Oats and Hay Experiments.
Bulletin No. 36, Dec., 1895.—Steer Feeding, a well-balanced vs. a poorly-balanced ration.
Bulletin No. 37, Feb., 1896.—Composition of Commercial Fertilizers sold in this State.
Bulletin No. 38, March, 1896.—Potato Experiments.
Bulletin No. 39, April, 1896.—Spray Calendar.
Bulletin No. 40, Aug., 1896.—Composition of Commercial Fertilizers sold in this State.
Bulletin No. 41, Sept., 1896.—Test of Methods of Preparing and Feeding Corn Fodder.
Bulletin No. 42, Oct., 1896.—The Maryland Trees and Nursery Stock Law and Other Information of Special Interest to Nurserymen and Fruit Growers.
Bulletin No. 43, Dec., 1896.—Report upon the Value of a New Corn Product.
Bulletin No. 44, Dec., 1896.—The Soils of the Hagerstown Valley.
Bulletin No. 45, Feb., 1897.—Composition of Commercial Fertilizers sold in this State.
Bulletin No. 46, March, 1897.—Corn and Potato Experiments.
Special Bulletin A, Fair Edition, 1889.—Facts about the Station.
Special Bulletin B, July, 1890.—Potash and Paying Crops.

Special Bulletin C, Oct., 1890.—Composition of Commercial Fertilizers sold in this State.

Special Bulletin D, Feb., 1891.—Composition of Commercial Fertilizers sold in this State.

Special Bulletin E, Aug., 1891.—Composition of Commercial Fertilizers sold in this State.

Special Bulletin F, Jan., 1892.—The Agricultural Outlook for Maryland.

Special Bulletin G, Feb., 1892.—Composition of Commercial Fertilizers sold in this State.

Special Bulletin H, July, 1892.—Government Direction of Agriculture in Europe.

Special Bulletin I, August, 1892.—Composition of Commercial Fertilizers sold in this State.

Special Bulletin J, Feb., 1893.—Composition of Commercial Fertilizers sold in this State.

Special Bulletin K, June, 1893.—Composition of Commercial Fertilizers sold in this State.

First	Annual	Report	of the	Maryland	Agricultural	Experiment	Station,		1888.
Second	"	"	"	"	"	"	"	"	1889.
Third	"	"	"	"	"	"	"	"	1890.
Fourth	"	"	"	"	"	"	"	"	1891.
Fifth	"	"	"	"	"	"	"	"	1892.
Sixth	"	"	"	"	"	"	"	"	1893.
Seventh	"	"	"	"	"	"	"	"	1894.
Eighth	"	"	"	"	"	"	"	"	1895.
Ninth	"	"	"	"	"	"	"	"	1896.

Geological Investigations carried on by Private Interests after the Civil War.

The contentions growing out of the Civil War were not conducive to scientific activity, particularly in the border states. The people of those states were in no condition to officially make provision for the continuance of geological surveys, while few of their residents or those beyond the borders were disposed to carry on the work. A marked exception to this general dearth of geological investigation in the border region of the middle Atlantic slope is seen in the labors of several members of the Philadelphia Academy of Sciences, whose observations during the period prior to the opening of the war have been already recounted. Most of the publications, however, relating to Maryland geology, that were brought out during the period and for the first decade after the close of the war, touch the subject only indirectly, the investigations having been carried on largely in the adjacent states. As Maryland is often mentioned in these publications, they have been referred to in the bibliography of the state.

The work of Dr. T. A. Conrad[1] of the Philadelphia Academy of Natural Sciences deserves especial mention. His publications deal entirely with the Tertiary fossils of eastern and southern Maryland, many articles appearing between the years 1862-67. Professors Joseph Leidy and Edward D. Cope,[2] colleagues of Dr. Conrad in Philadelphia, made several contributions to Maryland geology during this time, the latter describing in several papers the vertebrate fauna of the Miocene period in Maryland and Virginia.

During these years Professor James Hall of Albany, New York, continued his elaborate study of the Paleozoic fossils of the eastern border region, investigating among other forms large collections of Maryland fossils which had come into his possession. Numerous descriptions and figures of these forms are given in the reports of the State Geological Survey of New York.

Just after the close of the war there began to be renewed activity in the development of Maryland resources, and a few articles of an economic character appeared already prior to 1870. In 1871 Credner,[3] Harden[4] and Tyson[5] discussed the coal and iron deposits of the western portion of the state, and the same year Professor N. S. Shaler describes in two articles the physical features of the Middle Atlantic slope, in which the origin of the Delaware and Chesapeake bays is considered.

The appointment of commissioners on the part of the states of Maryland and Virginia to ascertain the boundary line between those states led to the publication in 1873-74 of official reports regard-

[1] Proc. Acad. Nat. Sci., Phila., vol. xiv, 1862, pp. 559-582, 583-586; vol. xvi, 1864, pp. 211-214; vol. xvii, 1865, pp. 70-73; Amer. Jour. Conch., vol. i, 1865, pp. 1-35, pp. 210-212; vol. ii, 1866, pp. 65-74; vol. iii, 1867, pp. 257-270; Smith. Misc. Coll., vol. vii, Art. 6, 1866, pp. 41.

[2] Proc. Acad. Nat. Sci., Phila., vol. xix, 1867, pp. 138-156; vol. xx, pp. 184-194.

[3] Petermann's Mittheil., vol. xvii, pp. 41-50.

[4] Trans. Amer. Inst. Min. Eng., vol. i, pp. 136-144.

[5] Proc. Amer. Phil. Soc., Phila., vol. ix, pp. 9-13.

ing the matter, in which much information is given concerning old maps and charts that deal with the physiography of the state.[1]

The proposed extension of the Chesapeake and Ohio Canal to the Ohio river led to the preparation of a report[2] to Congress about the same time in which a discussion of the country between Cumberland and Pittsburg is found.

An interesting contribution was made in 1875 by Dr. Christopher Johnston of Baltimore "About the rediscovery of the 'Bermuda Tripoli' near Nottingham, on the Patuxent, Prince George's County, Md."[3]

In 1878 Professor J. J. Stevenson published two articles dealing mainly with the geology of southwestern Pennsylvania, in which western Maryland is included. In the first[4] of these articles the surface features of the region are considered, and in the second[5] the Devonian rocks.

Scharf's "History of Maryland," which appeared in 1879, contains many references to the early maps, history and industries of the state, and has especial value on account of the accessibility of the volumes.

The discovery of *Butrotrephis flexuosa* in the Peach Bottom slate in 1879 and its determination by Lesquereux led to the publication of two articles by Professor J. P. Lesley in 1880[6] dealing with the age of the rocks. During the same year Professor Heilprin of Philadelphia published the first of his contributions upon the Tertiary fauna of Maryland, in which he discusses the "Stratigraphical Evidence afforded by the Tertiary Fossils of the Peninsula of Maryland."[7]

Scharf's "History of Baltimore City and County," which appeared in 1881, contains an account of the topography and geology of the

[1] See especially "Report and accompanying documents of the Virginia Commissioners appointed to ascertain the Boundary Line between Maryland and Virginia." Richmond, 1873.

[2] House Doc. No. 208, 43rd Congress, 1st session, 59 pp., 1874.

[3] Proc. Boston Soc. Nat. Hist., vol. xvii, 1875, pp. 127-129.

[4] Amer. Jour. Sci., 3 ser., vol. xv, 1878, pp. 245-250.

[5] Amer. Jour. Sci., 3 ser., vol. xv, 1878, pp. 423-430.

[6] Proc. Amer. Phil. Soc., vol. xviii, 1880, pp. 364-369. Amer. Jour. Sci., 3 ser., vol. xix, 1880, pp. 71-72.

[7] Proc. Acad. Nat. Sci., Phila., vol. xxxii, 1880, pp. 20-33.

country by Professor P. R. Uhler of the Maryland Academy of Sciences.

Further contributions were made by Professor Heilprin[1] upon the Tertiary formations of Maryland during the years 1881 and 1882, in which correlations are proposed for the Eocene and Miocene deposits of the state.

An article entitled "Notes on the Cumberland or Potomac Coal Basin," by H. G. Jones,[2] appeared during the latter year in the Proceedings of the American Philosophical Society, with a discussion by J. P. Lesley. Professor I. C. White contributed an article upon the same subject, which appeared in the same volume, entitled "A Rectification of the Section made by Mr. Jones."

Scharf's "History of Western Maryland, being a History of Frederick, Montgomery, Carroll, Washington, Allegany and Garrett Counties from the earliest Period to the present Day," contains an account of the topography and geology by Professor Uhler.

The contributions of Professor F. D. Chester on the geology of Delaware beginning in 1883 contain several references to the geological conditions of northeastern Maryland and should be consulted in a study of that area.

Several articles were published by Mr. Persifor Frazer, Jr., upon the geology of the northern portion of the Piedmont plateau during this decade, in which the slate and copper rocks are especially considered.

In 1884 Professor Heilprin published an important volume, entitled "Contributions to the Tertiary Geology and Paleontology of the United States," in which a systematic review is given of the Tertiary deposits of the Middle Atlantic slope, and a classification of the Eocene and Neocene deposits of Maryland is proposed.

Swank's "History of the Manufacture of Iron in all Ages," published in 1884, contains a special chapter entitled "Early Enterprises in Maryland," in which the early furnaces of the state are de-

[1] Proc. Acad. Nat. Sci., Phila., vol. xxxiii, 1881, pp. 444-447. Ibid. vol. xxxiv, 1882, pp. 150-186.

[2] Vol. xix, 1882, pp. 11-110.

scribed. Winsor's[1] history of America, which was published in the same year, contains very interesting notes on the gradual recognition of the resources and physical features of the state.

The continued work of Professor Hall upon the paleontology of the Paleozoic deposits found expression in Volume VII of the Paleontology of New York, which was published in 1888. This report contains descriptions and figures of many forms from Cumberland and vicinity.

The investigations of Professor Uhler which were carried on throughout this period have already been briefly referred to. In 1888 he presented two articles of significance, one dealing with "The Albirupean Formation and its nearest relatives in Maryland"[2] and the other containing a "Sketch of the History of the Maryland Academy of Sciences."[3] Further contributions were made by Professor Uhler[4] to the geology of Maryland between the years 1889 and 1892.

During the latter year Mr. J. T. Scharf published a statistical and popular account of the natural resources and advantages of Maryland.

Very little work has been done during later years by private interests in the study of the geology and mineral resources of the state. The great advance which has been made in our knowledge of Maryland has been accomplished through the official agencies, which will be described in the following pages.

Geological Investigations carried on under the Auspices of the Johns Hopkins University.

The organization of the Johns Hopkins University in 1876 upon the foundation left by Johns Hopkins of Baltimore, who had died in 1873, inaugurated a new period of scientific activity in Maryland that has meant much for the material advancement of the state. The laboratories of the University were equipped for the study of the broadest problems of scientific inquiry; and at the same time the authorities

[1] Narrative and Critical History of America, vol. iii, pp. 127-169, 517-562.
[2] Proc. Amer. Phil. Soc., Phil., vol. xxv, 1884, pp. 42-53.
[3] Trans. Md. Acad. Sci., vol. i, pp. 1-10.
[4] Trans. Md. Acad. Sci., vol. i, pp. 11-32, 45-72, 97-104, 185-204.

recognized the importance of a thorough study of the physical characteristics of the region adjacent to Baltimore.

In the winter of 1876-7 Professor J. E. Hilgard, the Superintendent of the United States Coast and Geodetic Survey, was invited to the University to give a course upon "The Methods and Results of extended Territorial Surveys carried on in America and in Europe." Twenty lectures were delivered, in the course of which the features of the Chesapeake basin were considered. A model showing the relief of the region of Druid Hill Park was prepared for use in the lectures, and was subsequently presented to the city.

A study of the physical resources of Maryland was subsequently undertaken by the members of the Biological Department, who particularly investigated the fauna and flora of the area. The organization of the Chesapeake Zoological Laboratory in the summer of 1878 under the immediate charge of Dr. W. K. Brooks marked the beginning of systematic work in this direction. A close association with the Maryland Fish Commission was effected, and in 1879 the laboratory was stationed at Crisfield, where an excellent opportunity was afforded for the special study of the oyster-beds of the Chesapeake. The results of this work were subsequently published as a report of the Maryland Fish Commission in a volume entitled "The Development of the American Oyster."

In 1880 the Baltimore Naturalist's Field Club was organized under the direction of Professor H. N. Martin of the University for the study of the fauna, flora, geology and physical geography of the neighborhood of Baltimore. The club was founded "in order to endeavor to meet the recognized want in the city of some organization for the active promotion of field work in natural history." All members of the University and residents of Baltimore of known attainments as naturalists were eligible for election to the club. The club began with twenty-two members, which number was doubled before the close of the year, much interest being manifested in the study of the region about Baltimore as the result of the weekly excursions which were made. Addresses were delivered before the club from time to time upon natural history, one, among others, by Professor P. R.

Uhler, President of the Maryland Academy of Sciences, on the "Geology of the Surface Features of the Baltimore Area."[1] An outcome of the work of the field club was the preparation in 1884 of an excursion map of Baltimore and its neighborhood by Mr. A. L. Webster, a student of the University, who had formerly been a topographer of the United States Geological Survey.

The Geological Department was organized in 1883, when Dr. George H. Williams began his connection with the institution as an instructor in mineralogy. His appointment marks the beginning of a period of investigation of the geology and mineral resources of the state that has been carried on by his associates and successors continuously to the present day. It is certainly not claiming too much to say that this period is by far the most important in the study of the physical features of the state of Maryland.

Almost from the first the members of the geological department have carried on their investigations in close co-operation with the United States Geological Survey and frequently as members of its staff, so that the results obtained have received wide publicity, and on that account have greatly benefited the state.

The investigations of Dr. Williams were largely devoted to the crystalline rocks of the Piedmont Plateau lying to the north and west of Baltimore, which through his labors has become classic ground in microscopical petrography.

The earliest work of Dr. Williams began shortly after his arrival in 1883, his first publication upon Maryland geology being a "Preliminary notice of the Gabbros and Associated Hornblende rocks in the Vicinity of Baltimore."[2] Another article followed shortly after, entitled "Note on the so-called Quartz-porphyry at Hollins Station, north of Baltimore."[3]

During the year 1885 Dr. Williams contributed articles upon "Dykes of apparently Eruptive Granite in the Neighborhood of Bal-

[1] Johns Hopkins Univ. Circ., vol. ii, No. 21, pp. 52-53.
[2] Johns Hopkins Univ. Circ. No. 30, vol. iii, 1884, pp. 79-80.
[3] Johns Hopkins Univ. Circ. No. 32, vol. iii, 1884, p. 131.

timore"[1] and "Amphibole-Anthophyllite from Mount Washington, Baltimore County."[2]

The work which Dr. Williams had been conducting upon the ancient eruptive rocks to the north and west of Baltimore ever after his arrival in Maryland found expression in a memoir entitled "The Gabbros and associated Hornblende Rocks occurring in the neighborhood of Baltimore, Maryland,"[3] that was published by the United States Geological Survey in 1886. A short article "On a Remarkable Crystal of Pyrite from Baltimore County, Maryland,"[4] appeared in the University publications the same year.

The growth of the Geological Department and the wider insight which was acquired regarding the complicated geological history of the Piedmont belt led to the preparation of a systematic scheme for the geological mapping of the region about Baltimore. An account of this is found in an article "On a Plan proposed for Future Work upon the Geological Map of the Baltimore Region."[5] A small pamphlet was also brought out by Dr. Williams about this time upon "Notes of the Minerals occurring in the Neighborhood of Baltimore."[6]

In the autumn of 1887 Dr. William B. Clark became associated with the Johns Hopkins University as instructor of stratigraphic geology and paleontology, and at once took up a study of the geological formations represented in the eastern and southern portions of the state, and an article "On Three Geological Excursions made during the months of October and November, 1887, into the Southern Counties of Maryland"[7] was published in the University Circulars in 1888.

In conformity with the plan outlined by Professor Williams and above described, Mr. W. H. Hobbs, a student of the University, prepared an article "On the Rocks occurring in the Neighborhood of

[1] Johns Hopkins Univ. Circ. No. 38, vol. iv, pp. 65-66.
[2] Amer. Nat., vol. xix, pp. 884-886.
[3] Bull. U. S. Geol. Surv. No. 28, 78 pp., 4 pls.
[4] Johns Hopkins Univ. Circ. No. 53, vol. vi, p. 30.
[5] Johns Hopkins Univ. Circ. No. 59, 1887, pp. 122-123.
[6] Baltimore, 1887, 8vo, 18 pp.
[7] Johns Hopkins Univ. Circ. No. 63, vol. vii, pp. 65-67.

Ilchester, Howard County, Maryland; being a detailed study of the area comprising Sheet No. 16 of the Johns Hopkins University map."[1]

The wider generalizations of Professor Williams found expression in 1888 in two articles that were published under the auspices of the University, the first, entitled "Geology of the Baltimore Region," was a report of a lecture in which the author referred to the sequence of the eruptive rocks in the area discussed. Another article, on the "Progress of Work on the Archean Geology of Maryland,"[2] appeared about the same time, in which a sketch of Maryland geology is given and the relations of the gneisses and eruptive rocks in Baltimore are shown.

The work of Dr. Clark upon the sedimentary formations of the southern portion of the state led the same year to the discrimination of the marine Cretaceous deposits of that area. An article entitled "Discovery of Fossil-bearing Cretaceous Strata in Anne Arundel and Prince George Counties, Maryland"[3] was published in 1889. Further "Contributions to the Mineralogy of Maryland"[4] were made by Dr. Williams somewhat later in the season.

During this year two students of the Geological Department contributed articles upon the mineralogy and geology of the crystalline rocks, the contribution of Mr. A. C. Gill being entitled "Minerals from the Chrome Pits of Montgomery County, Maryland,"[5] and that of Mr. W. H. Hobbs "On the Paragenesis of Allanite and Epidote as Rock-forming Minerals."[6]

The organization of extended expeditions for the study of the geology and physiography of tidewater Maryland and Virginia had been undertaken by Dr. Clark soon after his connection with the University. His report upon the "Third Annual Geological Expedition into Southern Maryland and Virginia"[7] describes the geological section of the Potomac river valley in Maryland and Virginia.

[1] Johns Hopkins Univ. Circ. No. 65, vol. vii, 1888, pp. 69-70.
[2] Johns Hopkins Univ. Circ. No. 65, vol. vii, pp. 61-63.
[3] Johns Hopkins Univ. Circ. No. 69, vol. viii, pp. 20-21.
[4] Johns Hopkins Univ. Circ. No. 75, vol. viii, pp. 99-100.
[5] Johns Hopkins Univ. Circ. No. 75, vol. viii, p. 100.
[6] Amer. Jour. Sci., 3 ser., vol. xxxviii, 1889, pp. 223-228.
[7] Johns Hopkins Univ. Circ. No. 81, vol. 9, 1890, pp. 69-71.

Further investigation was given to the crystalline rocks of Maryland by Dr. Williams during 1890. An article upon "The non-feldspathic Intrusive Rocks of Maryland and the Cause of their Alteration"[1] was published during the year.

An important "Discovery of Fossils in the Limestone of Frederick County, Maryland"[2] was made by Charles R. Keyes, a student of the Geological Department, which aided greatly in the elucidation of the stratigraphy of the western portion of the Piedmont belt.

A former student, Professor W. H. Hobbs of the University of Wisconsin, presented a paper to the Wisconsin Academy of Sciences in 1890 "On some Metamorphosed Eruptives in the Crystalline Rocks of Maryland,"[3] in which the work which had been carried on under the auspices of the University was described.

In the spring of 1891 Dr. Clark organized a scientific expedition in co-operation with members of the United States Geological Survey and the Maryland Agricultural College for the study of the physical features of southern Maryland. The party comprised twenty-five members, representing the United States Geological Survey and other institutions both within and without the state. An extended account of this trip was published by the University.[4] About this time a memoir by Dr. Clark upon "The Eocene of the United States"[5] appeared among the publications of the United States Geological Survey, in which the results of his researches upon the Eocene of Maryland found a place.

Professor Williams continued his observations upon the crystalline rocks of the Piedmont Plateau during 1891, accounts of which are found in the Administrative Reports of the Director of the United States Geological Survey. A paper read before the Geological Society of America the previous winter upon "Petrography and Structure of the Piedmont Plateau in Maryland,"[6] and one by Mr. Keyes upon "A

[1] Amer. Geol., vol. 6, 1890, pp. 35-49.
[2] Johns Hopkins Univ. Circ. No. 84, vol. x, 1890, p. 32.
[3] Trans. Wisconsin Acad. Sci., vol. viii, pp. 156-160.
[4] Johns Hopkins Univ. Circ. No. 89, vol. x, 1891, pp. 105-109.
[5] Bull. U. S. Geol. Surv. No. 83, 1891, pp. 43-45, 80, 86-87.
[6] Bull. Geol. Soc. Amer., vol. ii, 1891, pp. 301-318.

Geologic Section across the Piedmont Plateau in Maryland,"[1] were published during the year. A valuable paper by Mr. Keyes upon "Paleozoic Fossils of Maryland" was also published in the University Circulars.[2]

Further contributions were made by Professor Williams during this period upon the minerals of the state, and he also organized a geological excursion of the students of the University for a study of Appalachian geology, several days being spent in Allegany county during the month of May, 1891.

In 1891 a plan of co-operation was arranged by Professor Clark between the Johns Hopkins University, the Maryland Agricultural College, and the United States Weather Bureau for a study of the climatic conditions of the state of Maryland, and between May and November of that year monthly meteorological reports were published. The succeeding winter a bill was introduced into the General Assembly of Maryland requesting the official recognition of the bureau and the appropriation of $2000 annually for its maintenance. This bill was passed in March, 1892, and received the signature of the Governor upon April 7 of the same year. This co-operation with the state has been maintained since that date, the headquarters of the Service, in accordance with the provisions of the bill, being permanently established at the Johns Hopkins University.

In February, 1892, the American Institute of Mining Engineers held their annual meeting in Baltimore, and under the editorial direction of Dr. Williams there was prepared a "Guide to Baltimore, with an Account of the Geology of its Environs and three Maps," in which the general distribution of the geological formations in the vicinity of Baltimore is described. An important investigation[3] conducted by Dr. Williams during the early summer of 1892 was the determination of many of the rocks of the South Mountain district in Maryland and Pennsylvania to be of volcanic origin.

The importance of proper cartographic representation of the Balti-

[1] Bull. Geol. Soc. Amer., vol. ii, 1891, pp. 319-322.

[2] Johns Hopkins Univ. Circ. No. 94, vol. xi, 1891, pp. 28-29.

[3] Amer. Jour. Sci., 3rd ser., vol. xliv, 1892, pp. 482-496.

more region found expression in 1892 in the construction of a large scale relief map of Baltimore and vicinity in co-operation with the Real Estate Exchange. This model of Baltimore on the scale of 4 inches to the mile without vertical exaggeration is now deposited in the geological laboratory of the University. Another model, with the vertical scale four times the horizontal, is in the rooms of the Real Estate Exchange.

The preparation of a book upon Maryland which should properly set forth its resources, industries and institutions was intrusted in 1892 by the Board of World's Fair Commissioners to members of the faculty of the Johns Hopkins University; those portions relating to the physical features and mineral resources were prepared by Professor Williams and Professor Clark. This summary of the physiography, geology and mineral wealth of the state is the most complete statement which has been prepared up to the present time. The full volume appeared in 1893, although special portions had been published from time to time by the authors in scientific journals.

Several contributions were made by Mr. Keyes[1] during 1893 upon the Maryland granites, and likewise an article entitled "Note on a Quartz-bearing Gabbro in Maryland" was published by U. S. Grant,[2] a student of the University.

A valuable contribution also made by Dr. Williams during 1893 was an article entitled "Maps of the Territory included within the State of Maryland, especially the Vicinity of Baltimore."[3]

The last important work of Professor Williams upon the geology of Maryland embraced the fuller investigation of the ancient volcanic rocks of the Blue Ridge district,[4] the details of which have been still further elaborated by Miss Florence Bascom, a former student of the University. A contribution was made in 1894 to the "Granite of Cecil County in Northeastern Maryland"[5] by Mr. G. P. Grimsley, a member of the geological department.

[1] Bull. Geol. Soc. Amer., vol. iv, 1893, pp. 299-304; Proc. Iowa Acad. Sci., vol. i, part iii, 1893, pp. 22-26.

[2] Johns Hopkins Univ. Circ. No. 105, vol. xii, 1893, pp. 47-49.

[3] Johns Hopkins Univ. Circ. No. 103, vol. xii, 1893, pp. 37-44.

[4] Jour. Geol., vol. ii, 1894, pp. 1-31.

[5] Jour. Cincinnati Soc. Nat. Hist., vol. xvii, 1894, pp. 56-67, 87-114.

During 1895 the study of Maryland geology was pushed along various lines, Professor Clark continuing his observations upon the geology of the Coastal Plain and conducting two geological excursions into the tidewater area. Two articles were published by him dealing with Maryland geology, the first entitled "Contributions to the Eocene fauna of the Middle Atlantic Slope"[1] and the second "Cretaceous Deposits of the Northern Half of the Atlantic Coastal Plain."[2]

Dr. Edward B. Mathews, who had been appointed instructor in mineralogy and petrography in 1894, took up the work of Professor Williams in the Piedmont Plateau, devoting his attention especially to the northern counties of the belt.

Several contributions were made at this time upon Maryland geology by the students of the department, viz.: by H. S. Gane[3] on "Neocene Corals," by A. Bibbins[4] on "The Paleontology of the Potomac Formation," by J. A. Mitchell[5] on "The Discovery of Fossil Tracks in the Newark System (Jura-Trias) of Frederick County," and by D. E. Roberts[6] on "The Cretaceous Formations of the Eastern Shore of Maryland."

During the year 1896 the investigations of the instructors and students of the Johns Hopkins University have been so closely identified with the work of the Maryland Geological Survey that it is not necessary to describe the researches in detail, since most of the results will find place in the future publications of the Survey.

An Account of the Work of the recently organized State Bureaus.

The state of Maryland during the last three decades since the Civil War has done very little, until the organization of the Geological Survey, to encourage an investigation of her physical resources. The bureaus which have been established were restricted in their operations, so that comparatively little progress has been made in the study

[1] Johns Hopkins Univ. Circ. No. 121, vol. xv, 1895, pp. 2-5.
[2] Bull. Geol. Soc. Amer., vol. vi, 1895, pp. 479-482.
[3] Johns Hopkins Univ. Circ. No. 121, vol. xv, 1895, pp. 8-10.
[4] Ibid. p. 17. [5] Ibid. p. 15. [6] Ibid. p. 16.

of the broader questions relating to the physical features of the state. The several bureaus which touch these matters in one way or another are the Maryland State Weather Service, the Mine Inspector's Bureau, the Bureau of Industrial Statistics, and the Immigration Bureau. None of these organizations except the first are engaged in a scientific study of the physical features, the latter being occupied chiefly in an accumulation of statistical material which will show to the people both within and without the state the volume of her products, the condition of labor, and the advantages of Maryland as a place of residence, and in these directions are rendering an important service to the commonwealth.

The Maryland State Weather Service.—The Maryland State Weather Service was organized May 1, 1891, under the joint auspices of the Johns Hopkins University, the Maryland Agricultural College, and the United States Weather Bureau. The few scattered observers in Maryland and Delaware who had hitherto reported to the chief of the United States Weather Bureau were authorized to send their reports to the central office at the Johns Hopkins University. At the same time the Baltimore office of the United States Weather Bureau was moved to the University, as the efficiency of the State Service was recognized to depend largely upon the closeness of co-operation with the National Service. Two series of publications were at once established, viz., monthly Meteorological Reports and weekly Crop Bulletins.

It was evident from the start that the results of the local service could not be available to the people of the state unless provision was made for the publication and distribution of the information obtained. The institutions interested in the organization of the State Service were willing to prepare the data for publication, but they had no funds at their disposal for printing. To that end a bill was introduced in the General Assembly of 1892, was passed by both houses, and signed by the Governor. It provided for the establishment of the Maryland State Weather Service, the commissioning of its officers by the Governor, and an appropriation to defray the expenses of printing.[1]

[1] Laws of Maryland, 1892, Chapter 329.

The Maryland State Weather Service is similar in its organization and methods to like services in other states; the personnel consists of voluntary observers who have been selected at favorable points throughout the state, and of a corps of permanent observers who have been assigned from the United States Weather Bureau to take charge of the work at the central office. The National Bureau also supplies instruments, forms and stationery to all stations of the service, and all the correspondence and reports are mailed under the frank of the United States Department of Agriculture.

The stations connected with the service are of three classes: first, those which report meteorological facts; second, those which send crop notes; third, those which display signals. In a few instances the same person fulfills the duties of all three offices. Nearly every section of the state is represented in this manner, several stations having been established in each county.

The publications of the Maryland State Weather Service consist of monthly Meteorological Reports and weekly Crop Bulletins. Both of these reports were published independently by the Maryland State Weather Service until the autumn of 1896, but since that date they have been prepared and printed in co-operation with the United States Weather Bureau as part of its Climate and Crop Service, Maryland and Delaware Section. The publications are devoted chiefly to a discussion of the climate of Maryland, the efficacy of meteorological conditions upon the products of the soil, and the especial advantages in these directions to be enjoyed by the inhabitants of the state. On account of the varied climate of Maryland, the difference of its soil formations and its extensive coast-line, the agricultural and commercial interests of the state are many and important, and the Maryland State Weather Service has been of great value in bringing to the attention of the public the special advantages which the state possesses in these several directions.

Several special reports have been brought out by the Maryland State Weather Service in addition to the regular publications above described. In 1893 series of large Climatic Charts with explanatory texts were prepared to represent the seasonal and annual temperature and rainfall of the state. These charts were exhibited at the World's Fair at Chicago and distributed at important points both in Maryland and throughout the country. Two biennial reports to the General Assemblies of 1894 and 1896 have also been published, in which a general review of the climate, topography, geology and soils of the state was included. Maps and tables were introduced to show the leading climatic features of the state. Both the regular and special reports have been sent widely throughout this country and Europe.

The Mine Inspector's Bureau.—The position of Inspector of Mines was established by an act of the General Assembly in 1876,[1] "regulating the working and proper ventilation of coal mines in Allegany and Garrett counties." At the session of 1878[2] the original act was repealed and re-enacted with amendments, the duties of the Mine Inspector remaining substantially the same. Annual reports have been generally published by the Inspector of Mines, in which the volume of output, the condition of the mines and the number of workmen employed have been described. These reports are not intended to be of a geological nature, the information being in most instances restricted to statistical statements.

The Bureau of Industrial Statistics.—The Bureau of Industrial Statistics was created by the General Assembly of Maryland at the session of 1892.[3] It replaced a Bureau of Statistics which had been in operation since 1884 within a much more limited field. The law creating the office provided that "a bureau of statistics and information concerning the various branches of industry practised in this state, and the needs thereof, is hereby established." The duty of the chief of the bureau was to collect statistics of every sort, including "information in regard to the agricultural conditions and products," and "in regard to the mineral products of the state, the output of mines, quarries and so forth."

The appropriations for the Bureau of Industrial Statistics have been

[1] Laws of Maryland, 1876, Chapter 173.
[2] Laws of Maryland, 1878, Chapter 157.
[3] Laws of Maryland, 1892, Chapter 29.

so small that all lines of work prescribed by the law could not of necessity be taken up, its field of operations from the first being limited to special investigations relating particularly to the conditions of labor in the state and to those industrial statistics which especially refer to the wage-earners.

Reports have been made by the Bureau upon the public roads and the importance of their more systematic construction, also upon the coal statistics of the western counties. The last statement embraces a description of the George's Creek Basin and the conditions of coal production, together with tables showing the shipments from Maryland mines and a "Table of the Strata of the Potomac and George's Creek Coal Basin." Five annual reports have been prepared for the years 1893-97.

The Bureau of Immigration.—The Bureau of Immigration was organized by the General Assembly of 1896[1] and is intended to supply information to people without the state regarding the desirability of Maryland as a place of residence. Already much active work has been done along these lines, and a report upon the material advantages of Maryland has been published. This report, which is entitled "The State of Maryland: the Advantages it offers to Immigrants, especially Farmers, Manufacturers and Capitalists," contains a brief description of the physical features of the state, including the physiography, climate and mineral resources, based largely upon the statements contained in the World's Fair Book.

Operations of the United States Geological Survey in Maryland.[2]

The U. S. Geological Survey, which was organized in 1879 by the consolidation of existing surveys, initiated work in Maryland in 1883. The investigations of that year embraced a geologic reconnaissance of a portion of the state, but attention was directed more particularly in the beginning to the preparation of a topographic map of the region

[1] Laws of Maryland, 1896, Chapter 295.

[2] Prepared under the supervision of the Director of the U. S. Geological Survey.

as a prerequisite to detailed geologic mapping. Since 1883 the topographic mapping has been extended from time to time, until it now covers, either in completed or preliminary form, an area of 7100 square miles, or about 75 per cent of the state, while geologic work has been prosecuted along one line or another with varying degrees of activity to the present year. A more detailed review of these operations is given in the following pages.

In addition to the topographic and geologic work above referred to, mention should also be made of the hydrographic work done in the state, systematic measurements having been conducted on the Potomac river and its tributaries and on some of the smaller streams flowing into the Chesapeake Bay.

The statistical compilation of the mineral resources of the state should also be noted. This has been conducted yearly since 1882 and annual reports published. In these reports the coal, brick, pottery clays and building stones, of which Maryland is such an important producer, receive a large share of attention, and added to these are the statistics of iron ores, soapstone, tripoli, slate, etc., all going to make the report a highly useful one to the state.

Much increased activity has been manifested by the United States Geological Survey in Maryland since the organization of the State Geological Survey, it being the aim of the National Survey to aid those states which show a sufficient interest in the investigation of their resources to establish official surveys of their own. As the result of this co-operation between the National and State Surveys the geology and mineral resources of Maryland will receive thorough investigation.

TOPOGRAPHIC WORK.

Prior to the commencement of work in Maryland in 1883 by the United States Geological Survey, the only maps of the state were those prepared by private individuals, and were little more than diagrams of roads. Upon these maps the roads were shown in considerable detail, and as a rule not inaccurately, but the maps made little attempt to represent the streams and none whatever to show the relief. They were therefore of little service for either scientific or industrial purposes.

A small area, however, had already been mapped prior to this date by Mr. H. F. Walling, under the United States Coast and Geodetic Survey. This area included the Blue Ridge and the country lying to the eastward and southward as far as Sugar Loaf mountain, comprising several hundred square miles. This map, which was on the scale of one mile to an inch, was controlled by triangulation and was in all respects adequate for the scale. The streams were as fully represented as the scale would admit, and relief was shown by contours 100 feet apart. This work was immediately discontinued when the United States Geological Survey commenced operations in the state.

The United States Geological Survey commenced topographic work in July, 1883. The original plans contemplated the preparation of a map on a scale of 1:250,000, or about four miles to an inch, with contours at intervals of 100 feet. Under this plan work was continued during 1883 and 1884, and most of the western or mountainous part of the state was thus surveyed in a preliminary way. In 1885 it was decided to make the maps on a scale of 1:125,000, or about two miles to an inch, and for several years the work was continued upon that plan. Much of the work which had been surveyed during the first two years upon the smaller scale was revised to adapt it to the larger scale. Still later, in 1890, when work was commenced in the low country near the western shore of Chesapeake Bay, it was decided to map this region on the scale of 1 : 62,500, or about one mile to an inch. After mapping this region on this scale it was found that all necessary details could be represented quite as well on the scale of 1:125,000, and the sheets were therefore reduced to that scale, although meantime many of them had been published on the one-mile scale.

This successive shifting of scales has finally resulted in the adoption of the two-mile scale for the entire state, with the exception of the East Washington, West Washington and Baltimore quadrangles, which, being centers of large population and valuable industries, seem to require the larger or one-mile scale. At the same time the area north of 39° 30′ will be mapped on the larger scale.

The work in Maryland rests mainly upon the triangulation executed by the United States Coast and Geodetic Survey for the control of its coast work. For the eastern part of the state, including all the Atlantic coastal plain, this triangulation is adequate for control. Its points are sufficiently numerous and well distributed. It does not, however, extend west of the Blue Ridge at Harper's Ferry. Thence westward the United States Geological Survey found it necessary to extend triangulation for the control of its work, and owing to the difficult character of the country, this extension of triangulation was quite expensive, especially in the western counties comprised in the Alleghany plateau.

From these primary triangulation points secondary points were determined by triangulation with the plane-table, wherever it was practicable to do so, but outside of the mountain and piedmont regions the level character of the country precludes this method of making locations.

The roads, railroads and other minor features were located by traverses run by plane-table, connected at as frequent intervals as possible with triangulation points for the elimination of cumulative errors. Measurements of elevations for the location of contour lines were carried on by vertical angles, measured upon the vertical circles of theodolites, by spirit-level lines, and, for details, by aneroids.

The sketching of topography was carried on in the main in connection with the running of traverse lines.

The work of mapping the state was commenced at the western extremity, in Garrett county, and was carried generally eastward. The first work done was by a party in charge of Mr. S. H. Bodfish. Subsequently, upon the failure of Mr. Bodfish's health, Mr. W. T. Griswold took charge of the party and carried on the work during the latter part of the season of 1883 and the seasons of 1884 and 1885. In 1886 Mr. Merrill Hackett made a revision of the area surveyed by Mr. Walling, adding cultural details. In 1887 the Baltimore, East Washington and West Washington quadrangles were surveyed, the former by Mr. S. H. Bodfish, the latter by Mr. D. J. Howell. In 1888 the Frederick quadrangle was surveyed by Mr. Hackett. In 1890 and 1891 the quadrangles on the west shore of Chesapeake Bay were mapped by Mr. A. E. Murlin. In the following years those in the mountains were revised for the purpose of adapting them to the two-mile scale, and in 1895 and 1896 those on the eastern shore were mapped, thus completing the mapped area of the state. This is shown on the small accompanying map. The tier of partial quadrangles just south of the Pennsylvania line, in the western part of the state, was originally surveyed for publication on the four-mile scale, and this area has never been revised to adapt it to a larger scale.

GEOLOGIC WORK.

The earliest geologic work carried on by the United States Geological Survey in Maryland was, as has been said, of the nature of reconnaissance, with chief reference to the general stratigraphic relations. There followed from time to time the detailed mapping of certain formations, accompanied by extensive laboratory study of crystalline rocks, and field and laboratory studies of fossil plants and animals. The work is conveniently described under three geographic heads, the Piedmont Plateau, the Appalachian Region, and the Coastal Plain.

Piedmont Plateau.

The principal work of the Survey in the Piedmont region was conducted by Professor George H. Williams, of the Johns Hopkins University, who for several years made detailed studies of the crystalline rocks and their relations under the joint auspices of the Geological Survey and the University.

His field work for the Survey began in the spring of 1888, but for several years prior to this he had been engaged in the study of the crystalline rocks in the vicinity of Baltimore, some of the results of which were published in a government bulletin entitled "The Gabbros and Associated Hornblende Rocks occurring in the neighborhood of Baltimore, Maryland." [1]

His principal work in 1888-89 was carried on along two distinct lines and with two distinct sets of problems in view. First, to trace out the relations of the slightly crystalline or non-crystalline rocks

[1] Bull. U. S. Geol. Survey No. 28, vol. iv, 1886, pp. 613-688.

in the western part of the area to the highly crystalline rocks farther east and to discover the nature of the transitions by which this crystalline structure appears to be progressively developed. Second, to map minutely the highly crystalline rocks to the eastward, particularly about Baltimore, and to work out in detail certain petrographic problems with reference to the eruptive masses which occur there in such abundance. Considerable progress was made along these two lines, and a brief statement of the results is given in the Tenth Annual Report of the United States Geological Survey.[1] These and other results are also given in further detail in various unofficial publications.

Dr. Williams's operations in 1889-90 consisted of mapping the areal distribution of the crystalline rocks and collecting material for laboratory investigations in Harford, Baltimore, Carroll, Frederick and Montgomery counties, Maryland, as well as in the District of Columbia and in Fairfax county, Virginia.

Much progress was made in mapping the crystalline rocks of the Washington and Baltimore quadrangles. Incidentally to the work on the Baltimore quadrangle, a detailed investigation was made of a rare type of eruptive rock composed wholly of pyroxene, and its alteration into masses of steatite.

In the Frederick quadrangle the Triassic boundary was partially traced; the region about Barnesville, especially about Sugar Loaf Mountain, was mapped and studied; the great trap dike was traced entirely across the state, and many areas of sandstones and limestones were outlined. Incidentally a study was made of the Sykesville granite and its inclusions. Some account of the results of these investigations was communicated to the Geological Society of America at its Washington meeting, December, 1890, in a paper entitled the "Petrography and Structure of the Piedmont Plateau in Maryland."[2]

In 1890-91 the work was continued in Maryland and quite widely into the adjoining Piedmont area of Virginia. The boundaries of the Triassic in Maryland as determined by Professor Williams this season

[1] Tenth Ann. Rept. U. S. Geol. Survey, part i, 1890, pp. 152-154.
[2] Bull. Geol. Soc. America, March, 1891, vol. ii, pp. 301-318.

were contributed to Plate IV in "Correlation Papers, the Newark System," by I. C. Russell.[1]

In the summer of 1891 there was issued by the survey a preliminary edition of the Washington sheet, with the geology of the crystalline rocks by Dr. Geo. H. Williams, and of the overlapping sedimentary rocks by N. H. Darton. There was also prepared by Dr. Williams and Mr. Darton, jointly with Messrs. W J McGee and B. Willis, an account of the geology of Washington and vicinity for the "Guide to Washington and its Scientific Institutions," printed for the Fifth Session of the International Congress of Geologists.

During 1891-92 Dr. Williams continued field work in the area of crystalline rocks in Maryland. Work in the Baltimore quadrangle was completed, and in February, 1892, there was published for the American Institute of Mining Engineers a guide-book to Baltimore containing a description of the geology of that region, the crystalline rocks by Dr. Williams, and the sedimentary rocks by Mr. Darton, accompanied by the preliminary map, "The Baltimore Sheet," published by the United States Geological Survey. This map, with somewhat extended area, was republished by Johns Hopkins University as a "Geological Map of Baltimore and Vicinity," by G. H. Williams and N. H. Darton.

In 1892-93 Dr. Williams's studies were mainly directed toward mapping portions of the Ellicott and Laurel quadrangles, the determination of the rocks in Cecil county, an examination of the eruptive rocks in the South Mountain region, and a re-examination of crystalline rocks in the West Washington quadrangle, with a view to the publication of the final Washington folio.

In 1893-94 the time and survey allotment at Dr. Williams's disposal were limited, but considerable progress was made in mapping the crystalline rocks of the Gunpowder, Laurel and West Washington quadrangles. He also prepared a preface on "The general relations of the Granitic Rocks in the Middle Atlantic Piedmont Plateau" for the report by Mr. C. R. Keyes on "The Origin and Relations of Central Maryland Granites."[2] His last field work for the survey was in the

[1] Bull. U. S. Geol. Survey No. 85, 1892.

[2] Fifteenth Ann. Rept. U. S. Geol. Survey, 1895, pp. 651-740, pls. 27-48.

summer of 1894, on the Frederick quadrangle, accompanied by Mr. L. M. Prindle.

In 1895 it was arranged that Mr. Arthur Keith should continue the work on the crystalline rocks of the Piedmont area for the purpose of completing the Washington, Frederick and other folios, which had been mapped preliminarily by Dr. Williams. This work was carried forward during 1895 and 1896, and a wide area has been mapped in detail. The Washington folio is now ready for publication, and the Frederick and Patapsco folios are nearly completed.

The survey has done considerable chemical work in connection with rocks and minerals of the Piedmont region in Maryland.

In October, 1883, Dr. F. W. Clarke visited the mica mines in Montgomery county, and in March, 1884, examined a mica mine near Laurel in Howard county. The mineral gähnite was collected at Gilmore's mica mine in Montgomery county, and an analysis of this material by T. M. Chatard is given by Dr. Clarke in Bulletin No. 9 of the United States Geological Survey.[1]

In the following year Mr. J. E. Whitfield made an analysis of brown iron ore from near Timonium, Maryland, which is recorded in Bulletin No. 27 of the Survey.[2]

In 1886 Dr. F. W. Clarke made analyses of Triassic sandstones from Maryland.[3]

In 1887 Dr. T. M. Chatard and Mr. J. E. Whitfield made analyses of rocks from Baltimore county,[4] and in 1888 Dr. Chatard made further analyses of minerals and rocks from Maryland.[5]

In 1889 Dr. Chatard made analyses of websterite and associated minerals from Maryland.[6]

In 1890 there were analyzed in the chemical laboratory of the Survey nine rocks collected in the Piedmont region of Maryland by Dr. G. H. Williams.[7]

[1] Bull. U. S. Geol. Survey No. 9, 1884, p. 9.
[2] Bull. U. S. Geol. Survey No. 27, 1886, p. 72.
[3] Bull. U. S. Geol. Survey No. 55, 1889, p. 80.
[4] Bull. U. S. Geol. Survey No. 60, 1890, pp. 4-159.
[5] Bull. U. S. Geol. Survey No. 64, 1890, pp. 41-42.
[6] Bull. U. S. Geol. Survey No. 78, 1891, p. 122.
[7] Bull. U. S. Geol. Survey No. 90, 1892, pp. 66-67.

In 1889-90 Mr. S. F. Emmons published an account of observations on the gold deposits of Montgomery county, Maryland.[1]

In June, 1890, Prof. Lester F. Ward, accompanied by Prof. W. M. Fontaine and Mr. C. S. Prosser, made a geologic trip to examine the Newark formation. Their observations in Maryland were limited to the vicinity of the Potomac river.

Appalachian Region.

In July, 1885, Mr. H. R. Geiger began the study of the Paleozoic rocks in the Appalachian region along the Potomac river in western Maryland and West Virginia. He made detailed notes on the outcrops and carefully measured many local sections.

In 1886 and 1887 he extended his observations eastward down the Potomac river, and for some distance southward over the Great Valley region of Virginia.

In June, 1888, assisted by Mr. F. W. Geiger, he began work on the Harper's Ferry quadrangle, which extends over portions of Maryland, West Virginia and Virginia. As a result of several months' study, he arrived at a conclusion as to the relations of the sandstones and associated formations in the Blue Ridge and South Mountain to the limestones of the Great Valley.

In September, 1890, Mr. Arthur Keith began a re-examination of the Harper's Ferry quadrangle, accompanied by Mr. R. H. Gaines as assistant. An elaborate investigation was made of the difficult problem of the relations of the several formations, partly crystalline and partly sedimentary, which had puzzled geologists for so many years. A preliminary product of Mr. Keith's studies was a paper jointly with H. R. Geiger, read at the Geological Society of America, on "The Structure of the Blue Ridge near Harper's Ferry," [2] and a short notice on "The Geologic Structure of the Blue Ridge in Maryland and Virginia." [3] His final publication is the Harper's Ferry Folio, No. 10, Geologic Atlas of the United States.

[1] Trans. Am. Inst. Min. Eng., vol. xviii, pp. 391-411.
[2] Bull. Geol. Soc. America, vol. ii, 1891, pp. 155-164, pls. 4-5.
[3] Am. Geologist, vol. x, 1892, pp. 362-368.

In July, 1892, Mr. C. D. Walcott, the present director, made an examination of the Blue Ridge and South Mountain region and definitely determined the Cambrian age of its quartzites. A statement of the results of this investigation was set forth in two papers, one entitled "Notes on the Cambrian Rocks of Pennsylvania and Maryland from the Susquehanna to the Potomac,"[1] and the other "The Geologist at Blue Mountain, Maryland."[2]

In 1892 Mr. Keith, having continued his studies of South Mountain and Blue Ridge geology into Virginia, prepared a report on the "Geology of the Catoctin Belt." This report describes the Blue Ridge, South Mountain and Catoctin belts from northern Virginia through Maryland into Pennsylvania. It treats of the character of the rocks and their alteration, the general geologic relations and structures, and reviews the geomorphic development of the region.[3]

In the coal fields of western Maryland two investigations were made. In 1886 Prof. I. C. White made an examination of the coal fields of West Virginia, in which incidentally some study was made of the coal basins of Western Maryland. The results of these and some later observations by Professor White were published by the survey in a report entitled "Stratigraphy of the Bituminous Coal Field in Pennsylvania, Ohio and West Virginia."[4]

In the autumn of 1894 a party was organized under the direction of Mr. Bailey Willis for the mapping of the Piedmont quadrangle, which covers the southern part of Garrett county, Maryland. The geologic work was done by Messrs. N. H. Darton and J. A. Taff. The product is the Piedmont folio, No. 28, Geologic Atlas of the United States, which was published in 1896.

Coastal Plain.

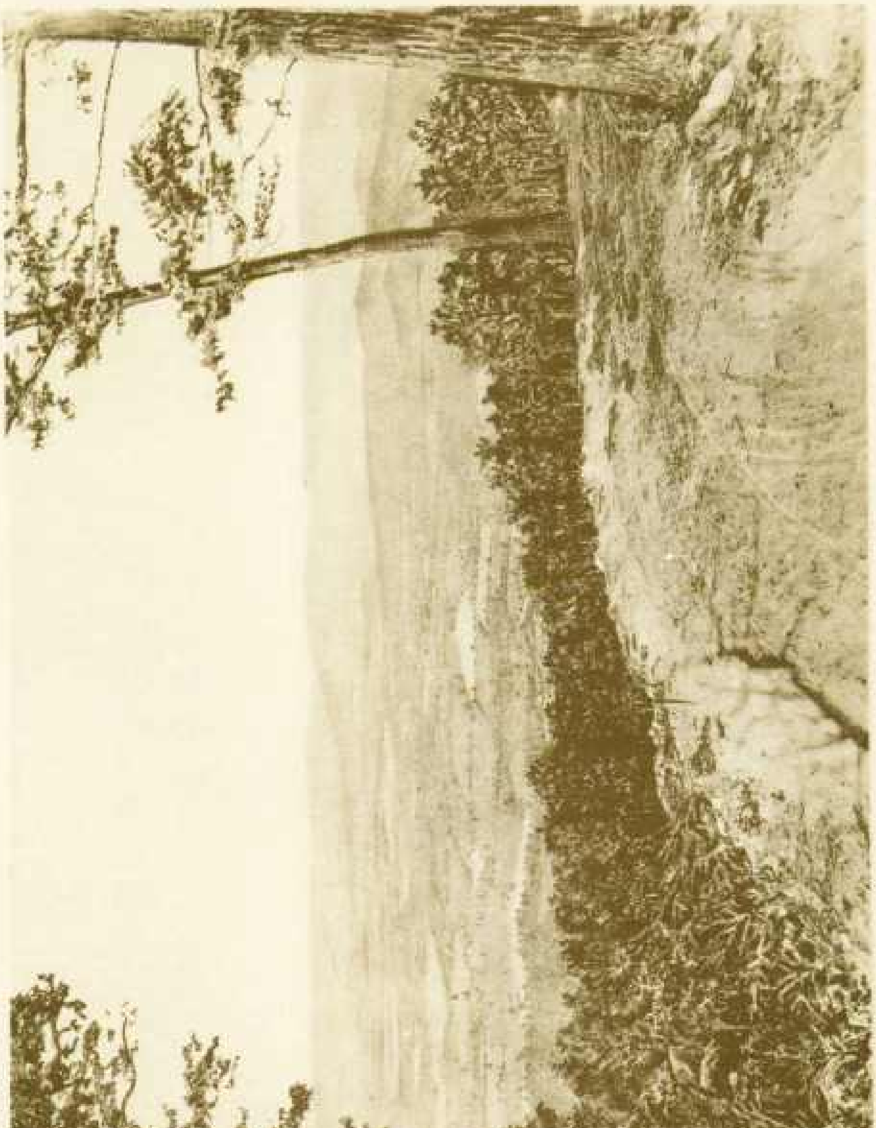
In July, 1883, the Potomac Division of Geology was organized, in charge of W J McGee, for the purpose of studying the Coastal Plain

[1] Amer. Jour. Sci. 3d series, vol. xliv, pp. 469-482.

[2] Nat. Geog. Mag., vol. v, pp. 84-88; Sci. Am. Supp., vol. xxxvii, pp. 14,753-14,754.

[3] Fourteenth Ann. Rept. U. S. Geol. Survey, part ii, 1894, pp. 285-395, pls. xix-xxxix.

[4] Bull. U. S. Geol. Survey No. 65, 1891, 212 pages, plates and maps.



VIEW OF THE GREAT VALLEY FROM BLUE MOUNTAIN, ON THE WESTERN MARYLAND R. R.

region adjacent to the Potomac river in the District of Columbia, Maryland and Virginia. Mr. McGee at once began making observations in the vicinity of Washington and the immediately adjoining portions of Montgomery and Prince George's counties, Maryland, and in this and several years following he made numerous local trips which threw much new light upon the obscure problems of the general relations of the Coastal Plain formations.

In 1884 he also made several trips westward over the adjoining provinces, one journey extending along the Potomac river to its source.

In July and August, 1885, he made a short trip with Profs. W. M. Fontaine and Lester F. Ward along the Potomac formations in Maryland and Virginia.

The first publication of the results of Mr. McGee's observations in the vicinity of Washington was in the report of the Health Officer of the District of Columbia for the year ending June 30, 1885.[1] A more extended memoir followed, entitled, "Three Formations of the Middle Atlantic Slope."[2] In this paper there was defined the Columbia, Appomattox (now Lafayette) and Potomac formations, and some account was given of their distribution and relations in eastern Virginia, District of Columbia and Maryland. An account of the Columbia formation was also given to the American Association for the Advancement of Science in 1888.[3]

In July, 1886, Mr. McGee made a trip to the region about the head of Chesapeake Bay to determine the prospects for an artesian water supply for the Fishing Battery Station. Facilities for this trip were given by the officials of the United States Fish Commission. On a short subsequent visit to the region Mr. McGee was accompanied by Prof. Lester F. Ward, who gave special attention to the Potomac formation and its plant remains. The results of Mr. McGee's observations were published in a paper entitled "The Geology of the Head of Chesapeake Bay."[4]

[1] Pages 19, 20, 23, 25, Washington, 1886.

[2] Am. Jour. Sci., 3d series, vol. xxxv, pp. 120-143, 328-331, 367-388, 448-466, pls. ii, vi, vii.

[3] Proc. Am. Assoc. Adv. Sci., vol. xxxvi, pp. 221-222.

[4] 7th Ann. Rept. U. S. Geol. Survey (for 1885-86), 1888, pp. 537-646, pls. 56-71.

In July and August, 1887, Mr. McGee traveled along the fall-line from Washington to New York. For a portion of the distance he was accompanied by Major J. W. Powell. New data were collected concerning the distribution and relations of the Potomac and Columbia formations, the history of river development in the region, and the nature and origin of the fall-line.

From 1887 to June, 1893, Mr. McGee had leisure only for occasional geological observations in the vicinity of Washington, and these mainly of transient exposures.

In 1890 he prepared an extended memoir on "The Lafayette Formation" for the report of the Director of the Survey.[1] This memoir relates mainly to the Southern States, but there are included brief summaries of the characteristics of the several sedimentary formations which extend across the Coastal Plain region of Maryland, and a review of the general geologic history of the province.

In 1888 Professor William B. Clark, of the Johns Hopkins University, was requested to prepare a report upon the Eocene formations of the United States, and from that time forward devoted considerable attention to the Cretaceous and Tertiary deposits of Maryland and Virginia.[2]

In June, 1889, Mr. N. H. Darton was assigned to work in the Coastal Plain region in Maryland, District of Columbia and Virginia. He spent the next five years in almost continuous field work in this portion of the province. The preliminary work was a reconnaissance in a boat along the shores of the Potomac, St. Mary's, Patuxent, South, Severn, Patapsco and Sassafras rivers, and the head of Chesapeake Bay, with Mr. F. M. Smith as assistant. Then a detailed examination was made of the East Washington quadrangle, which was mapped in greater part.

In the spring of 1890 considerable progress was made in mapping the Coastal Plain formations in the Baltimore quadrangle, on which the crystalline rocks had been mapped by Dr. G. H. Williams. In

[1] Twelfth Ann. Rept. U. S. Geol. Survey, 1891, pp. 347-521, pls. 32-41.

[2] Correlation Papers—Eocene. Bull. U. S. Geol. Survey No. 83, 1891, pp. 43-48.

the latter part of June a reconnaissance was made in portions of the Eastern Shore of Maryland.

In December, 1890, Mr. Darton presented to the Geological Society of America a résumé of the results of his observations in the Coastal Plain region in a paper entitled "Mesozoic and Cenozoic Formations of Eastern Virginia and Maryland."[1] In this paper there were defined the Pamunkey formation, of Eocene age, the Severn formation, comprising portions of the marine Cretaceous deposits, and the Chesapeake formation, of Miocene age. An account was given of the distribution and relations of these formations, and of the Potomac, Appomattox (Lafayette) and Columbia formations.

In the spring of 1891 Mr. Darton completed mapping the sedimentary formations of the Washington quadrangle, and during the summer of that year there was issued by the survey a preliminary edition of the sheet, with the geology of the crystalline rocks by Dr. Williams. There was also prepared by Mr. Darton an account of the sedimentary formations in the vicinity of Washington for the "Guide to Washington and its Scientific Institutions," printed for the Fifth Session of the International Congress of Geologists.

During 1891-92 Mr. Darton mapped in a preliminary way the greater part of the Western Shore of Maryland embraced in the Nomini, Patuxent and Patapsco quadrangles, together with a strip extending along the eastern side of this area along Chesapeake Bay.

As a result of this work there was published in 1895 the Nomini folio, No. 23, Geologic Atlas of the United States.

During the summer of 1891 Professor Clark was detailed to work in the northern Atlantic Coastal Plain, embracing New Jersey, Delaware and the Eastern Shore of Maryland, and began investigations upon the Cretaceous formations in the northern portion of the district.

In February, 1892, as has been said, there was published for the American Institute of Mining Engineers a guide-book to Baltimore, to which Mr. Darton contributed a description of the geology of the sedimentary rocks, and which was accompanied by a preliminary geo-

[1] Bull. Geol. Soc. America, vol. ii, pp. 431-450.

logical map, "The Baltimore Sheet," published by the United States Geological Survey. This map, with somewhat extended area, was republished later in 1892 by Johns Hopkins University as a "Geological Map of Baltimore and Vicinity" by G. H. Williams and N. H. Darton.

In July, 1892, Mr. Darton made some progress in mapping the sedimentary formations of the Gunpowder quadrangle. This trip was followed by ten days' field work on the Eastern Shore of Maryland, mainly for the purpose of investigating the relation of soils to the peach yellows, the investigation being made at the request of the United States Department of Agriculture.

During the spring and early summer of 1893 a number of trips were made to Maryland for additional data for Geologic Atlas folios. At this time the Magothy formation, which in a portion of eastern Maryland lies between the Potomac formation and the marine Cretaceous sediments, was discriminated. It was defined and described in a paper entitled "The Magothy Formation of Northeastern Maryland."[1]

In the following year some additional observations were made in the Gunpowder district by Mr. Stanley-Brown.

In 1893-94 Mr. Darton made many observations about Washington to obtain data for the Washington folio, and some trips were made into eastern Maryland to obtain photographs to illustrate the final report.

During the progress of the Coastal Plain work in previous years much attention had been given to the collection of data regarding underground water supplies, especially those available for deep wells. In February, 1894, Mr. Darton presented to the American Institute of Mining Engineers a short paper entitled "Artesian Well Prospects in Eastern Virginia, Maryland and Delaware."[2]

In the following year many additional data of artesian and other deep wells were collected for Maryland and the other states of the Atlantic Coastal Plain, which afforded the basis for a more elaborate

[1] Am. Jour. Sci., 3d series, vol. xlv, 1893, pp. 407-419, including map.

[2] Trans. Am. Inst. Min. Eng., vol. xxiv, pp. 372-397, pls. 1-2.

publication entitled "Artesian Well Prospects in the Atlantic Coastal Plain Region."[1] The chapter on Maryland occupies pages 124-155, with maps and sections.

In 1894-95 and 1895-96 Mr. Darton made occasional trips in Maryland, mainly for the purpose of obtaining final data for the Washington folio. He also differentiated the Pleistocene formations into "earlier Columbia" and "later Columbia," and ascertained their geologic history. Some of the results of this investigation were set forth in "An outline of the Cenozoic History of a Portion of the Middle Atlantic Slope."[2]

In 1896 a map showing the distribution of the Potomac formation in Maryland and Virginia was prepared for Professor Fontaine's paper on the Potomac formation.[3]

During 1896 much work was done upon the Cretaceous formations of Maryland and Delaware by Dr. Clark and his assistant, Dr. Bagg, partly under the auspices of the United States Geological Survey and partly under those of the Maryland Geological Survey.

Much attention has been given by the United States Geological Survey to the paleobotany of the Potomac formation. Professor W. M. Fontaine made extensive observations and collections in Virginia in 1886 and 1887, and examined some localities in its northern extension as far as Baltimore. Fossil plants were also obtained in Baltimore by Professor Ward in 1886 and forwarded to Professor Fontaine for study. The publications by Professor Fontaine are a monograph on the "Potomac or Younger Mesozoic Flora"[4] and a bulletin recently issued entitled "The Potomac Formation in Virginia."[5] Both of these publications relate in some measure to the Potomac formation in its extension into Maryland.

The studies by Professor L. F. Ward of the Potomac formation and its flora began in the summer of 1885 with a trip with Professors McGee and Fontaine along the formation in Virginia and Maryland.

[1] Bull. U. S. Geol. Survey No. 138, 1896.
[2] Jour. of Geology, vol. ii, pp. 568-587.
[3] Bull. U. S. Geol. Survey No. 145, 1896, pl. 1.
[4] Mon. U. S. Geol. Survey, vol. xv, 1889, 377 pp., 180 pls., 4°.
[5] Bull. U. S. Geol. Survey No. 145, 1896, 149 pp.

In October, 1886, he visited Baltimore to observe outcrops and collect plants as above mentioned, and thence accompanied Professor McGee on a trip to the head of Chesapeake Bay. On this trip plant collections were made in the Potomac and overlying marine Cretaceous. In 1886-87 Professor Ward prepared a paper on "The Geographical Distribution of Fossil Plants,"[1] in which those from Maryland are referred to.

In 1888 Professor Ward presented before the National Academy of Sciences the "Evidence of Fossil Plants as to the Age of the Potomac Formation."[2]

In 1888-89 Mr. F. H. Knowlton, under the direction of Professor Ward, prepared a report on "Fossil Wood and Lignite of the Potomac Formation," collected at various points in the District of Columbia and adjacent portions of Maryland. This was published as a Bulletin of the Survey,[3] and as a brief preliminary report in the American Geologist.[4]

At various times during the next two years Professor Ward made a number of trips to localities in the Potomac formation area in Virginia and Maryland, and in November and December, 1891, accompanied by Mr. David White, collected Potomac fossil plants from the Potomac formation east of Washington. In the spring of 1892, accompanied by Mr. White, he made an extensive examination of many localities in the Potomac area of Maryland and northward.

In the latter part of 1893 Professor Ward, accompanied by Professor W. M. Fontaine, examined representative exposures about Washington, Baltimore and Fredericksburg, and on the banks of the Severn, Potomac and Rappahannock rivers. In March, 1894, Professor Ward made a short trip to examine the localities at which many cycadean remains had been discovered by Mr. Bibbins. An account of these remains was published in a paper entitled "Recent Discoveries of Cycadean Trunks in the Potomac Formation of Maryland."[5]

[1] Eighth Ann. Rept. U. S. Geol. Survey, part ii, 1889, pp. 870-872.
[2] Am. Jour. Sci., 3d series, vol. 36, pp. 119-131.
[3] Bull. U. S. Geol. Survey No. 56, 1889, 72 pp., 7 pls.
[4] Am. Geologist, vol. iii, 1889, pp. 99-106.
[5] Bull. Torrey Bot. Club, vol. xxi, 1894, pp. 291-299.

The extended studies which Professor Ward had made of the Potomac formation during the past few years had thrown much light on the stratigraphy and fauna of the formation. In order to present these results, Professor Ward prepared a paper entitled "The Potomac Formation" for the report of the United States Geological Survey for 1893-94.[1]

This was followed by a paper entitled "Some Analogies in the Lower Cretaceous of Europe and North America," prepared for the report of the same survey for 1894-95.[2] In this paper Professor Ward compares the Potomac formation of Maryland and its extension with European Lower Cretaceous formations. He figures the cycads found in Maryland.

Some attention has been given by the survey to the collection of fossil bones from the Potomac formation.

In 1886-87 Mr. J. B. Hatcher, working under the direction of Professor O. C. Marsh, examined the clays in the iron mines near Beltsville, Maryland, and found a number of vertebrate remains and Sequoia cones. These remains were described by Professor Marsh in a paper entitled "Notice of a New Genus of Sauropoda and other New Dinosaurs from the Potomac Formation."[3]

In October, November and December, 1887, Mr. Hatcher, under the direction of Professor Marsh, made a further examination of the Potomac formation between Washington and Baltimore and obtained some additional vertebrate remains.

The stratigraphy and paleontology of the Eocene deposits of Maryland and Virginia were very fully investigated by Professor Clark during the years 1888-92 for his memoir on "The Eocene Deposits in the Middle Atlantic Slope in Delaware, Maryland and Virginia,"[4] which appeared in 1896.

Numerous short trips have been made by members of the survey to collect molluscan remains from the marine Cretaceous, Pamunkey

[1] Fifteenth Ann. Rept. U. S. Geol. Survey, 1895, pp. 307-397, pls. 2-4.
[2] Sixteenth Annual Rept. U. S. Geol. Survey, 1896, pp. 463-542, pls. 97-107.
[3] Am. Jour. Sci., 3d series, vol. 35, 1888, pp. 89-94.
[4] Bull. U. S. Geol. Survey No. 141, 1896, 167 pp., 40 pls.

and Chesapeake formations in Maryland. Tertiary fossils were collected for Dr. Dall by Messrs. Harris and Burns in May, 1891, from near Easton, Maryland, and in May and June, 1892, Mr. Burns was sent to the Calvert Cliffs, Maryland, to obtain fossils for Dr. Dall. Mr. Gilbert D. Harris, who accompanied Mr. Burns, made observations on the Tertiary formations in these cliffs, which led to his paper on "The Tertiary Geology of Calvert Cliffs, Maryland."[1]

In 1891-92 Messrs. Dall and Harris, in reviewing the literature and knowledge of the Neocene in the United States, in "Correlation Papers, Neocene," wrote a short chapter on the Neocene of Maryland.[2]

Mr. G. D. Harris collected from some of the Eocene localities in Maryland and Virginia and arrived at conclusions in regard to the position of the deposits, which are set forth in a paper "On the Geological Position of the Eocene Deposits of Maryland and Virginia."[3]

The marine Cretaceous formations in Maryland received some study from Professor C. A. White, who in May, 1888, made a trip through eastern Maryland northward to examine the deposits. Probably these observations had their influence in the preparation of the chapter on Maryland and the District of Columbia, in Correlation Papers, Cretaceous.[4]

In the latter part of 1891 Mr. T. W. Stanton and Mr. F. E. Willard collected Cretaceous fossils in Prince George's county, Maryland.

In May, 1891, there was a joint scientific expedition into the tidewater region of Maryland with representatives from Johns Hopkins University, the Maryland Agricultural College, and the United States Geological Survey. The survey was represented by Messrs. W J McGee, N. H. Darton, G. D. Harris and David White. The party traveled by boat along the Chesapeake Bay and the Patuxent and Potomac rivers.

HYDROGRAPHIC WORK.

The hydrographic work of the United States Geological Survey in

[1] Am. Jour. Sci., 3d series, vol. 45, pp. 21-31.
[2] Bull. U. S. Geol. Survey No. 84, 1892, pp. 49-55.
[3] Amer. Jour. Sci., 3d series, vol. xlvii, 1894, pp. 301-304.
[4] Bull. U. S. Geol. Survey No. 82, 1891, pp. 88-90.

Maryland began in 1891, when a study of the Potomac river was commenced, the investigations being carried on by Mr. Cyrus C. Babb, under the direction of Mr. F. H. Newell, the Chief Hydrographer of the Survey. Observations of river height were first made at Chain Bridge, about 3 miles above the city of Washington, and at later times reconnaissance and discharge measurements were made on some of the higher branches in order to obtain data of run-off from the catchment areas of different character under similar climatic conditions.

Later the matter was given more careful attention and preparations were made for a thorough series of measurements. A number of stations were established along the line of the river, viz., at Point of Rocks, Great Cacapon and Cumberland. Preparatory to this work at each of these points, apparatus for registering the heights of the water was established, and careful records have been kept since that time.

Use has also been made of the daily record kept since 1878, by the officials of the Washington Aqueduct, of the height of the water flowing over their dams at Great Falls.

Simultaneously with the gauge height records at Great Falls, another record has been kept, viz., *condition of water*, as it is called, or observations on the amount of matter carried in suspension in the river.

Several stations upon other streams were established during the year 1896 in co-operation with the Maryland State Weather Service, viz., at a point four miles northeast of Frederick on the Monocacy river, at Laurel on the Patuxent river, near Woodstock on the Patapsco river and at Rowlandsville on Octararo creek. It is planned to extend this work in the near future.

STATISTICAL WORK.

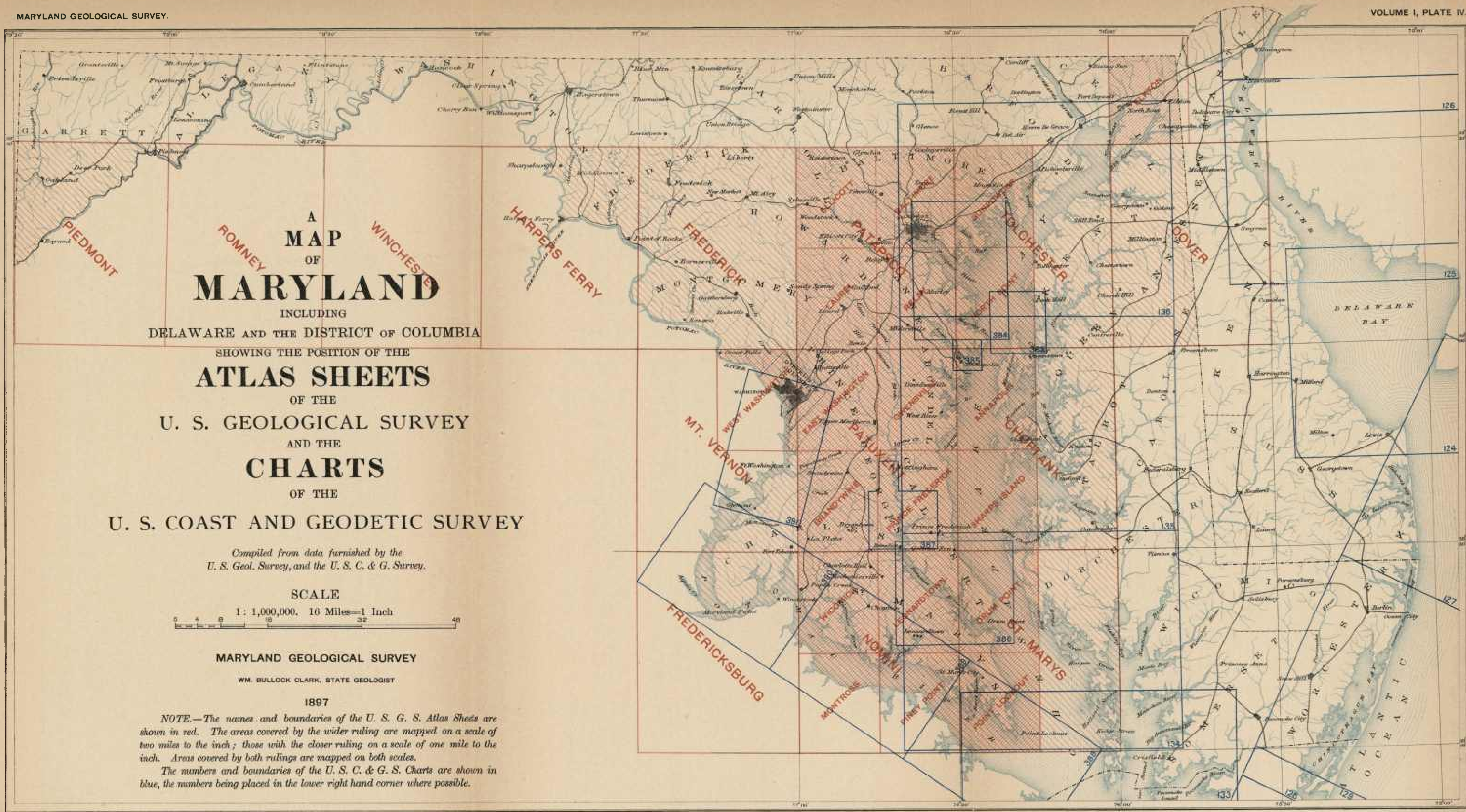
An annual tabulation of the mineral resources of the United States in which Maryland appears, was undertaken by the United States Geological Survey in 1882, the first report by Albert Williams, Jr., being published in 1883. Since 1886 this work has been under the direction of Dr. David T. Day, who has published annual reports regarding the mineral resources of the country. In these reports Maryland's output of coal, brick and pottery clays, building stones, iron, flint, diatomaceous earth, soapstone, slate, etc., has been described.

LIST OF PUBLISHED ATLAS SHEETS IN THE STATE OF MARYLAND.[1]

Sheet Name.	State.	Proportional.	Inch to St. M.	Contour Interval.	Surveyor.	Year of Survey.
Annapolis	Md.	1 : 62500	1	20	A. E. Murlin,	1890
Baltimore	"	1 : 62500	1	20	S. H. Bodfish, A. E. Murlin,	1887 1890
Baltimore (*a*)	"	1 : 62500	1	20	S. H. Bodfish,	1887
Brandywine	"	1 : 62500	1	20	A. E. Murlin,	1890
Drum Point	"	1 : 62500	1	20	A. E. Murlin,	1890
East Washington	Md. & D. C.	1 : 62500	1	20	D. J. Howell,	1886 1897
Ellicott	Md.	1 : 62500	1	20	A. E. Murlin,	1890
Frederick	Md. & Va.	1 : 125000	2	50	M. Hackett,	1888 1889
Fredericksburg	Md. & Va.	1 : 125000	2	50	D. C. Harrison,	1887 1888
Gunpowder	Md.	1 : 62500	1	20	A. E. Murlin,	1891
Harpers Ferry	Md., Va. & W. Va.	1 : 125000	2	100	W. T. Griswold,	1884
Laurel	Md.	1 : 62500	1	20	A. E. Murlin,	1890
Leonardtown	"	1 : 62500	1	20	A. E. Murlin,	1890
Montross	Md. & Va.	1 : 62500	1	20	A. E. Murlin,	1890
Mt. Vernon	Md., Va. & D. C.	1 : 125000	2	50	D. J. Howell,	1886
Nomini	Md. & Va.	1 : 125000	2	20	A. E. Murlin,	1890
North Point	Md.	1 : 62500	1	20	A. E. Murlin,	1890 1891
Owensville	"	1 : 62500	1	20	A. E. Murlin,	1890
Piney Point	"	1 : 62500	1	20	A. E. Murlin,	1890
Piedmont	Md. & W. Va.	1 : 125000	2	100	M. Hackett and R. H. Chapman,	1894
Point Lookout	Md.	1 : 62500	1	20	A. E. Murlin,	1890
Prince Frederick	"	1 : 62500	1	20	A. E. Murlin,	1890
Relay	"	1 : 62500	1	20	S. H. Bodfish and A. E. Murlin,	1887 1890
Sharps Island	"	1 : 62500	1	20	A. E. Murlin,	1891 1892
West Washington,	Md., Va. & W. Va.	1 : 62500	1	20	D. J. Howell,	1886 1897
Wicomico	Md.	1 : 62500	1	20	A. E. Murlin,	1890

(*a*) Special map, including area between parallels 39° 10′ and 39° 25′ and meridians 76° 30′ and 76° 45′.

[1] The Atlas Sheets can be obtained at the price of 5 cents a sheet by addressing *The State Geologist, Baltimore, Md.*, or *The Director U. S. Geological Survey, Washington, D. C.* The location of the Atlas Sheets is shown upon the accompanying map.


A
MAP
OF
MARYLAND
INCLUDING
DELAWARE AND THE DISTRICT OF COLUMBIA
SHOWING THE POSITION OF THE
ATLAS SHEETS
OF THE
U. S. GEOLOGICAL SURVEY
AND THE
CHARTS
OF THE
U. S. COAST AND GEODETIC SURVEY
Compiled from data furnished by the
U. S. Geol. Survey, and the U. S. C. & G. Survey.
SCALE
1: 1,000,000. 16 Miles=1 Inch
MARYLAND GEOLOGICAL SURVEY
WM. BULLOCK CLARK, STATE GEOLOGIST
1897
NOTE.—The names and boundaries of the U. S. G. S. Atlas Sheets are shown in red. The areas covered by the wider ruling are mapped on a scale of two miles to the inch; those with the closer ruling on a scale of one mile to the inch. Areas covered by both rulings are mapped on both scales.
The numbers and boundaries of the U. S. C. & G. S. Charts are shown in blue, the numbers being placed in the lower right hand corner where possible.
PIEDMONT
ROMNEY
WINCHESTER
HARPERS FERRY
FREDERICK
PATAPSCO
CHESTERTOWN
DOVER
MT. VERNON
PATUXENT
CHOPTANK
FREDERICKSBURG
NOMINI
ST. MARYS
MONTROSE
PINEY POINT
POINT LOOKOUT
BRANDYWINE
PRINCE FREDERICK
SHARPS ISLAND
DRUM POINT
DELAWARE BAY
ATLANTIC OCEAN
126
125
124
127
128
129
133
134
135
136
384
385
386
387
388
391
LITH. BY A. HOEN & CO. BALTO.

LIST OF UNPUBLISHED ATLAS SHEETS IN THE STATE OF MARYLAND.[1]

Sheet Name.	State.	Proportional.	Inch to St. M.	Contour Interval.	Surveyor.	Year of Survey.
Choptank	Md.	1 : 125000	2	20	A. E. Murlin, F. Sutton, J. H. Wheat, J. W. Thom,	1891 1895
Dover	Md. & Del.	1 : 125000	2	20	H. S. Wallace, J. W. Thom,	1896
Elkton	Md., Del. & Pa.	1 : 62500	1	20	H. S. Wallace, J. W. Thom,	1896
Patuxent	Md.	1 : 125000	2	20	D. J. Howell, A. E. Murlin,	1886 1897
Patapsco	"	1 : 125000	2	20	S. H. Bodfish, A. E. Murlin,	1887 1890
Tolchester	"	1 : 125000	2	20	A. E. Murlin, F. Sutton, J. W. Thom,	1891 1895
St. Marys	Md. & Va.	1 : 125000	2	20	A. E. Murlin,	1890 1895

[1] The surveys for these sheets have been completed and the maps will be published at an early date.

LIST OF PUBLISHED GEOLOGIC FOLIOS IN THE STATE OF MARYLAND.[2]

Sheet Name.	State.	Proportional.	Inch to St. M.	Contour Interval.	Surveyor.	Year of Survey.
Fredericksburg ..	Md. & Va.	1 : 125000	2	50	W J McGee, N. H. Darton,	1890
Harpers Ferry	Md., Va. & W. Va.	1 : 125000	2	100	Bailey Willis, Arthur Keith,	1890 1891
Nomini	Md. & Va.	1 : 125000	2	20	W J McGee, N. H. Darton,	1891
Piedmont	Md. & W. Va.	1 : 125000	2	100	B. Willis, N. H. Darton, J. A. Taff,	1894

[2] The Geologic Folios can be obtained at the price of 25 cents a folio by addressing *The State Geologist, Baltimore, Md.*, or *The Director U. S. Geological Survey, Washington, D. C.* The location of the Folios is shown upon the accompanying map.

Operations of the United States Coast and Geodetic Survey in Maryland.[3]

The following memoranda relative to the history of the United States Coast and Geodetic Survey operations in the state of Maryland, giving dates of triangulation, successive charts, etc., are herewith presented.

[3] Prepared under the direction of the Superintendent of the U. S. Coast and Geodetic Survey.

SURVEYS OF BALTIMORE AND VICINITY.

In the early years of the United States Coast and Geodetic Survey a topographic survey of Baltimore and vicinity, incidental to that of the state of Maryland, became a subject of interest. A letter of Professor Hassler, the first Superintendent of the Coast Survey, date of January 7, 1834, to the Secretary of the Treasury, remarks: "It is proper for me to get more information upon the views of the survey of a map of the state of Maryland upon which Professor Ducatel had corresponded with me last summer." He writes under date of January 9: "In the course of last summer, Professor D. informed me that he and Mr. Alexander had been appointed by the Legislature of Maryland to make a topographical map of the state and its junction with the Coast Survey."

In April, 1834, Professor Hassler, in another letter to the Secretary of the Treasury, writes: "Upon your favor of the 9th, relative to the junction of the survey of Maryland with the Coast Survey, authorizing me to make the proper arrangement to put the measure into execution, I shall make the appropriate agreement with Messrs. Ducatel and Alexander, combine with them and then give you details upon the plans agreed upon mutually."

Three months later Mr. Hassler reports to the Secretary the indefinite postponement of the proposed work, the Maryland committee not being ready to perform its part.

A period of ten years then elapses before any steps were taken for surveys in Baltimore or the Patapsco river.

Professor Hassler had in the meantime been succeeded by Professor A. D. Bache.

December 23, 1844, in report of Professor Bache, mention is made of the beginning of the secondary triangulation in the Patapsco river under the direction of Assistant F. H. Gerdes. The triangulation in the near vicinity of Baltimore was done by Assistant Ferguson, who determined the positions "Rosanne," five miles from the centre of the city, near the old Frederick road, and "Finley," several miles farther in a northeasterly direction.[1] These points were important factors in

[1] Washington Monument was also determined during the same period.

the several triangulations made in after years. Hydrographic work had not yet been begun. Topographical surveys were in progress in charge of Assistant Geo. D. Wise, at the entrance of the Patapsco river.

In his report of December, 1845, Professor Bache states: "Materials for a chart of the Patapsco river and Baltimore harbor will, it is confidently expected, be ready for use this winter, and the chart will at once be drawn and put in the hands of the engraver. The topography has been executed by Assistants Gerdes, Hassler, Wise and Cutts. Sheets Nos. 6 and 8 are completed, and on No. 9 considerable progress made. No. 8 includes Baltimore City and adjacent country." Referring to sheet No. 8, Mr. Wise remarks: "Having found it impossible to reconcile the measured distance with printed plan of the city (Poppleton's map presumably), it was found necessary to make a detailed survey, especially of the part near the water."

During 1845 the hydrography of the Patapsco river and Baltimore harbor was begun and completed. Topographical work was continued in the same localities during this year and 1846.

In 1847 engraving of the chart of the localities above named was begun.

In 1848 magnetic observations were made at Fort McHenry.

Report of Professor Bache, December 27th, states: "Map of Baltimore harbor and Patapsco river still in hands of engravers."

"During the year a verification[1] of the topography of the city of Baltimore was made by Assistant J. B. Gluck."

Report of November 5th, 1851, mentions: "Map of Baltimore harbor, etc., still in hands of engravers."

During 1853 Assistant H. L. Whiting was engaged in verification of topography of the Patapsco shores.

1854, a re-survey of the Patapsco river entrance was made by request of the Engineer Department, U. S. A.; no considerable changes were developed. With this the record of field operations by the Coast Survey in the vicinity of Baltimore, prior to the Civil War, closes.

In July, 1863, by request of the military authorities at Baltimore,

[1] These verifications were in reality re-surveys.

a topographical survey of the city and its approaches was begun. The triangulation, in charge of Sub-Assistant C. H. Boyd, based upon such data as could be availed of or discovered (the primary and secondary points of the work of 1844), was extended over the area designated. The points determined by Assistant Boyd included the following objects, whose identification at the present time is quite possible: "House of Refuge," "Mt. de Sales," "Druid Hill," "Greenmount Cemetery," "St. John's," "Baltimore Cemetery," "Pious" (Rives Hill), and "Clifton." The topography was begun at the same time by Aid J. W. Donn. It was designated that the area of the survey should be limited to a circuit of four miles, with the Battle monument as the centre. The triangulation was completed during the summer and the topography advanced to the south along the principal roads. J. W. Donn was succeeded by C. T. Iardella in this work in October. C. M. Bache was also assigned to a part of the survey in January, 1864. C. M. Bache advanced the work from Jones' Falls westward to a junction with the initial survey of J. W. Donn, while C. T. Iardella proceeded eastward of the Falls to Cross Keys village. C. M. Bache finished his work in September, having covered an area of 20.5 square miles. C. T. Iardella continued his work until the middle of 1865, the last part of it upon the south side of the Patapsco. The area surveyed was 30 square miles.

Hydrographic Survey of the Branches of the Lower Patapsco.—During the early summer of 1869 the following branches of the Patapsco river were surveyed by Assistant J. W. Donn: Curtis creek and its branches, Stony creek and its branches, Rock creek, Bodkin creek and its branches—all on the west side—and Bear creek and its branches, North Point and Welshman's creek on the east side.

Triangulation of 1866.—This work, by Assistant F. P. Webber, was carried over the Patapsco river from the entrance at Seven-foot Knoll to the city. One point, "Washington Monument," distant from the river and within the city limits, was included in his scheme. The points in his work were generally useful in harbor and river resurveys, and comprise the following, many of which entered into succeeding schemes: "Monument," "Bayview Asylum," "Fort Mc-

Henry flag-staff," "Lazaretto," "Buchanan," "Fishing Point," "Sollers' Point," "Hawkins' Point," "Fort Carroll Light House," "Sparrows' Point," "Rock Point," "North Point" (upper light), "North Point" (lower light), "Bodkin," and "Seven-foot Knoll Light House."

Survey of 1876.—The interest manifested by the municipality of the city of Baltimore in regard to permanent improvements of the harbor took form in May of this year. The Legislature of Maryland, in its session of 1875-76, passed a special appropriation of $5000 for the purpose of a proper topographical survey in furtherance of that purpose. The bill provided for the co-operation of the Coast Survey in the work, and requested the appointment by the President of a Commission composed of the Chief of Engineers, the Superintendent of the Coast Survey, and the U. S. Engineer in charge of harbor and river improvements at Baltimore.

The Commission, appointed as requested, consisted of Major-Gen. A. A. Humphreys, Dr. C. P. Patterson, and Major W. P. Craighill. J. W. Donn, Assistant Coast Survey, was assigned to make all surveys needful for the deliberations of the Commission in the establishment of permanent harbor lines. These surveys were shown upon five sheets of wharf, pier and shore lines, and the same number included full hydrographic details.

For this special survey a careful triangulation was made during July and August, 1876. In the course of this triangulation the following easily recognized points and discoverable with little trouble at the present time were determined: "Bayview Asylum," "Washington Monument," "Light Street Corner," "Gail & Ax's Cupola," "Malt House," "Knabe's Piano Factory," "Chase's Wharf," "Bonded Warehouse," "Abbott's Foundry," "Mill Cupola," "Central Cupola," "Green Cupola," "Elevator B," "Lazaretto," "Iron Foundry," "Parapet," and "Fort McHenry flag-staff." Subsequently the entire wharf-line was measured carefully with a steel tape as a check and for comparison with the plane-table determinations. As usual, the topographical work was done entirely upon the ground, the only record being delineations upon the field sheets. Comparisons were frequently made with the measured lines of wharves, piers and docks, and the agreement left nothing to be desired in point of accuracy.

In extending the survey along such parts of the shore as were not occupied by wharves or piers, and which could not be clearly defined otherwise, a leveling instrument was used to mark out the line of mean high water. This plan was ascertained by the observation of a series of day and night tides extending through two lunar months. Tide stations were established at Henderson's wharf (Fell's Point), Woodall's ship yard (Locust Point), Bollman's wharf (Canton), and at Winans' dock in the Patapsco river. The series was recorded at the Fell's Point gauge, and during intervals free from winds and abnormal tides, simultaneous observations were made to determine differences of period of maximum of flood and ebb. These differences were found to be less than 15 minutes, or practically inappreciable in the limited tidal flow of the harbor, which the mean of one hundred and fifteen tides show to be 1.16 feet, or .04 feet less than that established for the station at Fort Carroll. The sounding of the harbor was begun early in October and continued without interruption until that part of the area known as Spring Garden was closed by ice.

During the progress of hydrographic work the shores of the Patapsco river on both sides were surveyed, scale 1:3600 (300 feet to the inch). The space between the head of the basin and the lines of Canton was mapped on the scale of 1:1800 (150 feet to the inch). The hydrographic survey covered the entire area above the line of the Lazaretto and Marine Hospital wharf, excepting the main branch of the river above the Long Bridge. The area of the basin and harbor to the entrance at Fort McHenry was sounded and plotted on the scale of the topographical sheets that covered the same locality.

On June 1, 1877, the survey was resumed at Spring Garden and in the Patapsco (main branch) between the drawbridge and Brooklyn, west of the bridge.

The recorded details show that in the course of the survey 17,400 soundings were made and 1443 angles measured for determining the position of the boat while sounding in midwater. The positions at ends of lines were determined by the plane-table. Principal lines of soundings were run parallel to the meridian. Cross or check lines intersected them at right angles. Lines of levels were run between the tide gauges at Henderson's, Bollman's and Woodall's, but no appreciable differences of plane were found. The same result was obtained by simultaneous observation of tide at the several stations mentioned.

This, the most thorough and elaborate survey hitherto made in and adjacent to the harbor of Baltimore, is represented by five topographic and five hydrographic sheets.

In March, 1881, Mr. Charles Junken, United States Coast and Geodetic Survey, made a re-survey of that part of the Patapsco lying between Fort Carroll and the line of Marine Hospital Lazaretto.

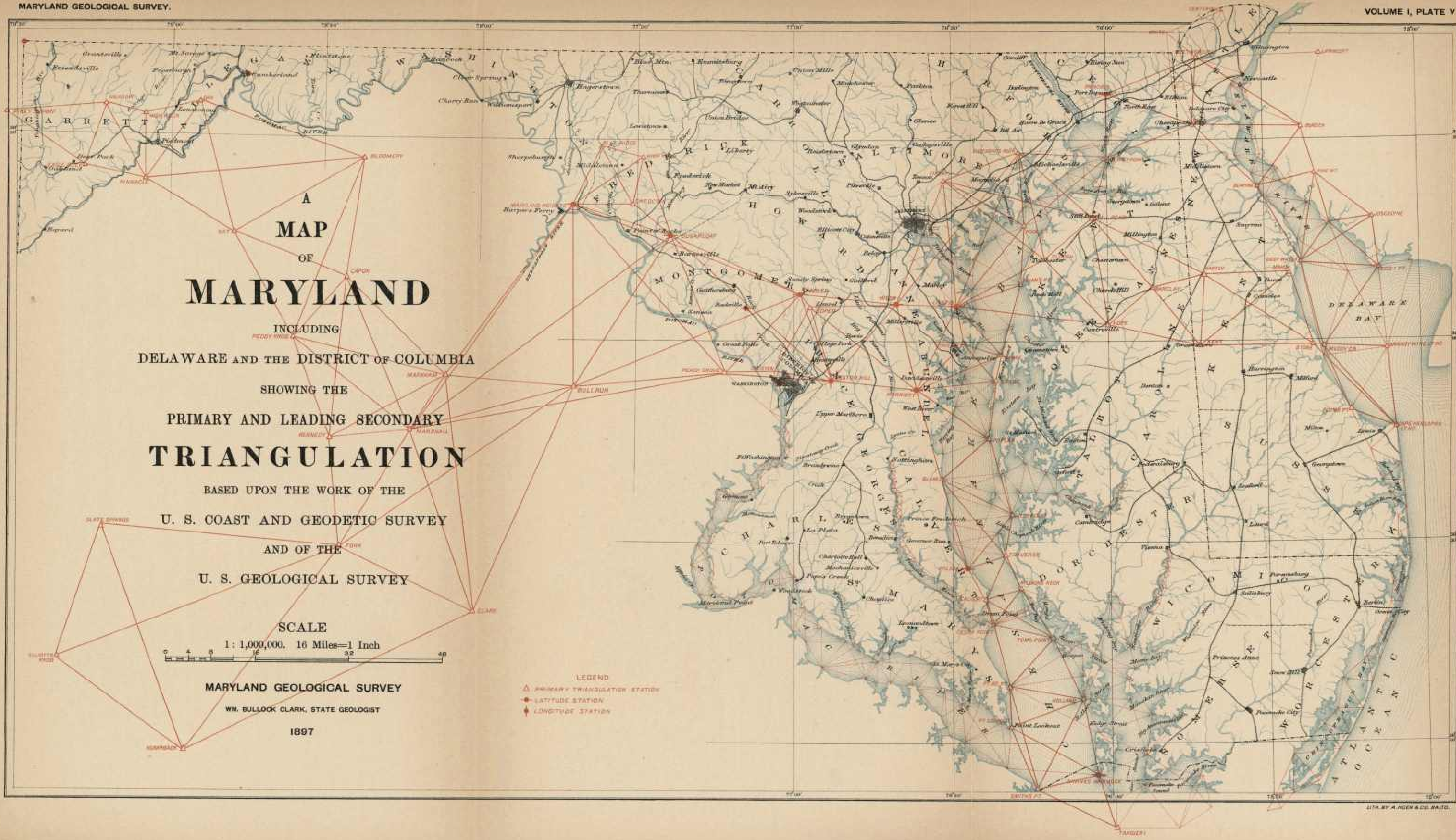
Survey of 1886.—In June, 1886, at the request of Major N. H. Hutton, Engineer of the Harbor Board, the work of 1876 was supplemented by a verification of the triangulation and its adjustment to more recent computations made by the Computing Division of the Coast and Geodetic Survey Office of the triangulation of the Chesapeake Bay. The purpose of Major Hutton's request, however, was the tracing upon the ground of the Port Warden line established by the Commission of 1876 and its connection with the triangulation in such a way that its identification could be secured by reference to established ground-marks. The Superintendent of the Coast and Geodetic Survey assigned to this work Assistant O. H. Tittmann. Copies of the original plane-table sheets of the special survey of 1876 were in possession of the Harbor Board of Baltimore, and upon these were laid down the Port Warden line of the harbor after due consultation with the engineer of the Board. In conformity with the suggestions of Major Hutton, Mr. Tittmann confined that part of his work to tracing the pier-head lines around the harbor—the bulk-head lines in certain places only being marked.

The method pursued was to transfer the Port Warden line to the original sheets. These sheets were then taken into the field, and in general the points of deflection of these lines were identified by means of the plane-table. They were then referred by distance measurements and deflection angles to stones planted in the streets or sidewalks of the city, except where no streets had been opened, as along the middle branch of the Patapsco river, where the stones were set along the high-water line. These stones were connected with the triangulation and their location accurately described in the records.

As a base for the needful triangulation, Assistant Tittmann adopted the same line, Bayview monument, that had been used in 1876, and as the progress of the measurements between the reference stones in the streets disclosed a want of accord between the distances determined by these measurements and those deduced from the triangulation, it was deemed advisable to strengthen and check the triangulation by connecting it with some of the primary stations. Finally, however, on account of the difficulties of recovering the stations proposed and the expense attending their occupation, it was decided to obtain the desired check by the measurement of a base line and its introduction into the triangulation. A site about a mile in length having been selected on Fort Avenue, the measurements were made with the four-metre contact slide case apparatus and a correction found and applied to the previously accepted distance, Bayview monument. One hundred and seven geographical positions were determined, of which all but eleven were new.

In the scheme of triangulation carried out by Assistant Tittmann, many points of the work of 1876 were included. Of the one hundred and eleven geographical positions determined, nearly all can be identified and made available for future surveys. The prominent new positions added to the previous lists are: "Grace Methodist Church Spire," "St. James' Church Spire," "Johns Hopkins Hospital," "City Hall," "Holy Cross Church Spire," and the "Canton Elevator."

At the end of March, 1887, Major Hutton applied for the assignment of an officer of the survey to execute certain work supplementary to that accomplished by Assistant Tittmann, and Sub-Assistant W. I. Vinal was assigned for that purpose. In connection with the soundings made, some miscellaneous measurements of streets and wharves along the water front were included in his work.


A
MAP
OF
MARYLAND
INCLUDING
DELAWARE AND THE DISTRICT OF COLUMBIA
SHOWING THE
PRIMARY AND LEADING SECONDARY
TRIANGULATION
BASED UPON THE WORK OF THE
U. S. COAST AND GEODETIC SURVEY
AND OF THE
U. S. GEOLOGICAL SURVEY
SCALE
1: 1,000,000. 16 Miles=1 Inch
MARYLAND GEOLOGICAL SURVEY
WM. BULLOCK CLARK, STATE GEOLOGIST
1897
LEGEND
PRIMARY TRIANGULATION STATION
LATITUDE STATION
LONGITUDE STATION
DELAWARE BAY
ATLANTIC OCEAN
LITH. BY A. HOEN & CO. BALTO.

Survey of Sparrows' Point, 1891.—In May, 1891, a closely detailed topographical survey of the locality of the works of the Maryland Steel Company at Sparrows' Point, Patapsco river, and the hydrographic survey of its water-front to the Baltimore ship channel, and Bear creek to the railroad bridge, were made by Assistant J. W. Donn.

SURVEYS OF OTHER PORTIONS OF MARYLAND AND ADJACENT TERRITORY.

The following report shows in a partly tabulated form the work of the Coast Survey in other portions of the state of Maryland and the District of Columbia between the years 1832 and 1896.

Triangulation.—In 1844-45-46 the primary triangulation was carried across from the Delaware Bay to the head of the Chesapeake and down to the Kent island base-line, established during this period by Assistant Edward Blunt and James Ferguson. In the latter year the work was extended to the District of Columbia, and in 1847 had reached Point No Point and Hooper's island. In 1848 the entrance of the Potomac river was included in the lines.

The secondary triangulation progressed with the primary, but incidental to topographic work was continued over the Chesapeake and its Maryland tributaries during the entire period closing with 1870.

Primary triangulation was begun in 1864-65 by Assistant J. A. Sullivan, in western Maryland, as a part of the trans-continental scheme. Afterward this was continued by Assistant C. O. Boutelle. At the present time the stations Maryland Heights and Sugar Loaf Mountains are connected with the work of Chesapeake Bay and the work passing over western Virginia. The position of Rockville, Md., has also been determined as described by Assistant Edwin Smith, in Bulletin No. 25.

The map shows the primary and secondary triangulation; the tertiary work cannot well be put on, owing to the great detail, the number of lines would be confusing.

The geographic positions in Maryland, determined by the United States Coast and Geodetic Survey up to the end of 1896 number 1173.

Base-lines were measured at Kent island (primary), 1844; at Sinepuxent Beach (secondary), 1853; at Port Tobacco (tertiary), 1862; at Baltimore (secondary), 1886 and (tertiary) 1894.

Astronomy.—Stations were established and observations made in 1844-45-46-47 at the following primary points: Osborne's river (head of Bush river), Taylor (near Severn river), Marriott (near West river), S. Base (Kent island), Poole's island.

Astronomic latitudes were determined at the trigonometric stations: Marriott, 1846 and 1849; Taylor and Poole's island, 1847; Soper, Hill and Webb, 1850; Cumberland, 1864; Principio, 1866; Maryland Heights, 1870; Calvert, 1871; Sugar Loaf Mountain, 1879; Rockville, 1892.

Astronomic longitude was determined telegraphically at Cumberland, 1864. To this might be added Washington, D. C.

Astronomical azimuths were measured at Marriott, 1849; Soper, Hill and Webb, 1850; Davis, 1853; Principio, 1866; Maryland Heights, 1870; Calvert, 1871; Sugar Loaf Mountain, 1879.

Hypsometry.—Elevations above half-tide or mean level of the ocean were determined by zenith distances at various times at stations Taylor, Linsted, Webb, Marriott, Agricultural College, Hill, Blair's House, Soper, Stabler, Sugar Loaf Mountain and Maryland Heights.

A line of spirit levels was carried from Washington, D. C., to Annapolis in 1875, published as Appendix No. 15, Report for 1889. The line of spirit levels from Sandy Hook, N. J., to St. Louis enters Maryland near Hagerstown and leaves it near Oakland, 1878, published as Appendix No. 11, Report for 1882. A third line of spirit levels was run from Hagerstown to the District of Columbia, 1883, published as Appendix No. 4, Report for 1896.

Gravity.—The stations where pendulum observations were made for relative gravity and, consequently, also roughly (at present) for absolute measure, are Baltimore, Johns Hopkins University, 1893, and Deer Park, 1894.

Magnetics.—Between the years 1845 and 1897 there were occupied 22 different stations for the determination of the magnetic declination, dip and total intensity of the magnetic force. Several of these stations were occupied more than once, see Appendix No. 11, Report for 1889, and Appendix No. 6, Report for 1885, the latter for dip and intensity.

The secular variation of the magnetic force, in direction and intensity, has been studied for Baltimore and a number of surrounding stations available for Maryland. Appendix No. 1, Report for 1895, covers the whole period from the discovery of the country to the present time. The latest isogonic chart for the United States is given in Appendix No. 1, Report for 1896, and is for the epoch January, 1900. Isoclinic and isodynamic charts, the latter for the horizontal component of the magnetic force and for the total intensity, have likewise been constructed for the same advanced epoch.

INVESTIGATION OF OYSTER-BEDS.—The investigations were conducted by Francis Wilson, U. S. N., in Manokin river, Nanticoke river, Wicomico river, Big Annemessex river, Fishing Bay, Kedge Strait, Hooper Strait and Holland Strait. The object of this work was to determine the extent of the oyster-beds and to study the habits of the oyster, as will be seen in Appendix No. 11, Report for 1881. The examination was conducted between August 7, 1878, and October 15, 1878, in the Coast Survey schooner "Palinurus."

HYDROGRAPHY.—The work was executed by both civilians and naval officers, and includes the ocean shore as well as Chesapeake Bay and the rivers tributary to it. The area covered by this hydrography is about 2600 square miles. The number of miles of shore line is approximately 2800.

In connection with the hydrography, tidal observations were made at 113 stations, varying from two days to several months in duration, depending upon the needs of the hydrographic party.

TOPOGRAPHICAL SHEETS WITHIN BOUNDARIES OF THE STATE OF MARYLAND.

ON FILE IN THE ARCHIVES OF THE U. S. COAST AND GEODETIC SURVEY, GEOGRAPHICALLY ARRANGED, GIVING NUMBER OF SHEET, LOCALITY OF SURVEY, SCALE, TOPOGRAPHER AND DATE.

Atlantic Coast.

Register No.	*Locality.*	*Scale.*	*Topographer.*	*Date.*
299	From Salt Pond Beach Signal to Dromedary Signal......	1–20000	G. D. Wise,	1850
263	From Beach House to South Birch....................	1–20000	G. D. Wise, L. A. Sengteller,	1849 1877
264	From head of Assateague Bay to Popes Island Beach.....	1–20000	G. D. Wise,	1850

Register No.	Locality.	Scale.	Topographer.	Date.
311	From Popes Island Beach to Green River Inlet.........	1–20000	G. D. Wise,	1850
522	From Chincoteague Inlet to Lonesome Hill...........	1–20000	G. D. Wise,	1849
763	Assateague Island and vicinity.....................	1–20000	C. Ferguson,	1859
524	From Chincoteague Inlet to Lonesome Hill...........	1–20000	G. D. Wise,	1849
704	Chincoteague Bay and Inlet and part of Chincoteague Island..................	1–20000	N. S. Finney, G. D. Wise, J. L. Tilghman,	1857
890*b*	Map of boundary line.......	1–20000	C. T. Iardella,	1860
890*c*	Pocomoke River and part of boundary line...........	1–20000	C. T. Iardella,	1860

Chesapeake Bay, Eastern Shore.

Register No.	Locality.	Scale.	Topographer.	Date.
349	Pocomoke Sound, from Deep Creek to Pocomoke River..	1–20000	J. Seib,	1851
272	From Little Fox Island to Big Annemessex River....	1–20000	J. Seib, S. A. Wainwright, C. Junken,	1849 1851 1872
270	Deals Island to Big Annemessex River...............	1–20000	J. Seib, S. A. Wainwright,	1849
271	Smiths Island.............	1–20000	J. Seib, R. D. Cutts,	1849 1872
269	Bloodsworth and South Marsh Island..................	1–20000	J. Seib,	1849
268	Head of Tangier Sound, including Wicomico River ..	1–20000	J. Seib,	1849
528	Pocomoke Sound, vicinity of Apes Hole Creek..........	1–20000	S. A. Wainwright,	1851
265	Mouth of Honga River and Hooper Straits...........	1–20000	R. D. Cutts, J. Seib,	1848
266	Nanticoke River, from Chapters Point to Vienna......	1–20000	J. Seib, S. A. Wainwright,	1849
267	Fishing Bay and part of Nanticoke River..............	1–20000	J. Seib, S. A. Wainwright,	1849
255	Tar Bay and upper part of Honga River.............	1–20000	R. D. Cutts, J. Seib,	1848
451	Meekins Neck, Chesapeake Bay.....................	1–20000	H. L. Whiting,	1854
250	From Cooks Point to Meekins Neck, including Little Choptank River..........	1–20000	G. D. Wise,	1847
251	Sharps Island..............	1–20000	G. D. Wise,	1848
225	Choptank River, Cooks Point to Hambrook Point.......	1–20000	R. D. Cutts,	1847
253	Choptank River, from Hambrook Point to Cabin Creek,	1–20000	J. Seib, R. D. Cutts,	1848
254	Choptank River, from Cabin Creek to Wings Landing ..	1–20000	R. D. Cutts, J. Seib,	1848

Register No.	Locality.	Scale.	Topographer.	Date.
224	Vicinity of Wye Island, St. Michaels River, and Tred Avon Creek	1–20000	R. D. Cutts,	1847
215	From Wades Point to Tilghmans Island, including Poplar Island...............	1–20000	G. D. Wise,	1846–7
223	Chester River, Eastern Bay, Wye, and St. Michaels Rivers, and Broad Creek......	1–20000	R. D. Cutts,	1847
222	Eastern shore of Kent Island and Coxes Creek..........	1–20000	R. D. Cutts,	1847
181	Western shore of Kent Island from Lose Point to Kent Point, and location of base line.....................	1–10000	H. L. Whiting,	1844
200	Chester River, from its mouth to Piney Point............	1–20000	J. C. Neilson,	1846
2240	Mouth of Chester River......	1–10000	J. A. Flemer,	1896
2242	Mouth of Chester River......	1–10000	J. A. Flemer,	1896
199	From Swan Creek to Eastern Neck Inlet...............	1–20000	R. D. Cutts,	1846
201	Chester River, from Piney Point north.............	1–20000	J. C. Neilson,	1846
2241	Mouth of Chester River......	1–10000	J. A. Flemer,	1896
187	From Worton Point to Swan Point, including Pools Island..................	1–20000	R. D. Cutts,	1845
212	Chesapeake Bay, from Bush River to Turkey Point....	1–20000	G. D. Wise,	1845
279	Sassafras River, from Lloyds Creek to Swans Creek.....	1–20000	J. J. S. Hassler,	1846
469	Sassafras River, vicinity of Lloyds Creek and Sassafras Creek	1–20000	H. L. Whiting,	1854
788	South shore of Elk River, from Pond Creek to Cabin Johns Creek.............	1–20000	H. Adams,	1860
186	Elk River, Bohemia River, and Back Creek	1–20000	J. J. S. Hassler, H. L. Whiting,	1845 1855
170	From Ash Signal to Riggs Hill, including head of Elk River (interior)...........	1–20000	T. W. Werner,	1843
169	From Wilmington to Maryland boundary (interior)...	1–20000	T. W. Werner,	1843

Chesapeake Bay, Western Shore.

Register No.	Locality.	Scale.	Topographer.	Date.
458	Mouth of Potomac..........	1–20000	R. D. Cutts,	1849
257	From Cedar Point to Point on Point	1–20000	R. D. Cutts, J. Seib,	1856 1848
256	Mouth of Patuxent River....	1–20000	R. D. Cutts,	1848
2107	Hog Island, Patuxent River..	1–500	J. W. Donn,	1893

Register No.	Locality.	Scale.	Topographer.	Date.
812	Patuxent River, from St. Leonards Creek to Battle Creek	1–10000	H. Adams,	1860
813	Patuxent River, from Battle Creek to Swansons Creek..	1–10000	H. Adams,	1860
814	Patuxent River, from Swansons Creek to Black Swamp Creek	1–10000	H. Adams,	1859
815	Patuxent River, vicinity of Lower Marlboro	1–10000	H. Adams,	1859
388	Cove Point, western shore of Chesapeake	1–20000	J. Seib,	1852
281	From Parkers Creek to Cove Point	2–20000	J. J. S. Hassler,	1847
280	From Parkers Creek northward	1–20000	J. J. S. Hassler,	1847
198	From Saunders Point to Holland Point, including West River and Herring Bay....	1–20000	R. D. Cutts,	1846
249	South River	1–20000	G. D. Wise,	1847
248	Vicinity of South River......	1–20000	G. D. Wise, H. L. Whiting,	1847 1855
174	From Sandy Point to Thomas Point, including Mouth of Severn River	1–10000	F. H. Gerdes,	1844
1861	Bay Ridge, Tolly Point	1–5000	J. W. Donn,	1888
1857	Severn River, from Tolly Point to County Bridge....	1–10000	J. W. Donn,	1888
176	Severn River, and from Hasketts Point to Tolly Point,	1–10000	F. H. Gerdes,	1844
178	Severn River, lower part....	1–10000	G. D. Wise,	1844
1860	Naval Academy and Cemetery	1–5000	J. W. Donn,	1888–9
2232	Naval Academy grounds.....	1–10000	J. W. Donn,	1895–6
177	Severn River, upper part....	1–10000	G. D. Wise,	1844
175	From Sandy Point to Bodkin Point	1–10000	F. H. Gerdes,	1844
179	Magothy River	1–10000	F. H. Gerdes,	1845
221	Patapsco River (original work)	1–20000	G. D. Wise,	1847
218	Patapsco River, east side (duplicate)	1–20000	G. D. Wise,	1845–6
306	South shore of Patapsco River, from Gibsons Island to Smiths Cove	1–20000	J. B. Glück, H. L. Whiting,	1851 1855
220	Western shore of Patapsco River, from Bodkin Point to Ferry Point	1–10000	F. H. Gerdes,	1844
436	Patapsco Neck, from Bear Creek to North Point......	1–20000	H. L. Whiting,	1853
214	Back River	1–20000	G. D. Wise,	1846–7
450	From Back River to Middle River, including Harts, Millers, and Pools Islands....	1–20000	H. L. Whiting,	1854

Register No.	*Locality.*	*Scale.*	*Topographer.*	*Date.*
401	North shore of Patapsco River, from Colgate Creek to Bear Creek	1–20000	H. L. Whiting, A. Boschke,	1852
219	Eastern shore of Patapsco River, from North Point to Colgate Creek...........	1–20000	G. D. Wise,	1849
216	Baltimore City and Harbor..	1–10000	G. D. Wise,	1845
217*a*	Duplicate of 217...........	1–10000	G. D. Wise,	1845–6
2032	Steelton, Sparrows Point, Patapsco River...........	1–10000	J. W. Donn,	1891
983	South shore Patapsco River, Light Street Bridge to Swan Creek.............	1–10000	C. T. Iardella,	1865
1004	North shore of Patapsco River, Lazaretto Light to Bear Creek..............	1–10000	C. T. Iardella,	1866
1441*a*	Baltimore Harbor (sheet No. 1) from Hendersons Wharf to Pratt street...........	1–1800	J. W. Donn,	1876
1441*b*	Baltimore Harbor (sheet No. 2) from Fort McHenry to Hendersons Wharf	1–1800	J. W. Donn,	1876
1442	Baltimore Harbor (sheet No. 3) Lazaretto Light to Baltimore and Ohio ferry slip..	1–1800	J. W. Donn,	1876
1443*a*	Baltimore Harbor (sheet No. 4) Lazaretto Light to Ferry Point	1–3600	J. W. Donn,	1876
1443*b*	Baltimore Harbor (sheet No. 5) Vicinity of Ferry Point and Smiths Cove..........	1–3600	R. M. Bache, W. F. Downer, J. P. Bogart,	1875 1876 1877
929	Vicinity of Baltimore, west side.....................	1–10000	J. W. Donn,	1863
977	Vicinity of Baltimore, west side.....................	1–10000	C. T. Iardella,	1865
936	Vicinity of Baltimore, northwest side................	1–10000	C. M. Bache,	1863
955	Vicinity of Baltimore, northeast side	1–10000	C. T. Iardella,	1864
197	The intervening country between Bush River and Baltimore...............	1–20000	R. D. Cutts,	1846
213	Bush, Gunpowder, and Middle Rivers..................	1–20000	G. D. Wise,	1846–7
190	Swan Creek to Bush River..	1–20000	R. D. Cutts,	1845–6
188	From Havre de Grace to Spesutie Narrows............	1–10000	R. D. Cutts,	1845
189	Susquehanna River, including Havre de Grace and Port Deposit.................	1–10000	R. D. Cutts,	1845
185	Northeast River entrance, Chesapeake Bay	1–10000	J. J. S. Hassler,	1844–5
184	Head of Northeast River, Chesapeake Bay	1–10000	J. J. S. Hassler,	1844–5
212	Chesapeake Bay, from Bush River to Turkey Point	1–20000	G. D. Wise,	1845

Chesapeake Bay, Potomac River.

Register No.	*Locality.*	*Scale.*	*Topographer.*	*Date.*
776	St. Mary's River............	1-20000	H. Adams,	1858-9
804	St. Georges Island, St. Marys River....................	1-20000	H. Adams,	1859
1103	From St. Georges River to Higgins Point, including St. Clements Bay and Bretons Bay................	1-20000	J. W. Donn,	1868
1581	Potomac River, from Kingcopsico Point to Sandy Point, including Blakistone Island	1-20000	S. A. Wainwright,	1860
1105	Wicomico River and St. Catherines Sound and Island, with the shore line to Swan Point....................	1-20000	J. W. Donn,	1868
858	Potomac River, from Cob Point to Swan Point......	1-20000	C. Hosmer,	1862
859	Potomac River, from Swan Point to Lower Cedar Point....................	1-20000	J. Mechan,	1862
861	Potomac River, from Matomkin to Persimmon Point, including Port Tobacco River....................	1-20000	H. L. Whiting,	1862
862	Potomac River, vicinity of Nanjemoy Creek..........	1-20000	J. Mechan,	1862
863	Potomac River, from Smiths Point to Nanjemoy Creek,	1-20000	A. W. Longfellow,	1862
865	Potomac River, from Aquia Creek, and Smiths Point to Shipping Point	1-20000	C. Hosmer,	1862
866	Potomac River, from Budds Ferry to Indian Head	1-20000	A. W. Longfellow,	1862
875	Potomac River, from Indian Head to Fox Ferry........	1-20000	C. Hosmer,	1862
902	From Broad Creek to Oxen Creek	1-10000	A. M. Harrison,	1863
895	Vicinity of Rosiers Bluff....	1-5000	A. M. Harrison,	1862
925	Southeast portion of District of Columbia and adjacent country	1-15000	J. W. Donn,	1863
910*a*	Potomac River, from Jones Point to Little Falls Bridge	1-15000	C. H. Boyd, J. Hergesheimer,	1863 1874
910*b*	Site of United States naval magazine, near Marbury Point....................	1-1200	J. Hergesheimer,	1874
903	From Bladensburg to Leesboro, adjacent to District of Columbia	1-15000	C. Fergnson,	1863
1340	Potomac River, from Georgetown to Little Falls	1-2500	C. Junken,	1872
945	Tennallytown to Great Falls,	1-15000	J. W. Donn,	1864

Register No.	Locality.	Scale.	Topographer.	Date.
946	Tennallytown to Rockville..	1-15000	J. W. Donn, C. Rockwell,	1864
990	Potomac River, from Great Falls to Rushville........	1-10000	J. W. Donn, McL. W. Thomson,	1865
989	Potomac River, from Rushville to Youngs Ford	1-10000	J. W. Donn, McL. W. Thomson,	1865
988	Potomac River, from Youngs Ford to Whites Ferry	1-10000	J. W. Donn, McL. W. Thomson,	1865
987	Potomac River, from Whites Ferry to Masons Island No. 2....................	1-10000	McL. W. Thomson,	
986	Potomac River, from east end of Heters Island to Berlin,	1-10000	J. W. Donn, McL. W. Thomson,	1865
985	Potomac River, from Berlin to Harpers Ferry	1-10000	J. W. Donn, H. L. Marindin, McL. W. Thomson,	1865
1013	Potomac River, from Fort Duncan to High Knob....	1-10000	J. W. Donn,	1865-6
1014	Potomac River, from High Knob to Shepherdstown ..	1-10000	J. W. Donn,	1866
879	Vicinity of Williamsport (military survey)	1-20000	C. Hosmer, J. Meehan,	1862
1960	Defenses of Washington	1-31680	————	1863-4
1906	Vicinity of Harpers Ferry, Charlestown and Hagerstown...................	1-10000	H. F. Walling,	1881

HYDROGRAPHIC SHEETS WITHIN THE BOUNDARIES OF THE STATE OF MARYLAND.

ON FILE IN THE ARCHIVES OF THE U. S. COAST AND GEODETIC SURVEY, GEOGRAPHICALLY ARRANGED, GIVING NUMBER OF SHEET, LOCALITY OF SURVEY, SCALE, HYDROGRAPHER AND DATE.

Atlantic Coast.

Register No.	Locality.	Scale.	Hydrographer.	Date.
212	Indian River Inlet to State Line.....................	1-40000	S. P. Lee, U. S. N.,	1848
213	Ocean City to Sinepuxent Bay	1-40000	S. P. Lee, U. S. N.,	1849
251	North end Sinepuxent Bay to north end Assateague Bay,	1-40000	S. P. Lee, U. S. N.,	1848
1816	Inside waters, Miller Creek to Sinepuxent Bay........	1-20000	D. B. Wainwright,	1887
1455*b*	Chincoteague Bay, upper part	1-20000	E. P. Lull, U. S. N., D. B. Wainwright,	1880 1887
1455*a*	Chincoteague Bay, lower part	1-20000	D. B. Wainwright,	1887

Chesapeake Bay, Eastern Shore.

NOTE.—Sheets checked thus "*" are also contiguous to the Western Shore of Chesapeake Bay.

Register No.	*Locality.*	*Scale.*	*Hydrographer.*	*Date.*
515	Chesapeake Bay, east shore, Pocomoke Sound	1–40000	J. J. Almy, U. S. N.,	1855
1004	Chesapeake Bay, east shore, Pocomoke River, entrance to Taylor	1–10000	W. W. Harding,	1869
1022*a*	Chesapeake Bay, east shore, Pocomoke River, Taylors to Leaning Pine	1–5000	W. W. Harding,	1869
1022*b*	Chesapeake Bay, east shore, Pocomoke River, Leaning Pine to Ilsleys House	1–5000	W. W. Harding,	1869
1023*a*	Chesapeake Bay, east shore, Pocomoke River, Ilsleys House to Longs House....	1–5000	W. W. Harding,	1869
1023*b*	Chesapeake Bay, east shore, Pocomoke River, Longs House to Double	1–5000	W. W. Harding,	1869
1024*a*	Chesapeake Bay, east shore, Pocomoke River, Double to Mattapony	1–5000	W. W. Harding,	1869
1024*b*	Chesapeake Bay, east shore, Pocomoke River, Mattapony to Broad Creek......	1–5000	W. W. Harding,	1869
1024*c*	Chesapeake Bay, east shore, Pocomoke River, Broad Creek to Snow Hill	1–5000	W. W. Harding,	1869
557	Chesapeake Bay, east shore, Tangier Sound, Watts Island Light to Clay Island Light	1–40000	J. J. Almy, U. S. N.,	1856
1441*a*	Chesapeake Bay, Oyster Beds, Tangier Sound	1–40000	F. Winslow, U. S. N.,	1879
1441*b*	Chesapeake Bay, Oyster Beds, Tangier Sound	1–40000	F. Winslow, U. S. N.,	1879
1447*a*	Chesapeake Bay, Oyster Beds, Tangier Sound	1–40000	F. Winslow, U. S. N.,	1878
1447*b*	Chesapeake Bay, Oyster Beds, Tangier Sound	1–40000	F. Winslow, U. S. N.,	1878
985	Chesapeake Bay, east shore, Little Annemessex River, Crisfield Harbor..........	1–10000	W. W. Harding,	1868–9
997	Chesapeake Bay, east shore, Tangier Sound, vicinity of Smith, Goose and Fox Islands..................	1–20000	W. W. Harding,	1869
*211	Chesapeake Bay, east shore, south end Smith Island to Billy Island, and west shore, Smith Point to Point No Point....................	1–20000	S. P. Lee, U. S. N.,	1849

Register No.	*Locality.*	*Scale.*	*Topographer.*	*Date.*
707	Chesapeake Bay, east shore, Little Annemessex River, Big Annemessex River, Manokin River, Monie Bay, Wicomico River, and Ellis Bay......................	1–20000	W. T. Muse, U. S. N.,	1858–9
673	Chesapeake Bay, east shore, Nanticoke River and Fishing Bay.................	1–20000	S. P. Lee, U. S. N.,	1858
*209	Chesapeake Bay, east shore, Billy Island to Meekins Neck, and west shore, Point No Point to Cove Point Light....................	1–20000	S. P. Lee, U. S. N.,	1848
*199	Chesapeake Bay, east shore, Meekins Neck to Tilghman Island and Cove Point Light to latitude 38° 40′........	1–20000	W. P. McArthur, U. S. N.,	1848
200	Chesapeake Bay, east shore, Little Choptank River or Hudson River...........	1–20000	W. P. McArthur, U. S. N.,	1848
201	Chesapeake Bay, east shore, Choptank River entrance..	1–20000	W. P. McArthur, U. S. N.,	1848
1346*a*	Chesapeake Bay, east shore, Choptank River and tributaries, Jenkins, Secretary, and Cabin Creeks.........	1–10000	W. W. Harding,	1871
1346*b*	Chesapeake Bay, east shore, Little Choptank River and tributaries...............	1–10000	W. W. Harding,	1871
1346*c*	Calvert Bay, Jerome Creek, &c......................	1–10000	W. W. Harding,	1871
202	Chesapeake Bay, east shore, Choptank Light to Wing Landing, Tred Avon Creek and tributaries...........	1–40000	R. Bache, U. S. N.,	1848
1048	Chesapeake Bay, east shore Choptank River, Wing Landing to Denton.......	1–10000	W. W. Harding,	1870
1049*a*	Chesapeake Bay, east shore, Tred Avon Creek and tributaries..................	1–10000	W. W. Harding,	1870
1049*b*	Chesapeake Bay, east shore, Harris, Porters, and Broad Creeks..................	1–10000	W. W. Harding,	1870
*188	Chesapeake Bay, east shore, Tilghman Island to latitude 38° 54′; west shore, latitude 38° 40′ to South River....................	1–20000	S. P. Lee, U. S. N.,	1846
177	Chesapeake Bay, east shore, Eastern Bay, Wye and Miles Rivers	1–20000	W. P. McArthur, U. S. N., W. W. Harding,	1847 1870
1050*a*	Chesapeake Bay, east shore, Wye River and tributaries,	1–10000	W. W. Harding,	1870

Register No.	Locality.	Scale.	Topographer.	Date.
1050*b*	Chesapeake Bay, east shore, St. Michael River and tributaries	1-10000	W. W. Harding,	1870
*167	Chesapeake Bay, east shore, latitude 38° 54′ to latitude 39° 00′ west shore, Thomas Point to Sandy River	1-20000	G. M. Bache, U. S. N.,	1844
174	Chesapeake Bay, east shore, Chester River, entrance to Chestertown	1-20000	W. P. McArthur, U. S. N.,	1846
1078	Chesapeake Bay, east shore, Chester River, Langford Creek	1-10000	W. W. Harding,	1870
1026*a*	Chesapeake Bay, east shore, Chester River, Chestertown to Possum Point	1-5000	W. W. Harding,	1869
1026*b*	Chesapeake Bay, east shore, Chester shore, Morgan Creek Bridge to head of navigation	1-5000	W. W. Harding,	1870
1027	Chesapeake Bay, east shore, Possum Point to Crumpton,	1-5000	W. W. Harding,	1869
*166	Chesapeake Bay, east shore, north end of Kent Island, Fairlee Creek; west shore, Sandy Point to Robbins Point	1-20000	G. M. Bache, U. S. N.	1845
175	Chesapeake Bay, east shore, Chester River mouth	1-20000	W. P. McArthur, U. S. N.,	1847
*187	Chesapeake Bay, east shore, Fairlee Creek to Howell Point; west shore, Robbins Point to Old Womans Gut,	1-10000	S. P. Lee, U. S. N.,	1846
1072	Chesapeake Bay, east shore, Fairlee Churn, Stillpond, and Lloyd Creeks	1-10000	W. W. Harding,	1870
*186	Chesapeake Bay, east shore, Howell Point to Turkey Point; west shore, Old Womans Gut to Sandy Point	1-10000	S. P. Lee, U. S. N.,	1846
176	Chesapeake Bay, east shore, Sassafras River, Grove Point to Wilsons Wharf ..	1-20000	W. P. McArthur, U. S. N.,	1847
1071	Chesapeake Bay, east shore, Sassafras River, Wilsons Wharf to head and tributary	1-10000	W. W. Harding,	1870
172	Chesapeake Bay, east shore, to Elk River, Turkey Point, Elk Landing	1-10000	W. P. McArthur, U. S. N.,	1846
170	Chesapeake Bay, east shore, Bohemia River and Back Creek	1-10000	W. P. McArthur, U. S. N.,	1846

Register No.	Locality.	Scale.	Topographer.	Date.
*185	Chesapeake Bay head, Turkey Point to Havre de Grace...	1–10000	S. P. Lee, U. S. N.,	1846
173	Chesapeake Bay head, Northeast River................	1–10000	W. P. McArthur, U. S. N.,	1846
*898	Chesapeake Bay head, Susquehanna River, Spesutie Island to Havre de Grace..	1–10000	F. P. Webber,	1872
*168	Chesapeake Bay head, Susquehanna River, Havre de Grace Light to Silver Island	1–10000	W. P. McArthur, U. S. N.,	1846
*326	Chesapeake Bay head, Susquehanna River, Havre de Grace Light to Silver Island	1–10000	W. P. McArthur, U. S. N.,	1846

Chesapeake Bay, Western Shore.

Register No.	Locality.	Scale.	Hydrographer.	Date.
1072	Chesapeake Bay, west shore, Romney Creek............	1–10000	W. W. Harding,	1870
169	Chesapeake Bay, west shore, Gunpowder, Middle, and Back Rivers..............	1–20000	W. P. McArthur, U. S. N.,	1846
165	Chesapeake Bay, west shore, Patapsco River and Baltimore Harbor..............	1–10000	G. M. Bache, U. S. N.,	1845
339	Chesapeake Bay, west shore, Patapsco River, Sparrows Point to Leading Point....	1–10000	C. H. McBlair, U. S. N.,	1852
415	Chesapeake Bay, west shore, Patapsco River entrance..	1–20000	R. Wainwright, U. S. N.,	1854
469	Chesapeake Bay, west shore, Patapsco River, Belvidere Shoal and Swash Channel..	1–20000	A. Boschke,	1852
913	Chesapeake Bay, west shore, Patapsco River mouth.....	1–20000	F. P. Webber,	1866
914	Chesapeake Bay, west shore, Patapsco River, Brewerton Channel..................	1–10000	F. P. Webber,	1866
915	Chesapeake Bay, west shore, Patapsco River, Brewerton Channel, lower part.......	1–10000	F. P. Webber,	1866
2067	Chesapeake Bay, west shore, Patapsco River, Sparrows Point and vicinity........	1–10000	J. W. Donn,	1891
1007	Chesapeake Bay, west shore, Patapsco River, tributary creeks	1–20000	J. W. Donn,	1869
1451	Chesapeake Bay, west shore, Patapsco River, Lazaretto Point to Hawkins Point...	1–10000	C. Junken,	1880
1448	Chesapeake Bay, west shore, Baltimore Harbor, Henderson Wharf to head of basin,	1–1800	J. W. Donn,	1876

Register No.	Locality.	Scale.	Topographer.	Date.
1449*a*	Chesapeake Bay, west shore, Baltimore Harbor, Fort McHenry to Henderson Wharf..................	1–1800	J. W. Donn,	1876
1450*a*	Chesapeake Bay, west shore, Baltimore Harbor, Lazaretto Point to Ferry Point Bridge..................	1–3600	J. W. Donn,	1876
1450*b*	Chesapeake Bay, west shore, Baltimore Harbor, Ferry Point Bridge to head of Spring Garden...........	1–3600	J. W. Donn,	1877
164	Chesapeake Bay, west shore, Magothy River...........	1–10000	G. M. Bache, U. S. N.,	1845
1842	Chesapeake Bay, west shore, Annapolis Harbor.........	1–10000	M. L. Wood,	1888
1077*a*	Chesapeake Bay, west shore, Severn and South Rivers, tributaries...............	1–10000	W. W. Harding,	1870
1077*b*	Chesapeake Bay, west shore, Severn River above Round Bay......................	1–10000	W. W. Harding,	1870
210	Chesapeake Bay, west shore, Patuxent River mouth to Setterly Point............	1–20000	S. P. Lee, U. S. N.,	1848
641	Chesapeake Bay, west shore, Patuxent River, Setterly Point to God Point........	1–20000	W. T. Muse, U. S. N.,	1857
704	Chesapeake Bay, west shore, Patuxent River, Holland Point to Jones Point......	1–20000	W. T. Muse, U. S. N.,	1859

Chesapeake Bay, Potomac River.

Register No.	Locality.	Scale.	Hydrographer.	Date.
701	Chesapeake Bay, Potomac River, Cornfield Point to Piney Point.............	1–20000	W. T. Muse, U. S. N.,	1859–60
640	Chesapeake Bay, Potomac River, St. Marys River, Cornfield Point to St. Marys City.....................	1–21408	W. T. Muse. U. S. N.,	1857
695	Chesapeake Bay, Potomac River, St. Marys River, Kit Point to head of navigation....................	1–20000	W. T. Muse, U. S. N.,	1859
793	Chesapeake Bay, Potomac River, Piney Point to Blakistone Island....	1–20000	W. T. Muse, U. S. N.,	1860
827	Chesapeake Bay, Potomac River, Blakistone Island to Cobb Point.......	1–20000	T. S. Phelps, U. S. N.,	1862
969	Potomac River, Wicomico River, Saint Clements and Bretons Bays and Saint Georges River............	1–20000	W. T. Muse, U. S. N., J. W. Donn,	1860 1868

Register No.	Locality.	Scale.	Topographer.	Date.
778	Chesapeake Bay, Potomac River, Cobb Point to Mathias Point............	1–20000	T. S. Phelps, U. S. N.,	1862
738	Chesapeake Bay, Potomac River, Lower Cedar Point and Mathias Point........	1–10000	W. R. Palmer, U. S. A.,	1861
813	Chesapeake Bay, Potomac River, Mathias Point to Matomkin Point and Port Tobacco River............	1–20000	E. S. Phelps, U. S. N.,	1862
812	Chesapeake Bay, Potomac River, Matomkin Point to Shipping Point............	1–20000	E. S. Phelps, U. S. N.,	1862
814	Chesapeake Bay, Potomac River, Shipping Point to Hallowing Point	1–20000	E. S. Phelps, U. S. N.,	1862–3
815	Chesapeake Bay, Potomac River, Hallowing Point to Fort Washington	1–20000	E. S. Phelps, U. S. N.,	1863
816	Chesapeake Bay, Potomac River, Fort Washington to Alexandria	1–10000	E. S. Phelps, U. S. N.,	1863
766	Chesapeake Bay, Potomac River, Alexandria to Hunter Point....................	1–10000	C. P. Patterson,	1862
864	Chesapeake Bay, Potomac River, Anacostia River, Bennings Bridge, to Bladensburg	1–5000	A. Balbach,	1865
1367*a*	Chesapeake Bay and estuaries, densities of waters..	1–80000	F. Collins, U. S. N.,	1877
1367*b*	Chesapeake Bay and estuaries, densities of waters..	1–80000	F. Collins, U. S. N.,	1877
1367*c*	Chesapeake Bay and estuaries, densities of waters..	1–80000	F. Collins, U. S. N.,	1877
1319	Boundary line between Maryland and Virginia (not a hydrographic sheet)	1–80000	W. J. Twining and U. S. Engineers.	1877

LIST OF CHARTS IN THE STATE OF MARYLAND.[1]

Cat. No.	TITLE.	STATE.	Class.	SCALE. Proportional.	SCALE. Inch to St. M.	Size of Border.	Date of 1st and last Edition	Price.
128	Isle of Wight to Chincoteague Inlet	Md. & Va.	F	$\frac{1}{80\,000}$	0.79	30″x33″	1866 / 1890	$0.50
133	Chesapeake Bay, Pocomoke Sd. to Potomac R	" "	F	$\frac{1}{80\,000}$	0.79	25 x38	1863 / 1877	.50
134	Chesapeake Bay, Potomac R. to Choptank R	Maryland	F	$\frac{1}{80\,000}$	0.79	29 x38	1863 / 1896	.50
135	Chesapeake Bay, Choptank R. to Magothy R.	"	F	$\frac{1}{80\,000}$	0.79	29 x38	1863 / 1895	.50
136	Chesapeake Bay, Magothy R. to Head of Bay	"	F	$\frac{1}{80\,000}$	0.79	29 x38	1863 / 1877	.50
383	Mouth of Chester River ..	"	F	$\frac{1}{40\,000}$	1.58	14 x17	1849	.25
384	Baltimore Harbor and approaches with sub-charts of the Basin and Sparrows Point on scale $\frac{1}{10\,000}$	"	F	$\frac{1}{40\,000}$	1.58	27 x39	1882 / 1895	.50
385	Annapolis Harbor	"	L	$\frac{1}{10\,000}$	6.34	30 x32	1889	.50
386	Patuxent R. (lower part)..	"	F	$\frac{1}{60\,000}$	1.06	19 x22	1859 / 1880	.20
387	Patuxent R., Pt. Judith to Nottingham	"	F	$\frac{1}{30\,000}$	2.11	19 x22	1860 / 1881	.20
388	Potomac R., Entrance to Piney Pt	Md. & Va.	F	$\frac{1}{60\,000}$	1.06	23 x30	1868 / 1877	.40
389	Potomac R., Piney Pt. to Lower Cedar Pt	" "	F	$\frac{1}{60\,000}$	1.06	23 x29	1868 / 1877	.40
390	Potomac R., Lower Cedar Pt. to Indian Head	" "	F	$\frac{1}{60\,000}$	1.06	23 x29	1862 / 1882	.40
391	Potomac R., from Indian Head to Georgetown....	" "	F	$\frac{1}{40\,000}$	1.58	23 x39	1862 / 1896	.40
376[2]	Delaware and Chesapeake Bays		F	$\frac{1}{400\,000}$	0.16	26 x34	1855 / 1892	.50

[1] Very few of the topographic and hydrographic field sheets are published, but the data which they contain are combined so as to form Charts on different scales. These Charts can be obtained at the prices given by addressing *The State Geologist, Baltimore, Md.*, or *The Superintendent U. S. Coast and Geodetic Survey, Washington, D. C.*, or from local agents. The position of the Charts is shown upon the accompanying map.

[2] This Chart includes the area covered by all of the others.

PART III

OUTLINE OF PRESENT KNOWLEDGE OF

THE PHYSICAL FEATURES OF MARYLAND

EMBRACING AN ACCOUNT OF THE

PHYSIOGRAPHY, GEOLOGY AND MINERAL RESOURCES

BY

WM. BULLOCK CLARK

OUTLINE OF PRESENT KNOWLEDGE OF

THE PHYSICAL FEATURES OF MARYLAND,

EMBRACING AN ACCOUNT OF THE

PHYSIOGRAPHY, GEOLOGY AND MINERAL RESOURCES.

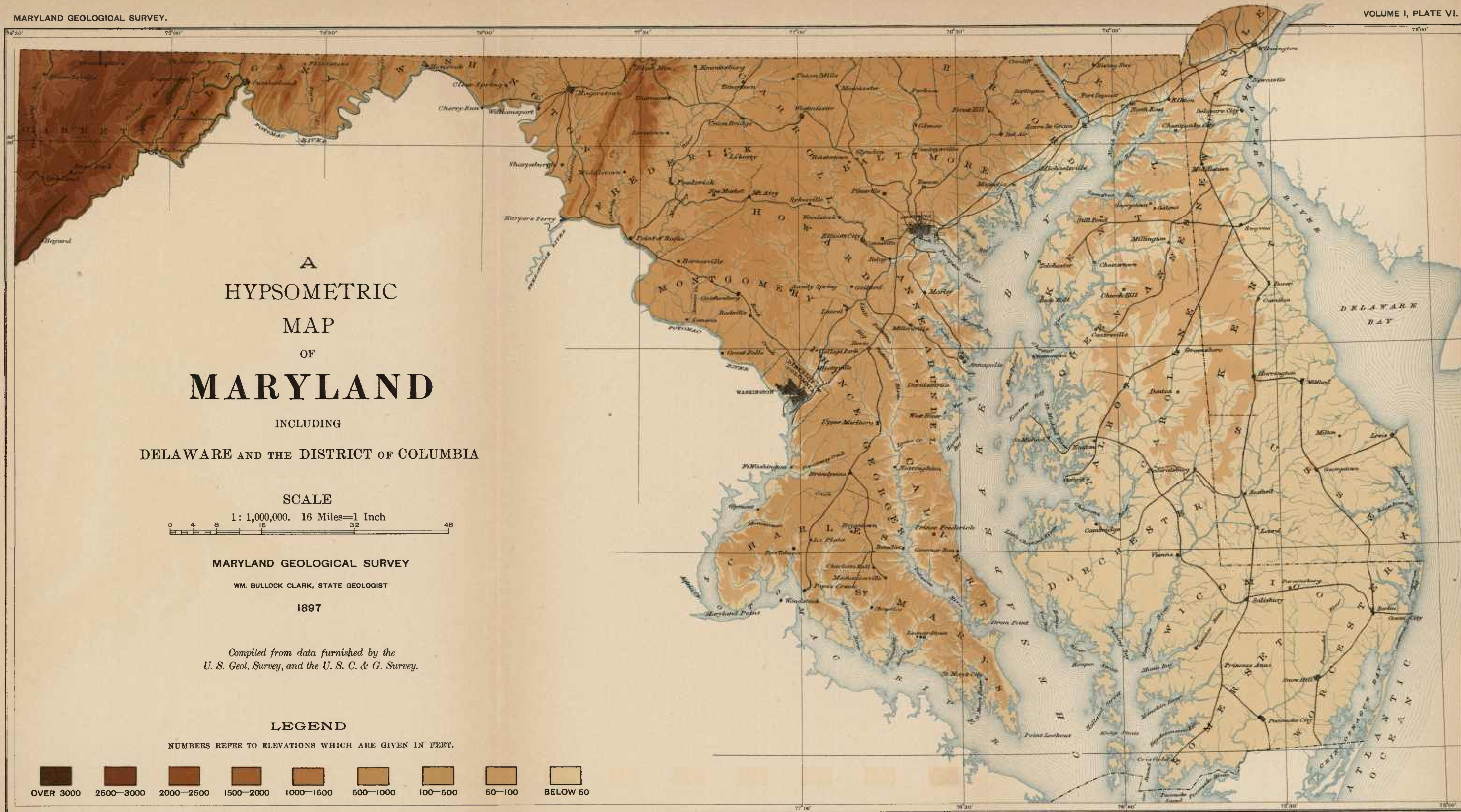
The present account of the physical features and natural resources of Maryland should be regarded solely in the light of a preliminary statement. While certain parts of the state have in later years received detailed investigation, there are many portions which are as yet but imperfectly known and some which have never been examined at all. Still, on the basis of this somewhat unequal knowledge, it seems desirable to prepare a brief general account at the present time, a more detailed treatment being accorded to each subject as investigation proceeds.

In the succeeding chapters the chief facts concerning the physical features of Maryland will be considered, but in order that this information may be placed in proper setting, a few preliminary remarks regarding the geographical position and political divisions of the state are necessary. Maryland is situated between the parallels of 37° 53′ and 39° 44′ north latitude, and the meridians of 75° 04′ and 79° 33′+ west longitude, the exact western boundary being yet undetermined. Its boundaries are: Mason and Dixon's line, separating it from Pennsylvania on the north; the state of Delaware and the Atlantic Ocean on the east; on the south Virginia and West Virginia, separated by a line drawn from the ocean to the western bank of the Potomac river, and thence following the western bank of that river to its source; and on the west, West Virginia, separated by a line drawn due north from this source to Mason and Dixon's line. The gross area of the state is 12,210 square miles, of which 9860 square miles are land surface; the included portions of Chesapeake Bay, 1203 square miles; Chincoteague Bay on the Atlantic coast, 93 square miles, and 1054 square miles of smaller estuaries and rivers.

Maryland is divided into twenty-three counties, of which Garrett, Allegany and Washington form the mountainous region known as Western Maryland; Frederick, Carroll, Baltimore, Harford, Cecil, Howard and Montgomery the Piedmont area, which is also referred to under the name of Northern-Central Maryland; Anne Arundel, Prince George's, Calvert, Charles and St. Mary's, commonly called Southern Maryland; and Kent, Queen Anne's, Talbot, Caroline, Dorchester, Wicomico, Somerset and Worcester, known as Eastern Maryland. Of these twenty-three counties there are but seven that do not lie upon navigable waters.

The physical features of a country to no inconsiderable degree determine the pursuits of its inhabitants, and these indirectly affect their social, political and financial welfare. The residents of mountainous districts have their peculiar occupations, while those of the low lands find their employment in other ways. In regions bordering the sea or inland bodies of water still other means of livelihood are sought by the people. The character of the soil and its adaptability to particular crops become also important factors, while the underlying rocks, not only by their influence upon the conditions of life already described, but also by their inherent wealth in mineral resources, still further influence the well-being of the community. It becomes important, therefore, to know something of the physical features of a country, or a state, if one would understand its past history or indicate the lines of future prosperity.

When we come to examine the physical features of the state of Maryland we find the greatest diversity in surface configuration and mineral contents. From its eastern to its western borders may be found a succession of districts suitable from their physical surroundings for the most diverse employments. Maryland possesses portions of all the characteristic divisions of the eastern United States, and there is no state in the country which has a greater variety in its natural surroundings.



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In the succeeding pages the Physical Features of Maryland will be considered under the three following headings, viz., Physiography, Geology, and Mineral Resources.

PHYSIOGRAPHY.

The state of Maryland in its physiographic features is closely related to the states which lie to the north and south of it. It is part of the eastern border region which stretches from the Atlantic coast-line to the crest of the Alleghanies and from its central situation affords, perhaps, the most characteristic section of this broad belt. The country rises from the sea level at first gradually and then more rapidly until it culminates in the high lands of the western portion of the state. It has been divided throughout the middle Atlantic slope into three physiographic areas known respectively as the Coastal Plain, the Piedmont Plateau and the Appalachian Region. Before taking up the more detailed description of the Maryland area a brief characterization of the three leading physiographic divisions will be given.

The Coastal Plain as a continuous tract begins in New Jersey on the south shore of the Raritan Bay, where it has a width of from fifteen to twenty miles, and extends thence southward, constantly broadening, until in Georgia it reaches nearly one hundred and fifty miles. North of New Jersey it is continued in the islands along the New England coast (the largest being Long Island, Martha's Vineyard and Nantucket) as well as in the narrow strip of main land which forms the southeastern portion of the state of Massachusetts. The Coastal Plain is characterized by broad, level stretches of slight elevation, which are cut by the larger rivers that flow across the area from the Piedmont Plateau, and the smaller streams that have their sources within the low land itself. Most of the streams have sluggish currents and the drainage of the land is imperfect. Throughout, the country is deeply indented with tidal estuaries and bays, the heads of which commonly reach quite to the border of the Piedmont

Plateau, and often admit throughout their entire length of the entrance of the largest ocean-going vessels. The deeper channels are generally the continuation of the leading rivers, which suddenly change in character as they enter the Coastal Plain with great loss in the velocity of their currents. All of the large streams and many of the smaller ones as they cross the western margin of the Coastal Plain are characterized by a marked decrease in the velocity of their currents and at times by falls or rapids, the name "fall-line" being given to this boundary on that account. The inland border of the Coastal Plain thus marks the head of navigation and has likewise conditioned from the earliest times the leading highways of trade which connect the north and south. Along this line have grown up the larger cities of the Atlantic seaboard, Trenton, Philadelphia, Baltimore, Washington, Richmond, Petersburg, Columbia, Augusta, and other less populous towns.

The Piedmont Plateau, which borders the Coastal Plain upon the west and extends thence to the foot of the Appalachian Mountains, is less clearly defined in the northern portion of the country than along the middle and southern Atlantic slope. It broadens from New York southward, reaching its greatest width of three hundred miles in North Carolina. The Piedmont Plateau is a region of somewhat greater elevation than the Coastal Plain which borders it upon the east, but stands in marked contrast to the high ranges of the Appalachian Region upon the west. It is characterized by a broken, hilly country with undulating surface, but with few mountains of conspicuous altitude or great extent. The region is crossed by numerous rivers which have their rise in the high mountains to the west, while many smaller streams and tributaries have their sources within the area. The streams flow with rapid currents and the country is everywhere well drained as compared with the low lands of the east.

The Appalachian Region is an area of high land which extends almost continuously from Cape Gaspé in Canada southward to Alabama, a distance of 1300 miles, and throughout most of that distance forms the divide between the streams which flow directly to the east across the Piedmont Plateau and the Coastal Plain into the Atlantic

Ocean, and those which find their outlet by less direct courses through the St. Lawrence and Mississippi basins. South of New York the Appalachian Region is divided into three more or less clearly defined districts. The eastern district is composed of ranges of mountains known in Pennsylvania by the name of the South Mountains, but in Maryland, Virginia and North Carolina commonly by the name of the Blue Ridge. South of Virginia this eastern belt increases in width, and in North Carolina contains the most lofty points in the whole Appalachian system. Along the western border of the Blue Ridge district lies the Great Valley, which in Pennsylvania is about ten miles in width but which broadens southward, attaining in Virginia for a distance of 300 miles a nearly uniform width of twenty miles. It forms one of the richest agricultural belts within the Appalachian Region. The central district is known as the Appalachian Region proper, and is characterized by parallel even-topped ranges throughout the whole length of the mountainous area. The continuity of these ranges is frequently interrupted, and sharp ridges and deep valleys everywhere abound. The western district is characterized by undulating ranges which rise from a high plateau that gradually decreases in elevation westward until it merges imperceptibly into the rolling country of the Mississippi Valley. Along the eastern side of this western district are the Alleghany Mountains, in which the parallel ridges so characteristic of the whole Appalachian Region are preserved. The streams everywhere flow with rapid currents and are extremely variable in the volume of water which they carry.

Let us now turn our attention to a consideration of the Maryland area the three regions of which have been above outlined, viz., the Coastal Plain, the Piedmont Plateau and the Appalachian Region. All are typically represented within the area of the state of Maryland and have conditioned to a marked extent its economic development.

The Coastal Plain.

The Coastal Plain embraces the eastern portion of Maryland and includes the area between the Atlantic Ocean on the east and a line passing northeast to southwest from Wilmington to Washington through Baltimore upon the west. This region comprises very nearly 5000 square miles, or somewhat over one-half of the land area of the state, and is about 100 miles broad in its widest part.

The Coastal Plain is formed, for the most part, of level areas of low land which extend with gradually increasing elevation from the coastal border, where the whole surface stands very nearly at sea-level to heights of three hundred feet and more along its western edge. The region is cut quite to the border of the Piedmont Plateau by tidal estuaries, and the topography becomes more and more pronounced in passing inland from the coast. The Chesapeake Bay extends nearly across its full length from south to north, while the larger rivers and their tributaries deeply indent the country in all directions, making the coast-line of Maryland one of the longest in the country. The drainage of the region, except near the margin of the Coastal Plain, and in some of the larger rivers which rise without the area, is consequent upon the present surface of the land, but has been considerably modified by oscillations in level. These oscillations have left the lower courses of the streams submerged, producing the Chesapeake Bay and the other tidal estuaries of the state.

The Coastal Plain in Maryland may be divided into a lower eastern and a higher western division, separated by the Chesapeake Bay. The former is known under the name of Eastern Maryland (or Eastern Shore), while the latter is commonly referred to as Southern Maryland.

The *eastern division* includes the counties of Worcester, Somerset, Dorchester, Caroline, Talbot, Queen Anne's, Kent and part of Cecil. To this region most of the state of Delaware properly belongs. Nowhere, except in the extreme north, does the country reach 100 feet in elevation, while most of it is below 25 feet in height. Both on the Atlantic coast and more especially upon the shores of the Chesapeake Bay it is deeply indented by bays and estuaries. The Atlantic coast especially shows very strikingly the result of sand-bar construction and the lagoons and inlets which are formed in consequence of it. The Chincoteague Bay is one of the most characteristic lagoons of this type on the Atlantic coast. The drainage of the region is

VIEW SHOWING ESTUARY OF THE CHESAPEAKE BAY, NEAR QUEENSTOWN.

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simple, the streams flowing from the watershed directly to the Atlantic Ocean and Delaware Bay upon the east, and to the Chesapeake Bay upon the west. The position of the watershed along the extreme eastern margin of the area is very striking; in Worcester county for much of the distance it is only a few miles distant from the Atlantic shore, and as a result the streams which flow to the east are small in comparison to those which drain toward the west. Among the most important rivers which reach the Chesapeake Bay from this area are the Pocomoke, Nanticoke, Choptank and Chester, which all have their headwaters within the state of Delaware and flow in a general southwest direction with sinuous channels.

The *western division* includes the counties of St. Mary's, Calvert, Charles, Prince George's, Anne Arundel, and portions of Baltimore, Harford and Cecil. In elevation this region stands in striking contrast to the eastern division, since it frequently has an altitude of 100 feet even along its eastern margin. In lower St. Mary's county the land reaches an elevation of 100 feet on the Bay shore, which is gradually increased westward, until, near the border of Charles county, it slightly exceeds 180 feet. In southern Calvert county an elevation of 140 feet is found to the west of Cove Point and this gradually increases to the northward and northwestward until near the southern border of Anne Arundel county the land rises above 180 feet. Throughout the western portion of this division in Charles, Prince George's and Anne Arundel counties the land gradually increases in height toward the border, reaching 280 feet to the east of Washington and very nearly the same elevation in the area to the south of Baltimore. Outlying patches of the Coastal Plain, as determined by their geological characteristics, are found at still higher elevations. This western division is traversed by several rivers which flow from the Piedmont Plateau, among the more important being the Potomac, Patuxent, Patapsco, Gunpowder and Susquehanna. The course of the Potomac is especially striking. After flowing in a nearly southeast direction across the hard rocks of the Piedmont Plateau, it is apparently abruptly turned aside by the soft materials of the Coastal Plain, and takes a course for forty miles nearly at right angles to that which it formerly held. It turns again by a long sweep to the southeast and flows in that direction to the Chesapeake Bay. The local drainage of the western division possesses the characteristics which have already been described for the eastern section, in that the streams throughout Southern Maryland flow chiefly to the westward. For example, the watershed of the country lying between the Chesapeake Bay and the Patuxent river is situated but a slight distance from the shores of the former, so that most of the natural drainage of Calvert county reaches the Patuxent river. A still more striking exhibition of this is seen in St. Mary's, Charles and Prince George's counties, where the streams nearly all flow to the Potomac river, the watershed of the region approaching very close to the valley of the Patuxent. The same peculiarity in the drainage is found to the southward in Virginia and the Carolinas.

The Piedmont Plateau.

The Piedmont Plateau borders the Coastal Plain upon the west and extends to the base of the Catoctin Mountain. It includes approximately 2500 square miles, or somewhat over one-quarter of the land area of the state. It is about 65 miles in width in the northern portion of the region, but gradually narrows toward the south until it becomes somewhat less than 40 miles broad. It includes all, or the greater part, of Montgomery, Howard, Baltimore, Harford, Carroll and Frederick counties. The region is broken by low undulating hills which gradually increase in elevation from its eastern margin until they culminate near the central portion of the area in Parr's Ridge. This ridge divides the district into an eastern and a western division, the latter gradually sloping into the Frederick Valley. The major drainage of the area shows but little relation to the underlying rocks, but gives evidence of having been superimposed through a cover of sedimentary materials which may have been the westward extension of the present Coastal Plain, although more recent adjustments to the underlying rocks have taken place.

The *eastern division* of the Piedmont Plateau has, on account of its varied crystalline rocks and their complicated structure, a highly

THE FALLS OF THE POTOMAC.

diversified topography. Along the eastern margin the land attains at several points heights exceeding 400 feet; while at Catonsville it reaches 525 feet above sea-level. Toward the west and northwest the land gradually increases until it culminates in Parr's Ridge, which exceeds 850 feet in Carroll county. The drainage of the eastern division is mainly to the east and southeast. On its northern and southern borders it is traversed by the Susquehanna and Potomac rivers, which have their sources without the area, while the smaller streams which lie between them drain directly to the Chesapeake Bay or into the main rivers. Among the most important of these intermediate streams are the Gunpowder, Patapsco and Patuxent rivers, whose headwaters are situated upon Parr's Ridge. The Patapsco flows in a deep rocky gorge until it reaches the Relay, where it debouches into the Coastal Plain. All of these streams have rapid currents as far as the eastern border of the Piedmont Plateau, and even in the case of the largest are not navigable. The broad, fertile limestone valleys to which the present drainage has become partially adjusted are a striking feature of this area and are well represented to the north of Baltimore in the Green Spring and Dulaney's valleys. On account of the complicated character of the stratigraphy, which will be later discussed, the valleys take different directions and are of very variable form and extent.

The *western division* extends from Parr's Ridge to the Catoctin Mountain. Along its western side is the broad limestone valley in which Frederick is situated and through which flows the Monocacy river from north to south, entering the Potomac river at the border line between Montgomery and Frederick counties. The valley near Frederick has an elevation of 250 feet above tide, which increases slowly to the eastward toward Parr's Ridge and very rapidly to the westward toward the Catoctin Mountain. Situated on the eastern side of the valley, just at the mouth of the Monocacy river and breaking the regularity of the surface outline, is Sugar Loaf Mountain, which rises rapidly from the surrounding plain to a height of 1250 feet. With the exception of a few streams which flow into the Potomac directly, the entire drainage of the western district is accomplished by the Monocacy river and its numerous tributaries, the latter flowing in nearly parallel west and east courses from Parr's Ridge and the Catoctin Mountain. The deeper portions of the valley are considerably to the west of the centre of the district, and as a result the streams upon the east are longer and of greater volume than those upon the west. The water-ways at a distance from the main valley flow in marked channels, which are frequently deeply cut in the land.

The Appalachian Region.

The Appalachian Region borders the Piedmont Plateau upon the west and extends to the western limits of the state. It comprises about 2000 square miles, or somewhat less than one-fourth of the area of the state and has a width of about 115 miles from east to west. It includes the western portion of Frederick and all of Washington, Allegany and Garrett counties. This region consists of a series of parallel mountain ranges with deep valleys which are cut, nearly at right angles, throughout much of the distance, by the Potomac river. Many of the ranges exceed 2000 feet, while some reach 3000 feet and more in the western portion of the mountainous area. The country illustrates in an exceptional manner the type of adjusted drainage. The Appalachian Region is divided into three distinct physiographic districts, based upon clearly defined geological differences, viz., an eastern (Blue Ridge and Great Valley), a central (Appalachian Mountains proper), and a western (Alleghany Mountains) division.

The *eastern division* comprises the area between the Catoctin and North Mountains and has a width of about 25 miles from east to west. Along the eastern border of this region the Catoctin Mountain extends from north to south, beginning in the highlands of Pennsylvania and reaching to the Potomac river at Point of Rocks. This range reaches an altitude of 1800 feet in Maryland. Succeeding the Catoctin Mountain upon the west is the Middletown Valley, with an elevation of 500 feet at Middletown. The valley drains southward into the Potomac river through the Catoctin creek and its tributaries, which receive their waters from the western flank of the Catoctin

Mountain and the eastern slope of the Blue Ridge. The Blue Ridge of Maryland is a continuation of the South Mountains of Pennsylvania and extends as a sharply defined range from the northern border of the state to the Potomac river, which it reaches at Weverton. Its crest forms the border between Frederick and Washington counties. The Blue Ridge reaches its greatest elevation of about 2400 feet at Quirauk, not far from the Pennsylvania border. The Blue Ridge in Virginia is not the direct continuation of the mountains so named in Maryland, but of a smaller range, the Elk Ridge Mountains, which adjoin them upon the west and which are pierced by the Potomac river at Harper's Ferry. Occupying the larger portion of this eastern district and reaching to its western border is the Hagerstown Valley, a portion of the Great Valley of the Appalachian Region hitherto described. It has an altitude of about 500 feet at Hagerstown, which increases somewhat to the northward near the Pennsylvania line, but declines considerably in the vicinity of the Potomac river. The Antietam river and its tributaries occupy the eastern section of the valley and the Conococheague river and its tributaries the western, leaving the central portion of the valley somewhat higher than the sides.

The *central division*, which comprises the Appalachian Mountains proper, is bounded by the North Mountain upon the east and Will's Mountain, near Cumberland, upon the west. Professor H. D. Rogers describes this district as follows in his report of the First Geological Survey of Pennsylvania: "It is a complex chain of long, narrow, very level mountain ridges, separated by long, narrow, parallel valleys. These ridges sometimes end abruptly in swelling knobs, and sometimes taper off in long, slender points. Their slopes are singularly uniform, being in many cases unvaried by ravine or gully for many miles; in other instances they are trenched at equal intervals with great regularity. Their crests are, for the most part, sharp, and they preserve an extraordinarily equable elevation, being only here and there interrupted by notches or gaps, which sometimes descend to the water level, so as to give passage to the rivers [Potomac]. . . . The ridges are variously arranged in groups with long, narrow crests, some of which preserve a remarkable straightness for great distances, while others bend with a prolonged and regular sweep. In many instances two narrow contiguous parallel mountain crests unite at their extremities and enclose a narrow oval valley, which, with its sharp mountain sides, bears not infrequently a marked resemblance to a long, slender, sharp-pointed canoe."

Among the more important ridges in Maryland west of North Mountain are Tonoloway Hill, Sideling Hill, Town Hill, Green Ridge, Warrior Ridge and Martin's Ridge, the latter reaching 2000 feet and upwards in elevation. They are arranged in groups of three parallel and closely adjoining ridges on the eastern and western sides with more distant ridges in the middle of the district. The drainage of this area is altogether to the southward into the Potomac river. The deeper valleys in the eastern portion of the region have an elevation of about 500 feet in their lower portions near the Potomac river, but they gradually become higher toward the west. Evitt's creek at its mouth near Cumberland has an elevation of about 600 feet above sea-level.

The *western division*, which comprises the Alleghany Mountains in its eastern half, forms the extreme western portion of the state. This region gradually merges into a high plateau in passing from its eastern to its western border, with gently undulating mountains rising from the surface, which continue beyond the western borders of the state. The leading ranges of this district are Dan's Mountain, Savage Mountain, Backbone Mountain, Meadow Mountain, Negro Mountain, Winding Ridge and Laurel Hill. Heights of 3000 feet and more are reached in Savage, Backbone and Negro Mountains. The streams flow in part to the southward into the Potomac river as in the central and eastern districts, but throughout much of Garrett county the greater number drain to the northward through the Youghiogheny valley into the Monongahela. This division of the drainage has particular interest, since it marks the watershed between the streams which flow into the Potomac river, reaching the sea by the eastern slope of the Appalachian Mountains, and those which flow to the Gulf by way of the Ohio and Mississippi rivers.

VIEW OF THE YOUGHIOGHENY VALLEY IN THE ALLEGHANY MOUNTAINS,
ON THE BALTIMORE & OHIO R. R.

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GEOLOGY.

The geology of Maryland as well as its physiography shows an intimate relationship to the adjacent areas upon the north and south, so that its complete interpretation can be gained only by taking into consideration the great eastern border region of which the state is not only geographically but geologically a part. Frequent reference will therefore be made in the succeeding pages to the general distribution and relations of the geological formations found represented within the limits of the state, although the detailed descriptions will be confined to those features more particularly characteristic of the Maryland area.

The state of Maryland is so situated as to display, in spite of its comparatively small size, less than 10,000 square miles of land area, a remarkable sequence of geological formations. The most ancient rocks which make up the earth's crust as well as those still in the process of deposition are here found, while between these wide limits there is hardly an important geological epoch which is not represented. It is doubtful whether another state in the Union contains a fuller history of the earth's past. To make the completeness of this record in Maryland somewhat more intelligible it is well to consider the basis on which geologists are able to determine the succession of deposits.

Geology in its broadest aspects must be regarded as the science of the earth from its very earliest beginnings down to the present day, and as such stands in close relationship to the science of astronomy in its study of the origin of the solar system. In the absence of a more satisfactory theory, most geologists to-day are prepared tentatively to accept the nebular hypothesis of Kant and Laplace as a starting point in earth evolution. This hypothesis supposes that the nebulous, gaseous mass out of which the planetary bodies were formed embraced the most distant orbit of the solar system. As condensation began, successive rings were thrown off, which by further condensation produced the several planets of our system. These in turn may also possess rings or satellites, as with Saturn, or these rings may condense to form a single satellite, as in the case of our Moon. The natural inference from this hypothesis would be that successive rings would increase in density from without toward the centre, and that as each ring became broken there would be a rearrangement of the parts according to the density of the materials out of which it was formed. This view is to a large extent substantiated by the fact that the planets and their individual satellites for the most part conform to this law. The materials of the earth thus become gradually more dense as its centre is approached.

If we accept the nebular hypothesis and consider that condensation and cooling have taken place, then as our globe slowly changed from a state of igneous fusion the first rocks must have been formed by solidification at the surface of the molten mass, while as yet the oceans and many of the more volatile substances existed in the dense cloudy atmosphere. Whether or not any portion of this first cooling crust now remains where it is accessible to man is a matter of doubt. It is probable, however, that ages must have elapsed before the crust had so far cooled as to allow the concentration of the oceans upon it; and ages more must have passed before this hot and chemically surcharged ocean had so far cooled and purified itself as to allow the development of life within it. We get a still further conception of the vast lapses of time which these early rocks imply, when we discover that, even after the waters had become suited for living beings, a great part of the development and differentiation of organic life went on in beings which have left no trace of their existence. Hardly a more remarkable fact confronts us in geology than the variety and complexity of types in the earliest rocks which contain any trace of life at all. This fact, which is all the more remarkable for being attested by the best of evidence from all parts of the earth's surface, compels us to assign to the history of life before its first permanent record was deposited a longer period perhaps than all that has since elapsed. These earliest forms were either unsuited for preservation or else they have been obliterated in the subsequent alteration of the rocks containing them.

All of the oldest rocks which are to-day entirely without, or with only slight traces of former life, are referred to the first great division of geological history called *Archean Time.* These oldest rocks are largely crystalline in character, so that there can be but little chance of encountering organic forms, even had they earlier existed in the strata. Even the least altered deposits, although they have afforded a few scattered remains of archaic forms at certain points, contain nothing more than the merest traces of the organisms of this early time.

When, however, life does once appear in all its variety, it is well nigh the same in all the older rocks. In the most widely separated localities the same types recur in rocks of the same age, and this furnishes us with the key to the succession of deposits. From the time when the oldest fossil-bearing stratum was deposited until now, the story of life-progress and development is told by the rocks with sufficient clearness to be unmistakable. Local differences of conditions have probably always prevailed, as they do now, but the same types of organisms have always lived at the same time over the entire globe, so that their remains serve as sufficient criteria for the correlation of the strata which contain them. The sequence of life-forms once made out gives us, for the whole earth, the means for fixing the order of deposits even when this is most profoundly disarranged by foldings of the strata into mountains or by other earth movements.

Geologists distinguish three principal divisions in the history of life as read in the record of the rocks. During the earliest of these great time-divisions, archaic forms of life flourished—uncouth fishes, crustaceans, mollusks, and tree-ferns—most of them very unlike those now extant. On this account this is known as the period of most ancient life or *Paleozoic Time.* To this succeeded a long lapse of ages when enormous reptiles predominated, associated with other types more like those that now inhabit the globe. To this is given the name of middle life or *Mesozoic Time.* Finally living things began to assume the form and appearance with which we are familiar, so that this last grand time-division, which includes the present, is designated as the period of recent life or *Cenozoic Time.*

Each of these three grand divisions of geologic time is in its turn separated into shorter subdivisions called *Periods*, characterized by their own peculiar types of life; and the several periods are themselves divided into *Epochs*, which vary more or less in character according to the region where they are developed. For this reason the chronological and stratigraphical divisions require an independent nomenclature, although this duality of geological classification can in most instances be readily adjusted to the contingencies of each district. The stratigraphical divisions are usually designated by local terms.

In Maryland we have representatives not merely of the great time-divisions, but of each of the subordinate periods, as well as of many of the epochs. This may be best appreciated by referring to the accompanying geological map and to the table of geological formations which follows.

TABLE OF MARYLAND FORMATIONS.

	Formations represented in Maryland.	
CENOZOIC TIME.		
Pleistocene Period represented by the	Columbia.	
Neocene " " "	Lafayette.	
	Chesapeake.	
Eocene " " "	Pamunkey.	
MESOZOIC TIME.		
Cretaceous " " "	Raucocas.	
	Monmouth.	
	Matawan.	
	Raritan.	= Potomac Group.
	Patapsco.	
Jurassic (?) " " "	Arundel.	
	Patuxent.	
Triassic " " "	Diabase.	
	Newark.	
PALEOZOIC TIME.		
Permian (?) " " "	Frostburg.	
Carboniferous " " "	Elkgarden.	= Coal Measures.
	Fairfax.	
	Bayard.	
	Savage.	
	Pottsville.	
	Mauch Chunk.	
	Greenbrier.	
	Pocono.	

TABLE OF MARYLAND FORMATIONS. (Continued.)

	Formations represented in Maryland.	
Devonian Period represented by the	Hampshire (Catskill).	
	Jennings (Chemung).	
	Romney (Hamilton).	
	Monterey (Oriskany).	
Silurian " " "	Lewistown (Niagara—L. Helderberg).	
	Rockwood (Clinton).	Phyllite and Crystalline Limestone. Quartzite.
	Tuscarora (white Medina).	
	Juniata (red Medina).	
	Martinsburg (Hudson River).	
	Shenandoah (upper part).	
Cambrian " " "	Shenandoah (lower part).	
	Antietam.	
	Harpers.	
	Weverton.	
	Loudoun.	
ARCHEAN TIME.		
Algonkian and Archean (?) " " "	Granite.	
	Diorite.	
	Basic Volcanics.	
	Acid Volcanics.	
	Peridotite and Pyroxenite.	
	Gabbro.	
	Marble.	
	Quartz-schist.	
	Gneiss.	

As has been pointed out in the physiographic description of the state, Maryland's territory falls naturally into three sharply contrasted provinces: an eastern coastal plain bordering the Atlantic Ocean and surrounding the Chesapeake Bay, a central plateau, and a western region of mountains. These three main physiographic divisions were found capable of further differentiation into seven topographic belts, and these seven subordinate regions are each composed of a distinct series of geological formations. This may be perceived readily by examining the geological map.

The separateness of the formations is less pronounced in the two divisions of the Coastal Plain, although the northeast-southwest trend of the nearly horizontal beds produces a predominance of the later Cenozoic formations in the eastern division and of the Mesozoic and early Cenozoic deposits in the western division.

In the Piedmont Plateau the twofold character of the district is very marked geologically. On the east side of the central watershed (Parr's Ridge) we have a sequence of highly crystalline rocks, in large part igneous in their origin, which represent the remains of a vast Archean continent, whose detritus furnished much of the material of which the Paleozoic sediments were made. On the western side of the median ridge the rocks are as yet only partly crystallized and represent the greatly folded and metamorphosed beds of early Paleozoic time. Along the western edge of this plateau, beyond the Monocacy river, is the Frederick valley composed of the blue Paleozoic limestone, in part overlain by the red sandstone and shale of Mesozoic age.

The threefold division of the Appalachian Region corresponds approximately to the threefold division in the sequence of the Paleozoic strata. The Blue Ridge and Great Valley are made of Cambrian and lower Silurian beds, in places so developed or eroded as to expose the Archean floor on which they rest; the Appalachian Mountains proper are made up of sharply folded upper Silurian and Devonian strata, each easily recognized by its characteristic life forms; while the Alleghany Mountains are mainly composed of more gently folded later Devonian and Carboniferous deposits, carrying the valuable coal seams of the Cumberland basin.

Such, in brief, is the distribution of the geologic formations in Maryland and their connection with the easily recognized types of surface configuration occurring within the state. The sequence is of remarkable completeness and of great interest on account of the many types of topography and soils which the various formations produce. In the succeeding pages the geological history of each of the three provinces—plateau, mountains and coast plain—will be traced out in more detail. A somewhat different sequence will be followed than in the preceding physiographic sketch, the Piedmont Plateau being considered first, as it is the oldest, and then in order the Appalachian Region, which is next in age, and finally the Coastal Plain, which is the youngest portion of the state. Constant reference to the geological map will be found of service in following the descriptions which will be given.

The Piedmont Plateau.

An adequate comprehension of the crystalline rocks occurring within the limits of the state of Maryland can only be gained through a knowledge of the great Piedmont belt of the Atlantic border. A brief characterization of this province must therefore precede a more detailed description of the local geology. Along the eastern flank of the Appalachian and Green Mountain uplifts there is an area of highly crystalline or semi-crystalline rocks which extends from Alabama to Maine, its northward extension reaching into the British possessions. This zone attains its maximum width of 300 miles or more in the Carolinas; further north it narrows and is nearly buried beneath the Trias in New Jersey, but beyond New York it again broadens so as to embrace the larger part of New England. Within this whole province the rocks are so crystalline as to make fossils rare, while their structure presents some of the most puzzling problems in American geology.

Many theories have obtained regarding the age of the strata of the Piedmont belt, but it is only within very recent years that elaborate and detailed work has begun a satisfactory solution of the mystery. In New England the entire sequence of Paleozoic sediments is found more or less completely metamorphosed with occasional outcrops of more ancient crystalline rocks (Archean) showing beneath them, and with a variety of younger eruptive masses which have been intruded through them. South of New York the crystalline belt acquires a more homogeneous character both structurally and topographically, which fact, together with its position at the eastern foot of the Appalachian system, has occasioned its designation as the Piedmont Plateau.

The rocks composing the Maryland portion of the Piedmont Plateau are divisible into two distinct classes. The members of the first class are all completely crystalline, and whatever was their origin they now retain no certain evidence of clastic structure, although their sedimentary origin in part seems probable. The rocks of this type are confined to the eastern portion of the plateau province and disappear beneath the overlying deposits of unconsolidated materials which compose the Coastal Plain. The Piedmont rocks of the second class are semi-crystalline, and while they have been subjected to a certain amount of metamorphism and alteration they still plainly show that they were once sediments of an ordinary type. While as yet only a few imperfect fossils have been found in them, they are not more altered than similar rocks which in other localities have yielded abundant fossil remains, so that there is good reasons to suppose that their age may yet be definitely determined on paleontological evidence. Although these semi-crystalline rocks are principally confined to the western half of the plateau region, there are isolated areas of them within the holocrystalline belt which appear to be much younger than the rocks around them, but which have been protected from removal by being infolded with them.

The line separating these two divisions of the Piedmont Plateau which we shall hereafter designate as the holocrystalline (eastern) and the semi-crystalline (western) areas, is not coincident with the crest of Parr's Ridge, but lies on its eastern flank. Commencing in the south near Great Falls on the Potomac it passes slightly west of Rockville and of Hood's Mills, then to the north through Westminster on the Western Maryland Railroad, and thence by a northeasterly course to the Pennsylvania line. Further eastward there is a larger area of semi-crystalline schists in Harford county surrounding the Peach Bottom and Delta roofing-slates. These appear to be infolded in the gneiss and are probably connected with the area near Finksburg by a narrow tongue passing the Northern Central Railway at Whitehall.

The most striking feature in the structure of the Piedmont Plateau is its radiating or fan-like structure, and the fact that the vertical strata forming the axis of this fan follow a direction neither parallel to nor coincident with the boundary between the crystalline and semi-crystalline rocks. These two lines start from the same point on the Potomac (Great Falls), but diverge more and more toward the north. The fan, therefore, while its axis is throughout composed of semi-crystalline rocks, has its western flank made up of the less crystalline and its eastern flank of the more crystalline portion of the Piedmont region.

The different divisions in the rocks of the Piedmont Plateau are the following:

ROCK DIVISIONS OF THE PIEDMONT PLATEAU.

		Rock Divisions of the Piedmont Plateau.
MESOZOIC.		
	Triassic	Diabase.
		Newark Formation.
PALEOZOIC.		
	Silurian and Cambrian	Phyllite and Crystalline Limestone.
		Quartzite.
ARCHEAN.		
	Algonkian and Archean (?)	Granite.
		Diorite.
		Basic Volcanics.
		Peridotite and Pyroxenite.
		Gabbro.
		Marble.
		Quartz-schist.
		Gneiss.

THE EASTERN DIVISION.

THE ARCHEAN AND ALGONKIAN PERIODS.

The formations of supposed pre-Cambrian age, which compose the eastern or holocrystalline division of the Piedmont Plateau, cross Maryland from the southeast corner of Pennsylvania and the northern end of Delaware in a general southwest direction. Their course, however, is not a straight one through the state, but forms a double curve whose south side is convex on the east and concave on the west. This curve corresponds to the great westerly bend in the course of the Triassic sandstone and folded Paleozoic bands of eastern Pennsylvania. It is much less distinct in the highly crystalline rocks of the eastern Piedmont region, but that its presence can be traced at all amid the varied and complex structures of these very ancient rocks is welcome evidence that at least the final impression was imparted to their strike by the great Appalachian folding. The convex or eastern branch of this curve may be most distinctly traced in the belt of marble north of Baltimore, which, near Towsontown, turns from a southwest direction to a trend directly west through the Green Spring valley. Toward the southwest these same marble belts turn again to the south-southwest, as do all the other rocks with which they are associated, and this course is held into Virginia. There is abundant evidence that these structural features of the eastern Piedmont region are not the only ones which belong to these rocks, but that their present metamorphism and complexity must be accounted for by assuming that they have been subjected to several successive periods of disturbance.

The rocks composing the holocrystalline portion of the Piedmont Plateau in Maryalnd are petrographically divisible into seven distinct types. Four of these are of undoubtedly eruptive origin and may be designated according to their chemical and mineralogical composition as diorite, gabbro, peridotite or pyroxenite, and granite. The remaining types through which the eruptive rocks have broken—gneiss, marble and quartz-schist—are completely crystalline, and therefore exhibit no certain trace of clastic structure, although it seems highly probable that they were of sedimentary origin. Since all four types of eruptive rocks have broken through and more or less modified the other rocks, they are younger than the latter. The intense dynamic action which has produced such recrystallization in the gneiss complex has likewise greatly metamorphosed the eruptive rocks, and yet not enough to obliterate their original character. Each type exhibits several chemical and structural facies dependent upon the original differentiation of the magma or upon the conditions of solidification, to which must be added other variations due to subsequent metamorphism.

The Gneiss.—The prevailing rock of the entire holocrystalline area is the gneiss. It enters the state from the north in a very wide band, completely surrounding the Delta Peach Bottom slate area, but its breadth rapidly contracts toward the Potomac. The remarkably irregular form of the marble areas which are intercalated in the gneiss complex shows how intricate the stratigraphy of the latter really is. Much of its apparent simplicity is due to the obliteration of its true bedding through secondary foliation. The Maryland gneiss embraces a great variety of types, which range from granitoid aggregates of feldspar and quartz on the one hand to nearly pure mica or hornblende schist on the other. All of these also show considerable structural variation in the coarseness of their grain, the perfection of their parallel arrangement, etc. The gneiss is sometimes quite constant or homogeneous for considerable distances, but more usually it consists of differently constituted layers.

The gneiss everywhere shows, in spite of a frequent persistence of strike and dip, that it has been subjected to intense and repeated dynamic action. This is apparent in the larger features of its structure, in its generally crumpled, gnarled and twisted character, and in the profound metamorphism, amounting to almost complete recrystallization, which has gone on within it. No certain traces of clastic origin have ever been detected in the Maryland gneiss, although its sedimentary character may be inferred from its rapid alternation of beds of different composition and from the nature of other rocks intercalated in it like the marble and quartz-schist.

The color of the more massive gneisses varies from white to a dark gray or blue. The more micaceous and hornblendic varieties are dark brown or green. The mineral composition and structure are quite normal for gneisses elsewhere developed. Superficial exposures of the gneiss are very rarely fresh. This wide-spread decay extends also for a considerable distance below the surface, at least in an incipient form, as may be seen from the very rapid disintegration in road and railroad cuttings of rock that is sufficiently hard to require blasting.

The Quartz-schist.—This type forms but a small portion of the rocks of probable sedimentary origin included within the eastern division of the Piedmont Plateau. It is more interesting from its influence on the topography, since it causes the low ridge extending along the south side of Green Spring and Mine Branch valleys known as Setter's Ridge, than it is from its areal extent or even its mineralogical composition. The quartz-schist rarely attains any considerable thickness, but instead seems to be closely related to the underlying gneiss into which it grades by imperceptible transitions. Between the schist and the marbles there is a sharp break, and it has been considered probable that this formation is in some way the result of fumerole action in the gneiss. This conclusion is borne out by the mineralogical composition. The most abundant constituent is quartz, which occurs divided into fine beds of varying thickness by parallel layers of muscovite. In the micaceous layers are numerous broken crystals of tourmaline whose fragments are separated along a single line as though they had been compressed and pulled apart by some earth movement.

THE MARBLE.—The marbles of the Piedmont Plateau are of interest topographically, structurally, mineralogically and economically. There are few areas in Maryland where the dependence of topography upon the nature of the underlying rocks is better shown than in the contrasts between the flat, narrow valleys in the marbles and the abrupt ridges or gorges of adjacent gneisses and quartz-schist. Geologically the marbles are younger than the gneisses and quartz-schist, but the detailed relations are obscured by great structural complexity and recrystallization. The general lines of structure might be inferred from the areal distribution were this not so anomalous and irregular as to render any explanation unsatisfactory. It is clear, however, that it is to be accounted for not by folding alone, but by folding accompanied by thrusts and faults at several successive periods.

The marbles of this division differ in texture and composition from the finer and more compact crystalline limestones of the western or semi-crystalline area. In the latter the impurities are in the form of thin, argillaceous bands, while in the former they are represented by layers of accessory minerals, including tremolite, white pyroxene, green muscovite, brown and black tourmaline, scapolite, quartz, pyrite and rutile, which correspond more or less closely with the original bedding planes. The marbles are often dolomites, frequently showing over 40 per cent of magnesium carbonate. The Baltimore county marbles are extensively quarried, either for burning or for use as a flux, or as a building stone (magnesian).

THE GABBRO.—One of the most ancient and most extensive of the three eruptive rocks which so abundantly intrude the gneiss complex is the gabbro. There are three main areas of this rock within the limits of the state—the Stony Forest area of Harford and Cecil counties; the great belt or sheet which extends from the north of Conowingo, on the Susquehanna river, in a south-southwest direction to Baltimore city; and the irregular intrusive area which is mainly developed to the west of Baltimore and extends thence as far south as Laurel. The gabbro is a rather fine-grained aggregate of hypersthene, diallage, plagioclase (bytownite) and magnetite, with varying amounts of apatite and brown hornblende. The unaltered gabbros are usually massive, heavy and dark colored. With the alteration the color changes through a pale buff to the characteristic deep reddish brown. By an increase in magnesia the gabbros pass by transitions towards the peridotites and pyroxenites; or in alumina, to highly feldspathic rocks; or in silica, to others which have free silica forming blue grains.

The action of pressure which has caused the recrystallization of the gneiss and marble is also well marked in the gabbros. It has caused the iron constituent, pyroxene, to change to another green mineral called hornblende; and has in some cases left the rock as massive as at first or in other cases rendered it schistose. The resulting rock is called *gabbro-diorite.* The change has always been most complete where the mass of gabbro is smallest, as in the narrow beds which connect the larger areas. This change is well shown along the Belair road near Baltimore.

The gabbro offers great resistance to the ordinary processes of decomposition, and hence it is strewn abundantly all over the area, which it occupies, in the form of boulders. It is at the same time so hard, so heavy, and so jointed that it could not be quarried to any advantage as a building stone. The loose blocks are much used for constructing stone walls or foundations, and occasionally whole buildings are erected of them.

The Peridotite and Pyroxenite.—The second type of eruptive rock which penetrates the gneiss complex near Baltimore is younger than the gabbro, but it is genetically closely allied to it. These two types are connected by many intermediate varieties; and the more basic rocks, which break through the gabbros as well as through the gneiss, may be regarded as having resulted from a gabbro-magma which had become relatively poor in alumina, or in alumina and silica. The absence of alumina would prevent the formation of feldspar, and hence in the first case crystallization produced an aggregate of pyroxene (bronzite and diallage) called *pyroxenite* (websterite); while in the second case an aggregate of olivene and pyroxene with more or less magnetite was the result. This type is called *peridotite* (lherzolite).

The two non-feldspathic types of eruptive rocks, pyroxenite and peridotite, are peculiarly subject to alteration, which is not, however, decomposition. Briefly it is this: the pyroxene, when it occurs alone, tends to pass into secondary hornblende, and this in turn gives rise to talc. This is the origin of the extensive beds of steatite in eastern Maryland and Virginia. The talc is always mixed with more or less pale, fibrous hornblende (tremolite) and chlorite.

When, as in the peridotite, olivene accompanies the pyroxene, especially if it is bronzite, the rock tends to form serpentine instead of talc. The serpentine also contains secondary hornblende formed from the diallage.

Both types of non-feldspathic eruptives are very intimately associated. They do not usually cover large areas, but occur in small lenticular patches. Varieties intermediate between the two extremes are common, so that the two alteration products, steatite and serpentine, are even more intimately mingled than the rocks themselves.

THE DIORITE.—The rocks included under this head are closely allied to the granites and at first glance may easily be mistaken for them. They differ, however, in the character of their feldspar and in their darker color. They always contain a green hornblende, and biotite with orthoclase and plagioclase, sometimes the former and sometimes the latter in excess. Quartz is usually present and the rocks then resemble the well-known tonalite from European localities. Under the microscope the diorites generally show evidences of the destruction of their constituents through dynamic action or through weathering processes.

The areal distribution of these rocks has not been fully studied, but they have been mapped in several small areas to the west of Washington on either side of the Potomac river. They are most extensively developed, so far as recognized, around Georgetown and near Cabin John's Bridge. At the quarries at the former place, clearly defined inclusions of other rocks have been noticed, which substantiate the view that these rocks represent ancient eruptive masses which subsequently have been greatly changed and recrystallized by the earth movements which have taken place since their formation. The exact time at which these rocks were intruded into the surrounding masses is not definitely known. They are clearly older than the youngest of the granites at Broad Branch and are younger than some of the older more metamorphic granites and granite gneisses. It seems reasonably probable that they were erupted just before or just after the gabbros.

THE GRANITE.—The eruptive granites of central Maryland rival the gabbros in extent and petrographical interest, while they greatly surpass them in economic importance.

These rocks are, as a rule, *granitites*, of medium grain and remarkably compact and homogeneous texture. They sometimes carry a considerable quantity of muscovite (Guilford), and are noticeable for the large and constant proportion of allanite which they contain, this latter mineral being surrounded by a parallel growth of isomorphous epidote.

Variations in the structure of the granites are due to the development of porphyritic crystals, as at Ellicott City and along the road from Meredith's Bridge on the Gunpowder river to Cockeysville. Other structural facies are due to secondary features, like foliation, produced by dynamic agencies.

The granites are partly younger and partly older than the other eruptive types, and are not connected with them, as those with each other, by intermediate facies. They represent entirely distinct epochs of eruptive activity. The evidence of their eruptive origin is most satisfactory and conclusive. They form intrusive bosses with diverging dikes and apophyses; they produce disturbance and crumpling in the rocks through which they break; they enclose fragments of the older rocks—gneiss, marble, quartz-schist, gabbro and pyroxenite; and finally they produce all the well-known phenomena of contact-metamorphism, both in these fragments and in the rocks which adjoin them.

The granites are extensively quarried for building and paving stones at Port Deposit, Woodstock, Granite, Ellicott City and Guilford, which represent great granite masses.

The gneiss of the Baltimore region is penetrated with a great abundance of dikes, veins and eyes of the coarse grained granite, known as *pegmatite*. The other crystalline rocks of the region, although to a less extent, contain the same materials. Within the eastern plateau region the pegmatite appears to have been produced in two ways, at least we seem compelled by direct evidence to assume that certain occurrences of it are true eruptive dikes genetically related to the normal granite already described; while for other occurrences an aqueous origin by segregation appears more probable, although the proof is not as good as in the former cases.

THE LATER PERIODS.

The rocks of post-Algonkian age are but poorly represented in the eastern division of the Piedmont Plateau, and are in the main simply outliers of those occurring in the western portion of the Piedmont area and in the Coastal Plain. Among the more important are the quartzites and phyllites of Paleozoic age, the Mesozoic diabase and the superficial late Mesozoic and Cenozoic deposits.

The Paleozoic Quartzite is confined to the area of Deer Creek, in Harford county, and is probably identical geologically with the quartzites of the western division of the Piedmont Plateau. It is closely related to them lithologically. The characteristics of the quartzite will be discussed when the rocks of that division are considered.

The Paleozoic Phyllites, which occur as semi-crystalline slates and schists, extend as a constantly narrowing belt from the northern borders of Cecil and Harford counties across Baltimore county into the southeastern part of Carroll county. They probably form simply an outlier of similar deposits found extensively developed in the western division of the Piedmont belt and will be more fully discussed in that connection.

The Mesozoic Diabase which intrudes the older crystalline rocks in Baltimore and Harford counties, occurring as a long dike, broken at several points, preserves all the features of the nominal Triassic diabase found in the Frederick valley.

The more recent *Mesozoic* and *Cenozoic deposits* occur as outliers upon the crystalline rocks, particularly along the eastern margin of the plateau country. They will be severally considered in the discussion of the Coastal Plain formations.

THE WESTERN DIVISION.

THE ALGONKIAN PERIOD.

The supposed Algonkian rocks of the western division of the Piedmont Plateau are infolded with the Paleozoic deposits of Montgomery, Frederick and Carroll counties. They consist, so far as has yet been observed, of but a single type, closely resembling the metamorphosed basic volcanic rocks of the Blue Ridge district.

THE BASIC VOLCANICS.—The basic volcanic rocks represented in Montgomery, Frederick and Carroll counties consist of long lenses or bands infolded with the phyllites and crystalline limestones. They follow the general structural lines in a N. E.-S. W. direction. The lenses are more numerous in Frederick county than in the area to the east. The rocks have been highly metamorphosed and show all the essential characters of the "Catoctin schist" of the Blue Ridge district and will be more fully described under that head.

THE CAMBRIAN AND SILURIAN PERIODS.

The western division of the Piedmont Plateau, comprising the larger part of the western slope of Parr's Ridge as far as the Monocacy river, has been described as composed mainly of semi-crystalline rocks of sedimentary origin. These rocks are almost unaltered along their western margin, and present the same characters as the sandstones, slates and limestones of the Blue Ridge and Frederick valley, where their age has been determined by fossils. As they approach the axis of the "fan," however, which has been shown above to be one of the principal features in the structure of the Piedmont Plateau, these schists become more crystalline. Here they stand nearly vertical, and show that the dynamic action has been at a maximum by the greatly contorted condition of the schists and the abundant development of new minerals within them. The slates have become roofing-slates, or chlorite and hydromica (sericite) schists, often full of ottrelite, rutile, biotite and other new constituents. The limestones have become compact, hard, fine-grained marbles. The geological position of these rocks has only in part been positively proved by fossils, and they are therefore designated on the geological map by different colors.

The Quartzite.—Isolated areas of quartzitic sandstone of supposed Cambrian age are found developed along the eastern side of the Monocacy valley in Frederick county. A single outlier, already referred to, is found in the eastern division in northern Harford county, which is supposed to be of identical age, but this fact has not been as yet fully established. The most extensive deposit of this material occurs in Sugar Loaf Mountain, near the boundary of Montgomery county. Here the sandstone is very homogeneous, fine-grained and compact, and is very light, frequently white, in color. The massive sandstone strata of Sugar Loaf Mountain form a series of antichines overturned toward the west. The formation continues toward the north in a few insignificant sandstone patches, while toward the south it soon disappears beneath the phyllite series. The Sugar Loaf sandstones pass on their eastern side upward by a gradual transition into the overlying deposits, which in their unaltered portion are somewhat shaley.

The Phyllite and Crystalline Limestone.—The shaley layers just described pass over into sandy slates, and these again into the succession of sericite and chlorite schists, which compose the mass of the "semi-crystalline" area. Considerable deposits of limestone, which are now highly crystalline fine-grained marbles, also occur, particularly throughout the northern portion of the district in the area to the west and north of Westminster. As these rocks are followed across their strike toward the east they are seen to become more and more contorted, cleaved and faulted. Closely folded and puckered layers are frequent, and the secondary cleavage approaches nearer and nearer to the vertical. The succession of beds is well displayed along the main stem of the Baltimore and Ohio Railway between Araby and Hood's Mills. The alteration, or re-crystallization, of these rocks, attendant upon the increasing disturbance to which they have been subjected, becomes so great that it is not always easy to distinguish the line of contact between them and the underlying and more ancient crystallines of the eastern Piedmont region. The recent discovery of fossils in the phyllites east of Araby by Mr. Keith proves some of these rocks to be of Cambrian age.

THE TRIASSIC PERIOD.

The rocks of Triassic age are mainly confined to the western margin of the Piedmont Plateau and are represented by both sedimentary and eruptive materials which will be further described under the head of the Newark Formation and the Diabase.

The Newark Formation.—The deposits of the Newark formation unconformably overlie the limestone and phyllite which have been above described and cover a considerable area along the western border of the Piedmont Plateau. Beginning as a belt some ten miles in width in northern Carroll and Frederick counties, the formation gradually narrows toward the south, until in the region of Frederick its full width does not exceed one mile, while at one point directly to the west of Frederick the continuity of the beds is completely broken. Farther southward in western Montgomery county the belt of Newark deposits again broadens to a width of several miles.

The rocks of the Newark formation consist largely of red and gray sandstones and conglomerates of both silicious and calcareous varieties. The finer grained and deeper colored deposits generally have their individual elements united by a ferruginous cement, while the calcareous conglomerate, which is largely made up of rounded limestone pebbles, is generally imbedded in a reddish calcareous matrix. All of the deposits present structures which indicate that they were formed in shallow water; the coarse conglomerates, the ripple-marked surfaces, and the tracks of animals all point indisputably to this conclusion.

The Diabase.—The sandstones and shales of the Newark formation, as well as the rocks of earlier age, are found penetrated by dikes of an igneous rock known as diabase. These dikes extend across the area, for the most part, in a north-south direction, and throughout central Frederick and Carroll counties, where the covering of sandstones and shales has been removed, are found penetrating the limestones and phyllites. It seems probable that the dikes before referred to as occurring in the eastern division of the Piedmont Plateau are of similar origin. The diabase is holocrystalline and is composed chiefly of plagioclase and pyroxene with olivene and magnetite. The rocks penetrated have been at times considerably metamorphosed by the molten rock, which was forced into their fissures, generally with a hardening of the beds by partial solidification and re-crystallization. The diabase decomposes with considerable rapidity, although the surface is generally covered with large boulders of undecayed material which show characteristic weathering.

The Appalachian Region.

The geology of the Appalachian Region, as in the case of the Piedmont Plateau, cannot be fully comprehended without taking into consideration the great belt of which it forms a part. The beds of sediments which form the limestones, sandstones and shales of the Appalachian mountains were deposited in a wide, long trough, which once extended from north to south throughout the region now occupied by the mountains. This trough was undergoing gradual depression through most of Paleozoic time, until many thousands of feet of conformable beds had accumulated in it, mainly as the debris of a continental mass lying to the east.

This vast accumulation, at the close of Paleozoic time, was so compressed as to be forced up into a series of great folds, forming lofty ranges of mountains. The present Appalachians are merely the remains of these ancient folds worn down by natural processes through many successive periods. It is by no means certain that the mountain crests ever stood higher than at present, for from the moment the land rose above the sea the forces of denudation became active, and with varying intensity have continued to the present day. The great folds have been from time to time planed down to be again sculptured as the result of elevatory movements. The compressive force which raised these mountains acted from the east toward the west, hence the most intense disturbance is always observable in the eastern portion of the range and dies away gradually into the central plains. A secondary result of this action from the east is that all the folds are tipped toward the west and all the great faults show a thrust in the same direction. In consequence of this the oldest of these sediments are toward the east and the youngest toward the west, although the more or less abrupt folds into which they were thrown, when raised into a mountain chain, have since been cut off by erosion in such a manner as to show a repeated succession of strata and at the same time to present in portions of the eastern border area rocks of still earlier age.

The section made by Maryland across the Appalachian system between the Frederick valley and the western line of Garrett county presents an almost complete series of these various formations. As has been already pointed out, the mountain system of Maryland is divisible into three distinct physiographic and geologic districts, but as the features of each division appear to some extent repeated in that which is adjacent to it, it seems more desirable to treat the geology of the Appalachian Region as a unit, and describe under each formation its distribution, character and structure. Reference to the map will show the relations which these formations bear to the several geographic divisions.

The following divisions are recognized in the rocks of the Appalachian Region.

FORMATIONS OF THE APPALACHIAN REGION.

	Formations of the Appalachian Region.	
PALEOZOIC.		
Permian (?)	Frostburg.	
Carboniferous	Elkgarden.	=Coal Measures.
	Fairfax.	
	Bayard.	
	Savage.	
	Pottsville.	
	Mauch Chunk.	
	Greenbrier.	
	Pocono.	
Devonian	Hampshire (Catskill).	
	Jennings (Chemung).	
	Romney (Hamilton).	
	Monterey (Oriskany).	

FORMATION OF THE APPALACHIAN REGION. (Continued.)

	Formations of the Appalachian Region.
Silurian	Lewistown (Niagara—L. Helderberg).
	Rockwood (Clinton).
	Tuscarora (white Medina).
	Juniata (red Medina).
	Martinsburg (Hudson River).
	Shenandoah (upper part).
Cambrian	Shenandoah (lower part).
	Antietam.
	Harpers.
	Weverton.
	Loudoun.
ARCHEAN.	
Algonkian (?)	Granite.
	Basic Volcanics.
	Acid Volcanics.

THE ALGONKIAN PERIOD.

The rocks of supposed pre-Cambrian age occur only in the extreme eastern division of the Appalachian Region and are confined to the area of the Catoctin and Blue Ridge mountains, including the Middletown valley, which occupies the region between them. The rocks of this age, which are represented, are entirely of igneous origin, and attain sufficiently distinct development to warrant separate treatment. The Algonkian rocks here found may be classified under the head of the Acid Volcanics, the Basic Volcanics, and the Granites.

THE ACID VOLCANICS.—The acid volcanics in Maryland occupy an irregular area north and northeast of Middletown between the Blue Ridge and Catoctin mountains, and extend nearly to the state line, while to the northwest of this main body are a few outlying masses. These rocks are close-grained and are holocrystalline mixtures of quartz and feldspar, which often show characteristic flow, spherulitic and even lithophysal structures. It seems evident, therefore, that the rocks were formed by the eruption of a silicious magma which cooled at or near the surface under conditions not unlike those shown by the volcanic rocks of the Yellowstone National Park. During the long periods of time that have followed since this mass has cooled, the material has slowly crystallized, so that the glass is now a quartz-feldspar mosaic, as the product of devitrification. In color, when fresh, it is dark blue or gray or occasionally red, although these colors change when the rock becomes weathered until the resulting tones are grayish or pinkish white. These acid volcanics have been known under the name of quartz-porphyries, quartzites, aporhyolites, etc., and have been the source of much discussion.

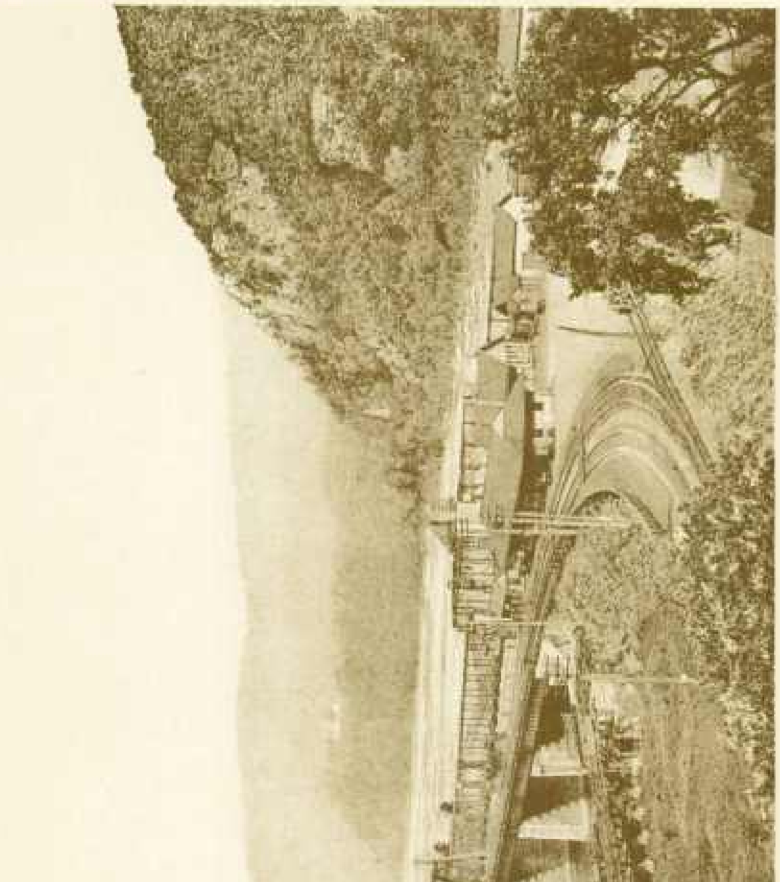
THE BASIC VOLCANICS.—The acid volcanics were preceded and followed by extrusions of more basic materials which now show considerable differences as the result of the varying conditions under which they were formed, and the earth movements to which they have been subsequently subjected. The rocks have been classed under the head of " Andesite " and " Catoctin schist " by Keith, who has made a special study of their occurrence. Both are affiliated in chemical composition with the Gabbro-Andesite family. The andesite as above distinguished is not developed in Maryland, the basic volcanics being alone represented by the Catoctin schists. On the Potomac river the schists seem almost crowded out by the numerous intrusions of granite. In the Middletown valley, however, about Middletown and to the north, as far as the state line, the schist is by far the most prominent type of rock. The fresh exposures of this rock are light bluish green in color and are usually covered with the schistose dull gray or yellow slabs which arise from weathering, or by the blocks of quartz and epidote which lie scattered over the surface after the rest of the material has been removed. The original rock was a diabase, which now has lost most of its characteristic features through the metamorphism which has developed the marked schistosity. The presence of amygdaloidal structures and textural variations, combined with the character of the field relations, makes it highly probable that these schists represent at least two lava flows (separated by longer or shorter intervals) which cooled slowly near the surface under conditions of low pressure.

THE GRANITE.—Intimately intermingled with and cutting the preceding acid and basic volcanics is an intricately anastamosing body of granite which occurs in long narrow belts varying in width from a yard to six miles, with an average of perhaps 100 yards. The areal distribution in Maryland is confined to the low land north of the Potomac river, between the Blue Ridge and Catoctin mountains. No evidence is at hand to show the relation between this mass of granite and those already described from northeastern Maryland. It seems probable, however, that they are of the same age and origin. The small tongues of granite running out into the schistose basic rocks indicate that the former is the younger and that it has been intruded into the latter. The granites show only a moderate amount of mica and are frequently garnet or epidote-bearing, the garnet-bearing type being well exposed along the Potomac a mile or so east of Harper's Ferry. Here, as in the rest of the area, the granites show marked evidence of dynamic metamorphism. The feldspars have been deformed and altered, first along the cracks and then finally entirely into lenticles of quartz, muscovite and chlorite. This final stage is macroscopically nothing more than a silicious slate or schist and is barely distinguishable from the end products of similar metamorphism in the more feldspathic schists and the Loudoun sandy slates.

THE CAMBRIAN PERIOD.

The rocks of the Cambrian are confined to the eastern division of the Appalachian Region, previously described as comprising the Blue Ridge and Great Valley, and cover considerable areas in Frederick and Washington counties. They consist of sedimentary materials that have been much metamorphosed since they were deposited, and also subjected to marked structural disturbances, rendering their relations at times difficult of interpretation. Five divisions have been recognized in the sequence of Cambrian deposits, known respectively as the Loudoun, Weverton, Harpers, Antietam and Shenandoah formations, the latter, however, being also in part of lower Silurian age.

The Loudoun Formation.—The Loudoun formation, so called from its typical development in Loudoun county, Virginia, is represented in Maryland in long narrow belts of rock accompanying the mountain ridges, and is found in the Catoctin Mountain, the Blue Ridge and the Elk Ridge. The deposits consist largely of a fine dark



THE GORGE OF THE POTOMAC AT HARPERS FERRY, LOOKING EAST, ON THE BALTIMORE & OHIO R. R.

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slate with limestones, shales, sandstones and conglomerates. The coarser and thicker deposits are found in narrow synclines upon the surface of the Algonkian rocks; the thinner and finer beds are in the synclines, which are succeeded by the Weverton sandstone. The limestones occur in the form of lenses in the slate and are best developed along the eastern side of the district just to the west of the Catoctin Mountain, where they are generally highly metamorphosed. Beds of sandstone occur in the Loudoun formation, although more prominently developed to the south of the Potomac river. The thickness of the formation is very variable, ranging from a few to over 500 feet.

The formation as a whole has been much metamorphosed, alteration being most apparent in the argillaceous beds, which have been changed into slates and schists, all traces of the original bedding being frequently lost. The slate readily decomposes, forming low ground, but the more silicious rocks commonly occur as small hills or ridges.

The Weverton Formation.—The Weverton formation, so called from its occurrence near Weverton at the point where the Blue Ridge reaches the Potomac river, consists of massive beds of fine, pure sandstone, quartzite, anl conglomerate. They are usually white, the coarser beds somewhat gray. In the Blue Ridge the sandstones are streaked with black and bluish bands. The deposits are mainly composed of quartz grains, which are well worn and are washed quite clean of fine argillaceous materials. They at times show cross-bedding, which indicates that the formation was largely laid down in shallow water. The thickness of the formation is quite variable, between 200 and 300 feet.

The Weverton sandstone has been subjected to but little metamorphism, as the quartz particles which comprise the deposits do not afford materials which admit of much alteration. Slight schistosity is evident in the southern part of the Catoctin Mountain. The sandstone decays slowly and generally forms projecting ledges on the surface of the country.

The Harpers Formation.—The Harpers formation, so called from its typical occurrence at Harper's Ferry, is composed largely of sandy shales with a few sandstone layers imbedded in its upper portion. The shales are of a dull bluish gray color when fresh, and weather to a light greenish gray. Argillaceous materials predominate, with frequent small grains of quartz and feldspar, while other materials derived from the Algonkian volcanics appear sparingly. The thickness of the Harpers formation is difficult to determine, owing to the absence of any complete section of it. Its outcrops are everywhere included between faults which have cut off intermediate thicknesses. It has been estimated, as the result of a number of measurements, to have a probable thickness of 1200 feet.

The shales have been subjected everywhere to considerable alteration, the feldspathic materials being partially recrystallized into quartz and mica, with the development of schistosity. The metamorphism is much more pronounced along the eastern border, in the Catoctin area, where the change has proceeded so far as to produce a mica-schist in which small quartz lenses are developed between the layers. Decomposition has affected the shale to considerable depths, the argillaceous materials furnishing a sufficient amount of clay to produce a soil of some value, but on steep slopes it is easily washed.

The Antietam Formation.—The Antietam formation receives its name from Antietam creek, along the tributaries of which the deposits of this formation are most typically developed. The rock is a sandstone which grades below by gradual transitions into the Harpers shale. The sandstone is composed of small grains of white quartzite well worn and sorted, and it contains a small percentage of carbonate of lime. Its color is almost invariably of a dull brown. It is more fossiliferous than the other Cambrian formations, remains of trilobites being not uncommon. The formation has a thickness of about 500 feet.

The Antietam sandstone shows little alteration in its typical area, but east of Catoctin Mountain there are some very silicious schists that may possibly represent it. The more calcareous varieties weather readily, but numerous blocks of the sandstone generally strew the surface.

The Shenandoah Formation (lower part).—The Shenandoah formation, so called from the fact that it forms the floor of the

Shenandoah valley, a part of the Great Valley above described, is composed of a series of blue and gray limestones and dolomites in which locally slates and sandy shales become imbedded. In certain places in eastern Washington county beds of pure fine-grained white marble are also found. The thickness of the Shenandoah formation is estimated to reach approximately 2500 feet. The slatey limestones and sandy shales are considered to form a series about 1000 feet below the top of the formation, and the white marble is known to lie below them. The structure is so complicated that the position of the various members of the formation is much obscured, and both the relations of the beds and the thickness of the formation can only be approximately given. Fossils are found in the lower portion of the limestones, but they are exceedingly rare. They are mainly trilobites and brachiopods of Cambrian age. The upper layers of the formation contain an abundance of fossils of lower Silurian age, and as no physical break occurs within the series of deposits the line between the Cambrian and Silurian cannot be definitely determined.

The limestone deposits have been but little altered, but the shaley beds have been generally more metamorphosed with the production of mica, which causes a more or less clearly defined schistosity. The decay of the limestone through solution has left an insoluble residuum of red clay, through which protrude at times beds of harder materials. The more rapid solution of the Shenandoah limestone than the rocks of the other formations has produced the broad fertile Hagerstown valley. Similar deposits also underlie much of the Frederick valley as well.

THE SILURIAN PERIOD.

The rocks of the Silurian period are found to the west of the Cambrian formations, which have just been described. They constitute a portion of the Great Valley, and together with the Devonian deposits enter into the formation of the Appalachian Mountains proper. They consist of sedimentary materials that have been but moderately metamorphosed since they were deposited, although at times subjected to considerable structural disturbances. Six divisions have been recognized in the sequence of Silurian deposits, known respectively as the Shenandoah (upper part), Martinsburg, Juniata, Tuscarora, Rockwood and Lewistown formations.

THE SHENANDOAH FORMATION (upper part).—The Shenandoah formation, which has already been described in the previous chapter as in part of Silurian age, contains an abundant fauna of fossil brachiopods, gasteropods, corals and crinoids in its upper beds. These forms are in the main identical with those found in the Trenton limestone of New York. As already stated, the line of separation between the Cambrian and Silurian portions of this formation cannot be definitely determined, since no physical break occurs. The upper portion of the formation does not differ materially from the lower, so that the description which has been given will serve for present needs.

THE MARTINSBURG FORMATION (Hudson river shales).—The Martinsburg formation, so called from its typical development in the vicinity of Martinsburg, West Virginia, occurs in several areas along the western border of the Hagerstown valley and in the region immediately adjacent to it upon the west. This formation consists of black and gray calcareous and argillaceous shales, which are fine-grained and show but slight variations within the limits of the state of Maryland. The shales bear from five to twenty per cent of carbonate of lime. The deposits were formed in shallow seas which abounded in graptolites, corals, brachiopods and trilobites which have left abundant fossil remains. The fauna is essentially that of the Hudson river shales of New York. The thickness of the formation varies from 700 to 1000 feet.

There has been but slight alteration in the shale, which is usually not sufficient to obscure the bedding which, however, was never sharply marked. The rocks of this formation have suffered considerable decay as the result of the solution of the carbonate of lime contained in them.

THE JUNIATA FORMATION (red Medina sandstone).—The Juniata formation, so called from its typical occurrence upon the Juniata river in Pennsylvania, is limited to the western portion of the central division of the Appalachian Region in western Allegany county. It is best developed in Wills Mountain to the northwest of Cumberland. The formation consists of alternating shales and sandstones of a deep red color. The formation has a thickness in Wills Mountain of at least 550 feet.

The Tuscarora Formation (white Medina sandstone), so called from its typical development in Tuscarora Mountain in Pennsylvania, is found at widely separated points in the Appalachian district. Upon the east it enters into the formation of North Mountain, the most eastern ridge of the central Appalachians, and upon the west forms Wills Mountain just to the west of Cumberland, and also occurs at several points in the intervening country. The rock is chiefly sandstone, which is hard and massive, generally white or gray in color, and consists for the most part of coarse quartz grains. Few fossils have been found in the Tuscarora formation, but it is the undoubted equivalent of the white Medina sandstone of the north. The thickness of the formation is probably not far from 1500 feet in the western portion of the district. The deposits of the Tuscarora formation have been subjected to little alteration and the hard sandstone stands out as ridges upon the surface.

The Rockwood Formation (Clinton shales).—The Rockwood formation, so called from its typical development at Rockwood, Tennessee, is confined to the central district of the Appalachian Region, occurring in three isolated belts in western Washington county, two to the east and one to the west of Hancock, and also in three tracts in central Allegany county, two to the east and one within and to the west of Cumberland, the latter area being separated into two parts by the ridge of Wills Mountain. The Rockwood formation consists mainly of brown and gray shales, which are very fine-grained and homogeneous. Bands of limestone are at times present in the shales in the upper portion of the formation. There are also two beds of iron ore, the lower near the base of the formation and the upper near the top. The original character of these two bands was probably that of a highly ferruginous, fossiliferous limestone from which the calcium carbonate has been removed in solution. Fossils are very numerous in the upper ore bed and in the shales immediately above and below it, and contain a mixed Clinton and Niagara fauna. The thickness of the Rockwood formation probably varies from 750 to 1000 feet in Maryland.

THE LEWISTOWN FORMATION (Niagara, Salina and Lower Helderberg).—The Lewistown formation, so named from its typical occurrence at Lewistown, Pennsylvania, is found in Maryland in the central portion of the Appalachian Region, occurring like the Rockwood formation in several belts confined to the eastern and western portions of this district, and occupying very nearly the same area as those above described for that formation. The deposits of the Lewistown formation consist chiefly of limestones with here and there interbedded shales. Three distinct divisions may be observed in the Lewtown formation which are well exposed to the east of Potomac Station in southern Allegany county, viz:

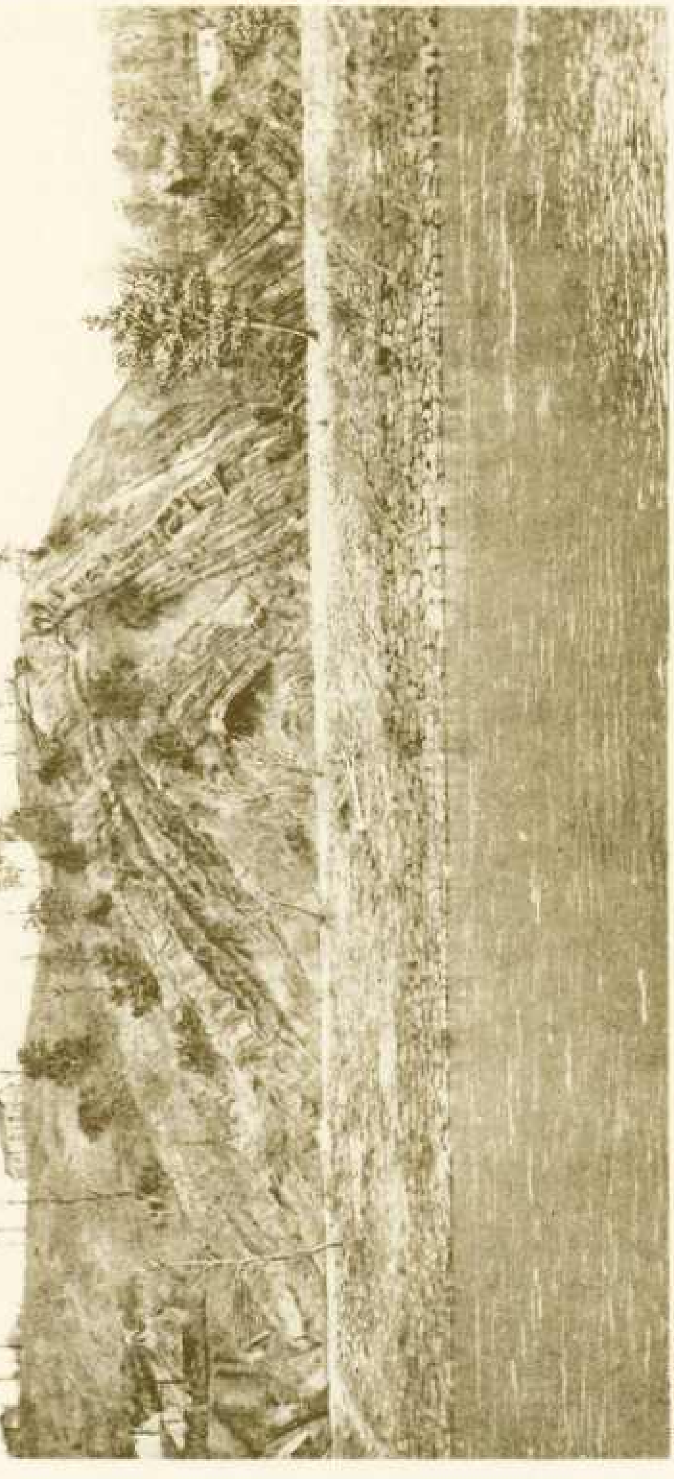
Upper limestone series	640	feet thick
Cement series	465	
Lower limestone series	200	
Total	1305	feet

The upper and lower limestone series contain fossils, but they are apparently entirely lacking in the intervening cement series.

THE DEVONIAN PERIOD.

The deposits of Devonian age enter, together with the Silurian rocks, into the formation of the central division of the Appalachian Region, and together with the Carboniferous deposits into the formation of the Alleghany Plateau. They consist of sedimentary materials that have been but little altered since they were deposited, although in places subjected to considerable structural disturbances. Four divisions are recognized in the sequence of Devonian deposits, known as the Monterey, Romney, Jennings and Hampshire formations.

THE MONTEREY FORMATION (Oriskany sandstone).—The Monterey formation, so called from its typical occurrence at Monterey,



FOLDED STRATA OF LEWISTOWN FORMATION AT HANCOCK, ON THE BALTIMORE & OHIO R. R.

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Virginia, is confined, like the upper Silurian formations, to the central division of the Appalachian Region in western Washington and Allegany counties. The deposits of the Monterey formation are typically rather coarse-grained, somewhat friable sandstones, white or yellow in color. At times the materials become very coarse-grained, resulting in a clearly defined conglomerate, while at other times, especially in the western portion of the area, the materials are fine-grained, with here and there interstratified layers of coarser materials. These deposits afford excellent glass sand. The sandstone is very fossiliferous and carries the typical Oriskany fauna of the north. The formation has a thickness of about 300 feet.

The Romney Formation (Hamilton shales).—The Romney formation, so called from its typical development in Romney, West Virginia, is also confined to the central division of the Appalachian Region and occupies very much the same areas as those above given for the Monterey (Oriskany) sandstones. The formation consists of black and drab shales with thin bands of limestone. No sandstones are known to enter into the composition of the deposits, which are uniformly fine-grained and homogeneous. The strata are fossiliferous and bear a fauna which is closely related to that of the Hamilton shales farther north. The formation has a thickness of about 750 feet.

The Jennings Formation (Chemung group).—The Jennings formation, so called from its typical development at Jennings Gap, Virginia, is found both throughout the central and western divisions of the Appalachian Region. With the Appalachian mountains proper it is frequently repeated throughout western Washington and Allegany counties and occurs as the oldest formation represented in the Alleghany mountains of Garrett county. It underlies the well known "glades." The deposits of the Jennings formation consist of dull green or gray shales with interbedded fine-grained sandstones, although the latter are not generally prominent. In some instances the sandstone beds are sufficiently resistant to form well-marked ridges, as is shown in the area to the east of Cumberland. Near the top of the formation there is a conglomerate, which serves to establish the upper limits of the formation in Maryland. The thickness of the Jennings formation in Maryland is probably between 2000 and 3000 feet. It has yielded a considerable fauna of trilobites, gasteropods, lamellibranchs and brachiopods which present close affinities with the Chemung forms of the north.

THE HAMPSHIRE FORMATION.—The Hampshire formation, so called from Hampshire county, West Virginia, is found represented, like the Jennings formation, both in the central and western portions of the Appalachian Region, but is best developed in the western portion of Allegany and Garrett counties, where excellent sections occur along the Alleghany front, and may also be seen to good advantage in Jennings' and Braddock's runs west of Cumberland. From these latter points the strata dip beneath the Carboniferous rocks of the George's Creek Valley, occurring again in a broad Y-shaped belt which extends from northeast to southwest across Garrett county. The deposits of the Hampshire formation consist principally of thin-bedded sandstones, separated by fine-grained shales, although at times the sandstones become thick-bedded and may merge gradually into the shales. The shales which predominate in the upper portion of the Hampshire formation are for the most part of a reddish color, although at times brown or grey. The thickness of the formation somewhat exceeds 2000 feet. No fossils have as yet been obtained from the Hampshire formation in Maryland, but the formation is undoubtedly the equivalent of the Catskill of the North.

THE CARBONIFEROUS PERIOD.

The rocks of Carboniferous age are confined to the western division of the Appalachian Region, where they largely make up the Alleghany Plateau and are found in western Allegany and Garrett counties. The formations represented are the Pocono, Greenbrier, Mauch Chunk, Pottsville, Savage, Bayard, Fairfax and Elkgarden.

THE POCONO FORMATION.—The Pocono formation, so called from Pocono, Pennsylvania, is the basal member of the Carboniferous and directly overlies the Hampshire formation above described. It occurs in a series of narrow belts which extend from northeast to southwest through western Allegany and Garrett counties. The Pocono formation consists mainly of hard, thin-bedded, flaggy sandstone which is seldom coarse-grained, although in a few instances slightly conglomeratic. Thin layers of black shale and coaly streaks, in which plant remains are sometimes preserved, occur in some localities, although not a conspicuous feature of the formation. The sandstones have afforded good flagging materials. The thickness of the formation varies from 100 to 200 feet, but the deposits are seldom well exposed. The sandstone is, however, something of a factor in the topography, and usually forms a line of foothills along the flanks of the mountains.

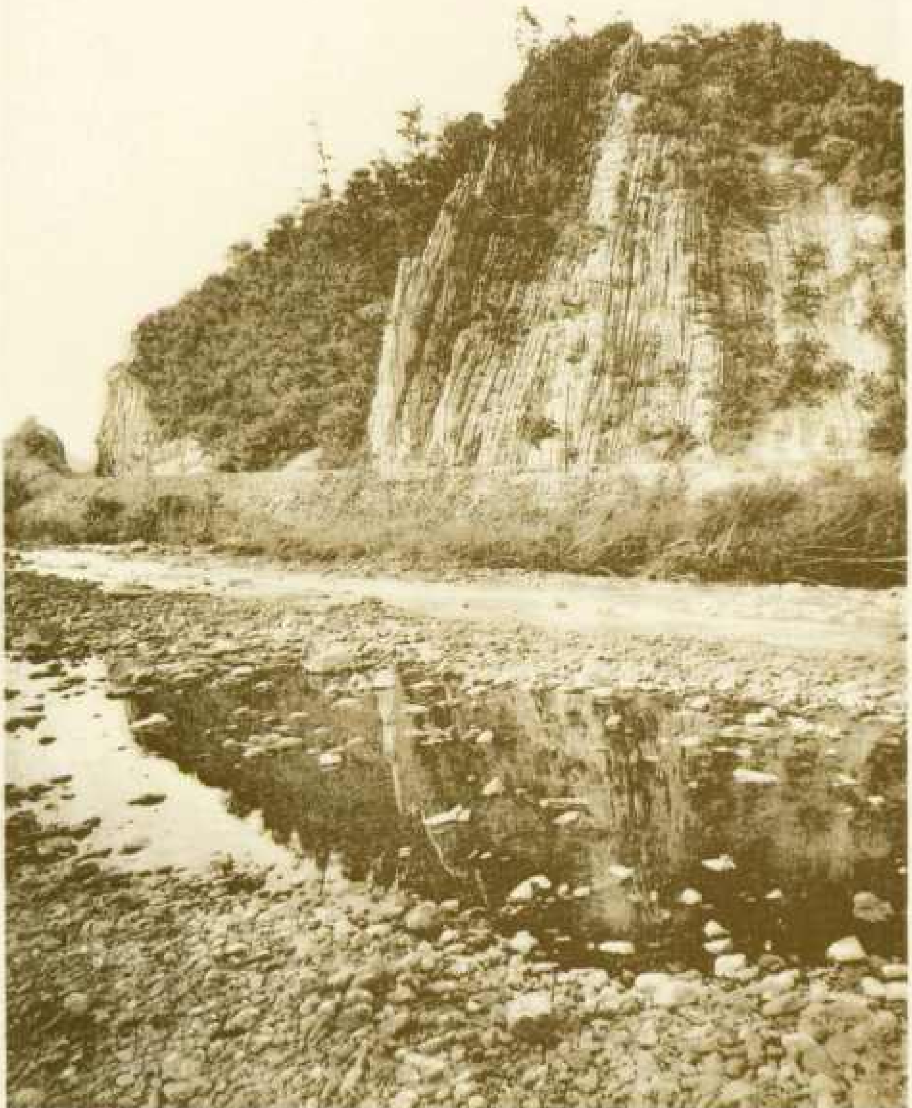
The Greenbrier Formation.—The Greenbrier formation, so called from Greenbrier county, West Virginia, occurs in very much the same areas in western Allegany and Garrett counties as above described for the Pocono sandstone, and outcrops above the line of foothills just described. The deposits consist mainly of limestone strata in which are interbedded shales and some sandstones. The limestones are more sandy towards the base. The limestones near the upper portion of the formation are of compact structure and gray in color. They are also at times marly in their upper layers and these marly strata are frequently fossiliferous. The limestone is burned locally for building and agricultural purposes. The formation has a thickness of about 200 feet.

The Mauch Chunk Formation (Canaan formation).—The Mauch Chunk formation, so called from Mauch Chunk, Pennsylvania, flanks the ridges of western Allegany and Garrett counties and grades gradually downward into the Greenbrier deposits. The strata consist chiefly of red shales interstratified with flaggy, red-brown, fine-grained sandstones. The sandstone is at times micaceous. Thin beds of dark carbonaceous shales occur at times near the top of the formation. The deposits have a thickness of from about 800 to 1000 feet.

The Pottsville Formation (Blackwater formation).—The Pottsville formation, so called from Pottsville, Pennsylvania, is the lowest division of the Coal Measures and forms the mountain ridges which border the coal basins. The Pottsville formation consists of beds of sandstone and conglomerate interstratified with sandy shales in which thin beds of coal are locally developed. The sandstones and conglomerates are mainly composed of pure quartz grains and pebbles, which are commonly cemented by means of silicious materials. These coarse deposits are also frequently cross-bedded and are very irregular in both their extent and sequence. Important deposits of fire-clays are found in the Pottsville formation. They occur at two horizons, one above the middle of the upper half of the formation and the other in a similar position in the lower portion. Overlying the upper fire-clay deposit is a thin seam of coal which has been exploited to some extent at the Mount Savage mines and may prove of value at other points. The thickness of the formation is between 300 and 350 feet.

THE SAVAGE FORMATION.—The Savage formation, so called from Savage mountain, Maryland, is the lowest of the coal-bearing formations in western Allegany and Garrett counties and occupies the basal portion of the basins within the synclines, which are outlined by the Pottsville conglomerates. The deposits consist of shales and sandstones in which are interbedded several coal seams. The most valuable of these coal seams is known as the "Six-foot Vein," which is found at the top of the formation. It is the most important coal seam next to the "Big Vein" of the Elkgarden formation. Another seam of coal of some importance, which, however, seldom reaches 3 feet in thickness, is found about 30 feet from the base of the formation. There are also one or two seams of smaller proportions which have never been regarded of economic importance. The sandstones and shales are very variable, the sandstones often becoming shaley. The thickness of the formation is about 150 feet.

THE BAYARD FORMATION.—The Bayard formation, so called from Bayard, West Virginia, overlies the Savage formation, above described, and has in general the same area of distribution. The deposits consist of sandstones in which are interbedded three workable seams of coal. The lower portion of the formation consists of rather thick-bedded sandstones in which are interbedded thinner sandstones and shales and an unimportant coal seam. The middle of the formation consists of shales, with thin-bedded sandstone in which are interstratified the three workable seams of coal, viz.: the "Three-foot Vein," near the base; the "Two-foot Vein," which is some 50 feet higher; and the "Four-foot Vein," which is at the top of this division.



VIEW OF "DEVIL'S BACKBONE" IN LEWISTOWN FORMATION,
NORTH OF CUMBERLAND, ON THE BALTIMORE & OHIO R. R.

Several bands of blue limestone are also found in this division. The upper member of the Bayard formation consists of thick-bedded sandstones, sometimes flaggy, but almost always without traces of coal. Its lithologic characters serve as a guide, however, to the location of the underlying coals. The Bayard formation has a thickness of about 400 feet.

The Fairfax Formation.—The Fairfax formation, so called from Fairfax, West Virginia, has only been observed to the east of the Alleghany front in western Allegany and eastern Garrett counties, where it occurs in a restricted area in the basin of the North Branch of the Potomac river and its tributaries. This formation is mainly composed of shales in which argillaceous sandstone beds are interstratified. It contains little carbonaceous material and has been referred to as the Barren Measures. There is, however, an "18-inch Vein," which generally bears coal of good quality, found about 50 feet below the top of the formation. At about the centre of the formation there is an impure carbonaceous bed that is locally known as "The Dirty Nine," but which has no economic value. The Fairfax formation has a thickness of about 300 feet.

The Elkgarden Formation.—The Elkgarden formation, so called from Elkgarden, West Virginia, is like the Fairfax formation confined to the valley of the North Branch of the Potomac river and its tributaries, and is especially well developed in the central and northern portions of the George's Creek Valley in western Allegany county. The formation consists for the most part of shales in which are interbedded several sandstone layers and two important coal seams. The most important coal vein is situated at the base of the formation and is called the "Big Vein" or the "Fourteen-foot Vein." It is the most important coal-bearing seam in Maryland and is known in Pennsylvania as the "Pittsburg Vein." It affords coal of high quality and great purity, and has been a source of great wealth to the state. It varies in thickness, commonly from 10 to 14 feet, but in local areas has been found to reach 17 feet. About 115 feet above the top of the "Big Vein" is a coal seam which is known as the "Gas Coal" or "Tyson Vein." It has a thickness of from 3 to 7 feet. The thickness of the Elkgarden formation is about 250 feet.

THE PERMIAN PERIOD.

The rocks which are here questionably referred to the Permian are confined to the central portion of the George's Creek valley in western Allegany county where they rest with apparent conformity upon the Carboniferous deposits below. The single formation recognized in these rocks of doubtful Permian age is denominated the Frostburg formation.

The Frostburg Formation.—The Frostburg formation, so called from Frostburg in Allegany county, apparently conformably overlies the Elkgarden formation of Carboniferous age. It occurs in patches along the centre of the Georges Creek valley, chiefly in the vicinity of Frostburg, where erosion has left fragments capping the tops of the higher lands. The Frostburg formation consists of limestones, sandstones, and shales, the limestones occurring in several bands and at different horizons. The most important of these limestone beds forms the base of the formation. Sufficiently distinctive fossils have not yet been obtained from the Frostburg formation and its separation from the Carboniferous formations below is not yet definitely determined. The difference in the character of the materials as compared with the formations below is striking, indicating that the physical conditions had changed prior to the deposition of the materials. The coal beds of earlier date are entirely lacking and in their place we have deposits which indicate deeper waters, in which, during much of the time, little sediment was being laid down. The thickness of the Frostburg formation is about 250 feet.

The Coastal Plain.

The area of low land which borders the Piedmont Plateau upon the east and passes with constantly decreasing elevation seaward has already been described under the name of the Coastal Plain. It is part of that great belt of low country which extends from New Jersey to the Gulf and is made up of geological formations of younger date than those which have been hitherto described. These later formations stand in marked contrast to the strata in other portions of the state in that they have been but slightly changed since they were deposited. Laid down one above another upon the eastern flank of the Piedmont Plateau when the sea occupied the present area of the Coastal Plain, these later sediments form a series of thin sheets, which are inclined slightly to the seaward, so that successively later formations are encountered in passing from the inland border of the region toward the coast. Oscillation of the sea floor, with considerable variation both in the angle and direction of the tilting, went on, however, during the period of Coastal Plain deposition. As a result the stratigraphic relations of these formations, which have generally been held to be of the simplest character, possess in reality much complexity along their western margin, and it is not uncommon to find that intermediate members of the series are lacking, as the result of transgression, so that the discrimination of the different horizons, in the absence of fossils, is often attended with great uncertainty.

The Coastal Plain sediments, deposited after a long break in time between the red sandstones and shales (Newark formation) of Triassic age (hitherto described as overlying the crystalline rocks of the western division of the Piedmont Plateau) and the lowermost of the series now to be considered, complete the sequence of geological formations found represented in Maryland. From the time deposition opened in the coastal region during late Jurassic or early Cretaceous time to the present nearly constant sedimentation has apparently been going on, although frequent unconformity appears along the landward margins of the different formations.

The formations of the Coastal Plain consist of the following:

FORMATIONS OF THE COASTAL PLAIN.

		Formations of the Coastal Plain.	
CENOZOIC.			
	Pleistocene	Columbia.	
	Neocene	Lafayette.	
		Chesapeake.	
	Eocene	Pamunkey.	
MESOZOIC.			
	Cretaceous	Raucocas.	
		Monmouth.	
		Matawan.	
		Raritan.	= Potomac Group.
		Patapsco.	
	Jurassic (?)	Arundel.	
		Patuxent.	

THE JURASSIC PERIOD.

The deposits in Maryland which are here doubtfully referred to the Jurassic period include the lower portions of what has been commonly denominated the Potomac formation, but which is now known to represent several quite distinct geological horizons. This thick series of strata which extends as a continuous belt from New Jersey southward across Maryland into Virginia and which occurs also in the South Atlantic and Gulf states can be separated upon both physical and paleontological grounds into four formations, the two lower known as the Patuxent and Arundel formations being provisionally referred to the Jurassic period.

THE PATUXENT FORMATION.—The Patuxent formation, so called from its typical development in the upper valleys of the Little and Big Patuxent rivers, is the basal formation of the Coastal Plain series, and is found lying directly upon the crystalline rocks of the Piedmont Plateau. It appears near the landward margin of the Coastal Plain and has been traced as a narrow and broken belt from Cecil county across Harford, Baltimore, Anne Arundel and Prince George's counties to the borders of the District of Columbia.

The deposits consist mainly of sand, sometimes quite pure and gritty, but generally containing a considerable amount of kaolinized feldspar, producing a clearly defined arkose. Clay lumps are at times scattered in considerable numbers through the arenaceous beds. Frequently the sands pass over gradually into sandy clays, and these in turn into argillaceous materials, which are commonly of light color, but often become highly colored and are locally not unlike the variegated clays of the Patapsco formation. The more arenaceous deposits are cross-bedded, and the whole formation gives evidence of shallow water origin. The Patuxent formation is estimated to attain a thickness of about 150 feet, but it may be considerably thicker at some points. No distinctive fossils have as yet been found in this formation in Maryland.

THE ARUNDEL FORMATION.—The Arundel formation, so called from Anne Arundel county, where the strata are well developed, consists of a series of large and small lenses of iron-ore bearing clays which occupy ancient depressions in the surface of the Patuxent formation. These lenses have been traced all the way from Cecil county to the border of the District of Columbia. The clays are highly carbonaceous, lignitized trunks of trees being often encountered in an upright position with their larger roots still intact. Scattered through the tough, dark clays are vast quantities of nodules of iron carbonate, at times reaching many tons in weight, and known to the miners under the name of "white ore." In the upper portion of the formation the carbonate ores have changed to hydrous oxides of iron, which the miners recognize under the name of "brown ore." The largest lenses have been found to reach a thickness of nearly 125 feet.

The fossils thus far found consist mainly of Dinosaurian remains, which Professor Marsh regards as indisputable proof of the Jurassic age of the deposits. Among the few plant fossils thus far collected from this horizon no dicotyledonous types of vegetable life have as yet been detected, and from what is known of the flora there is nothing that would hinder its reference to the Jurassic. Both the physical and paleontological characteristics of the deposits point to swamp conditions as affording the only satisfactory explanation for the origin of the formation. This could have been brought about by landward tilting of the continent accompanied by a clogging of the drainage lines.

THE CRETACEOUS PERIOD.

The formations grouped under this head comprise members of both the lower and upper Cretaceous, a marked line of unconformity occurring between the two groups. To the north of Maryland, in eastern New Jersey, deposits of undoubted Cretaceous age pass conformably over into the basal strata of the Tertiary, but in Maryland the break between the uppermost member of the Cretaceous series and the Eocene is sharply defined. The Cretaceous deposits extend as a broad belt from New Jersey across Maryland into Virginia. Five distinct formations may be recognized in Maryland, viz.: the Patapsco and Raritan formations of lower Cretaceous age and the Matawan, Monmouth and Rancocas formations of upper Cretaceous age.

THE PATAPSCO FORMATION.—The Patapsco formation, so called from its typical occurrence in the valley of the Patapsco river, forms the lowest division of the Cretaceous deposits here described. It extends entirely across the state from the Delaware border to the Potomac river, and throughout this distance is one of the most important members of the Cretaceous series.

The deposits of this division consist chiefly of highly colored and variegated clays which grade over into lighter colored sandy clays, while sandy bands of coarser materials are at times interstratified. The sands frequently contain much decomposed feldspar, and rounded lumps of clay occur at times. The sands are often cross-bedded, and all the deposits give evidence of shallow water origin. The formation is estimated to reach a thickness of 200 feet. The deposits rest very unconformably upon the Arundel below.

The fossils obtained from this formation consist entirely of plant impressions and a few indeterminate molluscan shells. The flora is very rich both in species and individuals. It has already been extensively investigated by Professor Ward of the U. S. Geological Survey, who finds a considerable representation of dicotyledonous types of vegetable life among the forms examined. The general assemblage of types is distinctly Cretaceous.

The Raritan Formation.—The Raritan formation, so called from its typical development in the valley of the Raritan river in New Jersey, extends across that state into Maryland. It is found in Cecil and Kent counties and extends thence southeastward along the eastern border of Harford and Baltimore counties into Anne Arundel county, where it broadens out and occupies a large extent of country along the Severn river. Beyond the Patuxent valley the area of outcrop narrows, as the result of the transgression of the overlying upper Cretaceous strata.

The deposits of the Raritan formation consist chiefly of thick-bedded and light colored sands, which at times become gravels. Frequently in the lower portion of the formation the sands grade over into clays, which are generally light in color and highly silicious, although they are sometimes deeply colored. The thickness of the Raritan formation reaches about 500 feet. The deposits overlie unconformably the Patapsco sediments below.

The fossils are quite distinct from those which are found in the Patapsco formation and abound much more largely in dicotyledonous types of vegetable life. Most of the species are identical with those found in the Amboy clays of New Jersey which form the northern extension of the formation as developed in Maryland.

The Matawan Formation.—The Matawan formation receives its name from Matawan creek in Monmouth county, New Jersey, where the deposits of this horizon are typically developed. It is the most widely extended of the upper Cretaceous formations and reaches from the shores of the Raritan Bay across New Jersey, Delaware and Maryland to the Potomac river. Throughout Virginia it is buried beneath later deposits which have transgressed it, but it reappears again in the Carolinas. Within the limits of Maryland it forms a narrow belt which crosses southern Cecil and northern Kent counties, and then reappears upon the western shore of the Chesapeake in eastern Anne Arundel county, and thence continues southwesterly with constantly narrowing confines across Anne Arundel and Prince George's counties, during the latter part of its course appearing as a narrow band along the westward face of an ill-defined escarpment.

The deposits of the Matawan formation consist mainly of dark colored micaceous, sandy clays, which are generally argillaceous in their lower part and sandy toward the top. Upon the eastern shore of Maryland the Matawan formation has a thickness of very nearly 100 feet, but it has already considerably declined in eastern Anne Arundel county, where it is about 50 feet, and thence continues to decrease southeastward, until in the vicinity of Fort Washington it has declined to 15 feet in thickness, as a result of the gradual transgression of the Eocene deposits.

The fossils of the Matawan formation are highly characteristic of its upper Cretaceous age. Numerous marine mollusca, among them several species of characteristic ammonites, are found among its fauna. Some of these forms range into the next succeeding Monmouth formation, but many are restricted to the Matawan.

The Monmouth Formation.—The Monmouth formation, so called from its typical development in the region of the Monmouth

Battle Ground, in Monmouth county, New Jersey, extends from New Jersey southward across Delaware into Maryland, but is much less extensively or typically developed in the state of Maryland than to the northward, although some of its characteristic features are still prominent. The Monmouth formation lies to the east of the Matawan deposits above described and forms a narrow belt crossing Cecil, Kent, Anne Arundel and portions of Prince George's counties, but gradually disappears beyond the valley of the Patuxent as a result of the transgression of the Eocene deposits.

Upon the eastern shore of Maryland we find the three subdivisions of the Monmouth formation which characterize the New Jersey deposits represented, viz.: the basal red sands (Mount Laurel sands), overlain by a well defined marl bed (Navesink marl), and this in turn capped by slightly glauconitic red sands (Redbank sands); but upon the western shore of Maryland the differentiation of the Monmouth formation into these several parts is no longer possible, the formation being represented by fine pinkish sands, which are sparingly glauconitic and which show no constant separation into lithologic zones. The deposits have a thickness of about 75 feet upon the eastern shore, but do not exceed 50 feet in Anne Arundel county, and gradually decline in thickness until their final disappearance beyond the Patuxent valley.

The fossils of the Monmouth formation are not strikingly different from those of the Matawan formation, although there are many which are distinctive; while at the same time the more characteristic forms of the Matawan formation are not found in the Monmouth. The deposits are of undoubted upper Cretaceous age.

The Rancocas Formation.—The Rancocas formation, so called from its typical occurrence in the valley of Rancocas creek in southern New Jersey, is well developed upon the eastern shore of Maryland, where it forms a broad belt across Cecil and Kent counties to the east of the Monmouth formation, and is the direct southward extension of similar deposits in New Jersey and Delaware. On the western side of the Chesapeake Bay it is found in only a few isolated patches in the extreme eastern portion of Anne Arundel county near the mouths of the Severn and Magothy rivers.

The Rancocas formation consists of greensand marls, which in some localities are highly calcareous on account of the large number of shells of various molluscan forms. In general the deposits are quite arenaceous and are commonly less glauconitic than the same beds in New Jersey. The deposits have a thickness of from 50 to 60 feet in Kent county, where they are most extensively developed, but on the western shore of the Chesapeake they nowhere appear at the surface with a greater thickness than 4 or 5 feet.

The fossils of the Rancocas formation are highly characteristic and are in the main quite distinct from those which are found in the Matawan and Monmouth formations. Their upper Cretaceous age is, however, clearly apparent, and they are generally regarded as occupying a very high position in that division.

THE EOCENE PERIOD.

The deposits overlying the Cretaceous formations, above described, have, from a very early period, been regarded as of early Tertiary age, although our knowledge of them was confined to a few localities from which characteristic fossils had been obtained. Later study, however, has shown both the proper stratigraphic and paleontologic relations of these deposits, so that they are now well understood.

The Pamunkey Formation.—The Pamunkey formation, so called from its highly characteristic development in the valley of the Pamunkey river in Virginia, extends across Maryland from northeast to southwest, through the counties of Kent and Queen Anne's on the Eastern Shore and of Anne Arundel, Prince George's and Charles in southern Maryland. Its area of outcrop constantly broadens from the Delaware line (to the north of which it is buried by the transgression of the Neocene deposits) toward the southwest, and in the valley of the Potomac river has a width of more than 15 miles.

The deposits of the Pamunkey formation are highly glauconitic and are found in their unweathered state either as dark gray or green sands or clays. The glauconite varies in amount from very nearly pure beds of that substance to deposits in which the arenaceous and argillaceous elements predominate, although the strata are generally very homogeneous through considerable thicknesses. In certain horizons the shells of organisms are found commingled with the glauconitic materials in such numbers as largely to make up the beds, producing what is known as a greensand marl, and these beds are at times so indurated as to form limestone layers. When the glauconite is weathered the deposits lose their characteristic gray and green color and generally become lighter gray with reddish or reddish brown streaks or bands, or may become entirely of the latter color. In this condition they are often cemented into a ferruginous sandstone. The unweathered deposits are found mainly in Charles and Prince George's counties, while the weathered beds appear chiefly to the northward in Anne Arundel county and upon the eastern shore of the Chesapeake.

The fossils of the Pamunkey formation are numerous and characteristic and admit of separation into two clearly defined faunal zones, the lower of which has been described as the Aquia Creek stage and the upper as the Woodstock stage.

The Aquia Creek stage, so called from its typical development along the banks of Aquia creek, a tributary of the Potomac, contains a highly characteristic fauna, which has caused the correlation of this division with the lower Eocene of the southern Atlantic and Gulf states. No satisfactory stratigraphic limits have as yet been assigned to this division and the deposits seem to grade gradually upward into the overlying division.

The Woodstock stage, so called from its typical development at Woodstock, Va., on the southern bank of the Potomac, about 15 miles below Aquia creek, is characterized by a fauna which has been shown to be the same as that contained in the middle Eocene in the Gulf states. As above stated, no satisfactory stratigraphic line has as yet been detected separating this division from that which is found beneath it, so that it may be regarded for the present simply as a faunal zone.

THE NEOCENE PERIOD.

The Neocene deposits of Maryland occupy a broad area in the eastern portion of the state and consist of strata which attain greater thickness than those of any other period represented in the Coastal

Plain, with the possible exception of the Cretaceous. The deposits of Neocene age have been divided into two formations, viz., the Chesapeake and Lafayette formations.

The Chesapeake Formation.—The Chesapeake formation, so called from its extensive development upon the shores of the Chesapeake Bay, extends as a broad belt across the state and occurs likewise in the areas both to the north and the south of Maryland as an important member of the Coastal Plain series. The strata overlie unconformably those of the Pamunkey formation and gradually overlap the latter toward the north, and just beyond the Delaware border rest directly upon the upper Cretaceous beds.

The deposits of the Chesapeake formation consist of sands, clays, marls and diatomaceous beds, the latter composed chiefly of the tests of the microscopic plant forms called diatoms, and mainly confined to the lower portion of the formation. The diatomaceous beds afford fine sections at Pope's creek on the Potomac, at the mouth of Lyon's creek, a tributary of the Patuxent, and at Herring Bay on the west shore of the Chesapeake. At these points the light colored bluffs are very striking objects in the landscape. The nearly pure diatomaceous earth reaches a thickness of about 30 feet, although the remains of diatoms are found scattered in greater or less amounts throughout the overlying strata. This diatomaceous earth can be traced from the eastern shore of Maryland entirely across the state and thence southward into Virginia. From its wide occurrence in the vicinity of Richmond it is sometimes known as "Richmond earth." It was long referred to in the literature of the subject as "Bermuda earth," from its supposed occurrence on the Island of Bermuda, but the specimen upon which the reference was based was ultimately shown to have come from "Bermuda Hundred" on the James river. The diatomaceous earth is frequently described under the names of "Infusorial earth," "Tripoli" and "Silica." The higher portions of the Chesapeake formation are comprised of sands and clays of various colors and frequently carry vast numbers of molluscan shells. Extensive beds of shell marl underlie much of the Miocene country. These deposits become at times cemented into hard limestone ledges. At some points the beds are carbonaceous, as at the mouth of the Patuxent river, where a bed of lignite several feet in thickness is exposed at water level.

The fossils are very numerous, consisting mainly of diatoms, corals, mollusks, brachiopods and cetaceans, which admit of a division of the strata into faunal zones, as in the case of the Eocene. Three such faunal zones have been described in the Miocene of Maryland, viz.: 1. *The Plum Point fauna,* 2. *The Jones' Wharf fauna,* 3. *The St. Mary's fauna,* the determination in each case being based entirely upon the molluscan types.

THE LAFAYETTE FORMATION.—The Lafayette formation, so called on account of the similarity of the strata in Maryland to those described by Hilgard in Mississippi under that name, widely covers the deposits of the Coastal Plain, hitherto described, and occupies a broad area throughout the southern and eastern portions of the state. In southern Maryland the Lafayette formation covers the higher levels, but is found at a much less elevation in the eastern counties, where it passes eastward beneath the covering of Pleistocene deposits.

The deposits of the Lafayette formation consist of gravels, sands and clays, which are very irregularly stratified and often change rapidly within narrow limits. Toward the ancient shore line the formation is a coarse gravel, through which is scattered a yellowish sandy loam, the whole cemented at times by hydrous iron oxide into a more or less compact conglomerate. The eastward extension of the formation shows a gradual lessening of the coarser elements and a larger admixture of loam. The constituent materials out of which the deposits are formed are frequently much weathered and become a pronounced arkose. The deep orange color of the strata is highly characteristic of the formation. The deposits seldom exceed 25 feet in thickness, although at some points a thickness considerably greater has been observed.

The Lafayette formation has afforded no fossils in the state of Maryland to indicate its geological age. From the fact, however, that the strata rest unconformably upon the underlying Chesapeake deposits of Miocene age and are in turn unconformably overlain by

Pleistocene strata, they have been considered to represent the Pliocene, and thus to belong to the Neocene. Where they are exposed as a superficial covering at the higher levels the strata exhibit much more extensive changes than the Pleistocene deposits, so that it is probable that much time must have elapsed after the former were laid down before the deposition of the latter. The chronological determination of the Lafayette formation is based, therefore, upon geological rather than paleontological grounds.

THE PLEISTOCENE PERIOD.

Superficially overlying the other formations of the Coastal Plain are deposits of Pleistocene age, which with marked variation in thickness, composition and structure extend from the glacial accumulations of northern New Jersey through the southern Atlantic and Gulf states to the Mexican border. The deposits of the Pleistocene in Maryland have been grouped in a single division, known as the Columbia formation.

THE COLUMBIA FORMATION.—The Columbia formation, so called from its characteristic development in the District of Columbia, widely covers the other deposits of the Coastal Plain throughout the eastern and southern counties of the state, and at the border of that region extends far along the various stream channels which enter from the Piedmont Plateau. The higher area of the central and western portions of the Coastal Plain were apparently never reached by the Columbia seas.

The deposits of the Columbia formation consist of gravels, sands and clays, which differ from the preceding deposits of the Lafayette formation in containing much less decomposed materials and in having suffered far less denudation since they were deposited. The deposits are generally coarsely stratified, with frequent occurrence of cross-bedding.

The Columbia period is divisible into an earlier and a later subdivision, represented in deposits occupying high and low levels respectively. The *earlier* deposits are more nearly similar to those of the Lafayette in color and in the greater frequence of decomposed materials, and were probably to a considerable extent formed of the redeposited materials of that formation. They show evidences of much less age, however, although they have suffered considerably as the result of denudation. The *later* deposits form well-marked terraces along the stream channels throughout the western portion of the Coastal Plain, and also cover much of the lower portion of the intervening country. In the low land of the extreme southeastern section of the state they bury from view all of the underlying strata.

The relatively small amount of denudation which the Columbia deposits have suffered as a whole, compared with the earlier formations, renders it possible to detect three distinct phases, which have been described as the *fluvial* phase, the *inter-fluvial* phase, and the *low-level* phase; the first or *fluvial phase* reaching the fullest development along the leading water-ways and their larger tributaries and consisting in its lower horizon of coarse pebbles and boulders, passing upward into a brownish loam; the second or *inter-fluvial phase* being found typically represented in the country which lies between the water-ways and characterized by materials of local origin and produced largely by wave action, although frequent gradations into the fluvial phase are to be found toward the leading water-ways or at points where the currents have transported large amounts of river-derived materials; the last or *low-level phase* being developed throughout the area of complete submergence, beyond the action of the streams, where more regularly stratified deposits of sands, clays and loams abound. It is this phase which is regarded as coating, with greater or less thickness, the great area of extremely low country which forms the eastern portion of the Coastal Plain.

Review of Geological Chronology as Represented in Maryland.

In the earliest days of the earth's existence of which we can take cognizance, when as yet the oldest strata which carry evidence of life had not been laid down, the continent of North America was but roughly outlined. There was above the ocean level, first of all, a great V of crystalline rock whose apex was in the Adirondack mountains in New York, while its two arms reached one toward Alaska and the other toward Labrador. Upon this great skeleton the continental area has since been gradually built up by accumulation of sediments along its borders; yet in these early days there were additional areas above the seas which furnished the source of some of this sedimentary material, but which have themselves more or less completely disappeared. We must to-day draw our inferences regarding the character and extent of these areas both from the nature of the rock comprising their scanty fragments and from the character and relations of the strata of later date. There is no positive evidence that we have represented in Maryland any of the rocks of this earliest portion of Archean time, although it is not impossible that part of the gneiss complex may represent it.

There is much evidence in support of the view that the later portion of Archean time, which has been referred to as the Algonkian period, is represented by rocks of many varieties within the limits of the state of Maryland. The proof of this is seen not only in the character of the rocks themselves, but also when we consider the vast thickness of sediments which accumulated later, during the whole lapse of Paleozoic time, in the great trough in which the Appalachian mountains were formed. We are compelled to assume a great continent or mountainous mass lying along the southeastern edge of our present continent and extending perhaps eastward well into, if not beyond, the limits of the Coastal Plain, although we can form but little conception of the form and area of this ancient land mass. That it must often have stood at some considerable elevation above sea-level and have borne streams of no mean proportion is shown by the rapidity with which sediments, often coarse in nature, were furnished to the inland sea which stretched along its western margin. To-day we have preserved to us in the crystalline plateau which extends from New York to Alabama along the eastern base of the present Appalachian mountains, with a width of 300 miles in the Carolinas, the merest remnant of this ancient continent. These rocks with the eruptives which have broken through them are confined in Maryland mainly to the eastern portion of the Plateau country, although on account of structural disturbances which have taken place in the area farther westward, they reappear again in the granite and volcanic rocks of the Blue Ridge district. Even before the close of Archean time the Algonkian rocks had already been greatly crumpled, altered and metamorphosed by the intrusion of the igneous masses.

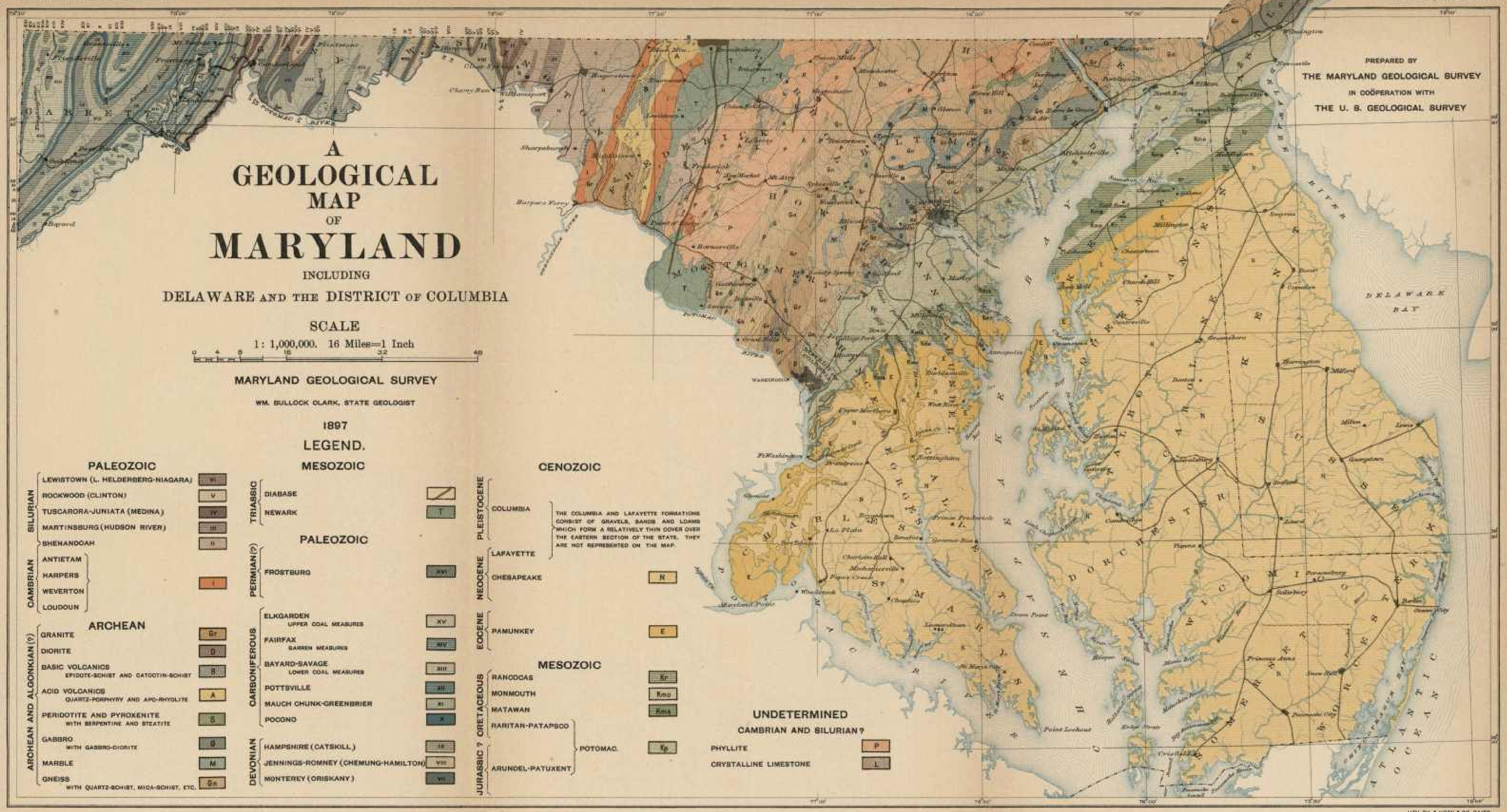
The oldest shore-line of Paleozoic time must have stood somewhere to the east of the Frederick valley, perhaps along the western flanks of Parr's Ridge, although smaller troughs penetrated the continental margin, as shown by the sandstone of Deer creek and the long band of phyllites and crystalline limestones which extend across Baltimore and Harford counties into the Peach Bottom region of the Susquehanna. Towards the close of the lower Silurian period occurred the first great mountain-making movement of Paleozoic time. It is known in New England as the "Green Mountain uplift." Although less pronounced toward the south, its influence was profoundly felt at least as far as Maryland, for it was probably during this period that the slates and limestones of the western Plateau region were so highly folded and metamorphosed.

During later Silurian time the shore-line of the inland sea was pushed considerably westward, and it is doubtful whether it ever again reached a point east of the Blue Ridge, as this barrier was doubtless raised in part at least by the disturbances of the lower Silurian, which have just been described. Through the upper Silurian, Devonian and Carboniferous periods comparative quiet reigned. While subject to continual oscillation, the sea-floor in the Appalachian Region was, in the main, sinking, although there was a gradual recession of the shore-line westward. Toward the end of Paleozoic time the great Appalachian trough gradually shallowed, and during the later part of the Carboniferous period became to a large extent occupied by swamps, in which the vegetable life of that time flourished luxuriantly. The remains of these ancient forests form the great coal seams of the Appalachian Region, although to-day we possess but their smallest remnants in Maryland.

At the close of the Paleozoic occurred probably the greatest mountain upheaval that eastern America has ever known. The vast sequence of sediments, which had accumulated in the great Appalachian trough to a depth of nearly three miles, was raised in a series of folds, transforming the former sea into a great mountain chain, although perhaps of no greater, if as great, proportions as it has to-day. From its first appearance above the waters, this mountain chain has been continually preyed upon by rain, wind, frosts and streams, with the result that the greater proportion of its bulk is to-day stretched out along our coastal border. Its growth was gradual—at least not the product of a sudden revolution—so that the period of its greatest elevation can be with difficulty determined. As the result of the elevation of the Appalachians into the great mountainous area the sea was crowded out of its position in the eastern interior portion of our continent; but early in Mesozoic time, already during the Triassic period, a long, narrow trough extended across Maryland near the eastern edge of the mountainous district, in what is to-day the Frederick valley, and in this trough was deposited a great thickness of red sandstones and shales (Newark formation), cut through and interbedded with flows of eruptive rock (Diabase). Toward the middle of Mesozoic time there was a decided continental elevation, which drained the interior trough, while the deposits of this period were doubtless laid down far to the eastward of the present coast-line.

Later in Mesozoic time, probably near the close of the Jurassic period, there was a marked depression of the continent along its eastern border which brought the sea to and beyond the present western margin of the Coastal Plain. There is good evidence that this eastward tilting of the continent was not at right angles to the present oceanic border or persistent for any great length of time in the same direction, as is shown by the irregular transgression of the several formations of the Cretaceous period. Broad reaches of shallow and brackish waters bordered the coast during the later Jurassic and early Cretaceous periods, and shore currents distributed the material brought to the sea by the rivers. Continuous depression, however, did not take place during this period; the deposits were several times raised and subjected to denuding agencies. At the close of the lower Cretaceous a pronounced erosion interval occurred prior to the depression, which brought in the marked marine conditions of upper Cretaceous time. During this period of upper Cretaceous submergence the land of the continent must have stood at a low level, since the sediments accumulated slowly and with a constantly decreasing quantity of land-derived materials.

At the close of Mesozoic time, or perhaps a little later, another elevation of the continent, accompanied by the gradual stripping off of the deposits of earlier date, took place. Over this irregular surface the Eocene deposits were laid down in the submergence which opened the Tertiary period. Again came elevation at the close of the Eocene, followed by another submergence during the early Neocene, although the transgression of the previous period, which had gradually overlapped the Cretaceous deposits to the southward, was now towards the north, so that the oscillations of the continent in Tertiary time were much less normal to the coastal border than they had been during the late Cretaceous. During the early Neocene period a great volume of sediments was deposited, the strata giving evidence of a large discharge of land-derived materials from the adjacent continent. The elevation at the close of this epoch was followed by a brief submergence in the late Neocene period, during which the sea encroached considerably upon the Piedmont Plateau, while during the elevation which followed this brief period of submergence the present topography of our Coast border region was largely carved out. It was then that the great valley of the Chesapeake Bay with its estuaries was formed and the drainage of the area reached the existing ocean through capes Charles and Henry. A further depression in early Pleistocene time submerged the valley together with the low country, and choked with sediment the former drainage lines. This submergence, however, was not sufficiently long continued to entirely obliterate the old channels, for in later Pleistocene time another elevation removed the water from the higher portions of the valleys, and, although there was a brief subsequent submergence with accompanying elevation, the main confines of the valleys can to-day be seen with their lower courses still occupied, as in the case of the Chesapeake Bay and its major tributaries, by tidal waters.



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MINERAL RESOURCES.

General Statement.

The geological formations which have been described in the preceding pages afford a great variety of mineral products, some of which are mined to-day with profit and are susceptible of further development; others which have in the past been successfully employed, but are not at the present time worked, although the commercial conditions may be such as to again render them of economic value; and still others which are known to occur, but have not yet been found in sufficient quantities to warrant their exploitation.

The location and distribution of each of these mineral products is determined by the geological formation in which it is found, the limits of the formation representing at the same time the boundaries within which the particular economic product may be anticipated. Many mineral products, to be sure, may be restricted to certain portions of a particular formation, or in some instances may be found in more than one such geological division. Still geological maps are recognized to-day as of much importance by those who are intelligently developing our resources, and are regarded as a valuable guide in determining the distribution of the economic deposits. The futility of attempting to develop mineral substances in a formation which has been shown by careful geological investigation to be devoid of them is also clearly recognized, and in this way large sums of money, which might otherwise be lost in fruitless enterprises, are saved.

The distribution of the mineral resources of Maryland may be best understood by reference to the geological map. In the crystalline rocks of the Piedmont region, between the Monocacy and the Chesapeake, we find the most varied, if not the most valuable list. Here occur the most important building stones: the slates of Delta and Ijamsville; the granites of Port Deposit, Woodstock and Guilford; the gneiss of Baltimore; the marble of Cockeysville and Texas; the sandstone of Deer Creek; and the serpentine of Broad Creek and Bare Hills. In these oldest rocks occur also the ores of gold, copper, chrome, lead and zinc. Much of the best iron ore also belongs here, while all the flint, feldspar, kaolin and mica in the state must be sought for in this horizon. These older or pre-Paleozoic rocks again appear in the centre of the Blue Ridge, where they form the Middletown valley, and here they yield traces of copper, antimony and iron.

The Paleozoic strata which stretch from the Frederick valley westward across the state, furnish much good sandstone and limestone, two horizons of valuable cement rock, and at the top carry what is left by man and the eroding agencies of nature of the wonderful Cumberland Coal basin, with its 14-foot vein of solid coal. This same basin contains also deposits of fire-clay and iron.

As we trace the sequence of formations through the more recently formed portions of the state (post-Paleozoic strata of the map), we find them not devoid of mineral deposits of economic value. The variegated limestone breccia, known as "Potomac marble," and the best brown sandstone for building purposes found in Maryland, both belong to the oldest of these post-Paleozoic strata—the Triassic belt of the Frederick valley and southern Montgomery county. The series of still unconsolidated beds which represents the lapse of time from the upper Jurassic or lower Cretaceous period to the present, and which composes all of eastern and southern Maryland, besides furnishing valuable lands for various agricultural interests, contains our principal supply of brick, potter's and tile clay; of sand, marl and diatomaceous earth; and much of our best iron ore.

These several economic products will be considered briefly in the following pages.

Special Descriptions.

THE BUILDING AND DECORATIVE STONES.

The building and decorative stones of Maryland are widely distributed throughout the central and western portions of the state, and consist of many different varieties which by their diversity in color, hardness and structural peculiarities are adapted for nearly all architectural and decorative purposes. Among the more important may be mentioned the granite, gneiss, marble, limestone, slate, sandstone and serpentine.

The Granite and Gneiss.—The gneiss, which has been fully described already, is the oldest of the Maryland rocks and covers a wide area in Cecil, Harford, Baltimore, Howard, and Montgomery counties. Through this ancient gneiss complex the granite was intruded at a later date. The gneiss differs from the granite only in having a more or less pronounced parallel and banded structure so that it is not always possible to distinguish sharply between them, especially as true granites have such a structure secondarily developed in them by pressure.

The regions in Maryland where the granite and gneiss are most extensively worked are at Port Deposit in Cecil county, in the vicinity of Baltimore, at Woodstock in Baltimore county, and at Ellicott City and Guilford in Howard county. Other areas in Howard and Montgomery counties and in the District of Columbia contain some good stone, but it is quarried only for local use.

In the extensive quarries of granite along the northern bank of the Susquehanna river near Port Deposit, Cecil county, the rock is a gray biotite granite-gneiss with dark colored constituents arranged in parallel directions so as to closely resemble a gneiss. The first serious working of the granite at this locality was in the years 1816-17, and the business has much increased in later years. The Port Deposit rock has afforded materials for the construction of Fortress Monroe, Forts Carroll and McHenry, the navy yard and dry dock at Portsmouth, Virginia; the Naval Academy at Annapolis; and many of the principal bridges of Baltimore and Philadelphia, besides a great many other structures both of a public and a private character.

Much granite has been quarried in the southwestern corner of Baltimore county near Woodstock, where a stone remarkably homogeneous in grain and color has been obtained. Operations were commenced in this area about the year 1832-33, when the large granite boulders of the vicinity attracted the attention of practical quarrymen.. Since that time extensive quarries have been opened in this area, the two most important known under the name of the "Waltersville" and the "Fox Rock." The rock obtained from this area has been extensively employed in the construction of public buildings, among them the Capitol, Patent Office, old Post Office and Congressional Library buildings in Washington, the Baltimore and Ohio Central and the Fidelity and Trust Deposit buildings in Baltimore, as well as other public and private structures.

The rock quarried near Ellicott City on the Baltimore county side of the Patapsco river is a fine-grained gray granite with a decidedly foliated or gneissic structure. On the opposite side of the river in Ellicott City itself the rock is more massive and also has a porphyritic structure, large flesh-colored crystals of feldspar being more or less regularly developed through it. The most perfect variety of this granite porphyry presents a striking and beautiful appearance. This rock was worked at an early date and afforded much of the material out of which the Cathedral in Baltimore was constructed. Many other structures have been built of the same rock in more recent years.

The granite found at Guilford, in Howard county, is of excellent quality and has a somewhat finer grain and lighter color than that occurring near Woodstock, but as yet has not been as extensively worked. There are also quarries at Sykesville, Garrett Park, Gunpowder, Texas, Relay and Dorsey's Run, all of which are susceptible of more extensive development.

The more solid varieties of the gneiss occurring in and near the city of Baltimore are extensively quarried for building and foundation stone. This rock is of a dark gray color and occurs in parallel layers, which are more or less contrasted. Buildings constructed of this stone, of which there are many in Baltimore, present an agreeable effect. The oldest and most important of the gneiss quarries are those on the eastern side of Jones' Falls, opposite Druid Hill Park. Openings of the same rock have also been made at Gwynn's Falls, Edmondson Avenue, near McDonogh, and at other places. The great gneiss quarries at Jones' Falls were in active operation very early in the century, the earliest openings being situated on the western side of the creek.

The total value of the output of granite and gneiss in Maryland in 1896 was $355,000.

The Marble and Limestones.—The deposits of carbonate of lime in the form of marble and limestone which are so abundant in the central and western portions of the state differ widely in geological age and lithological character, and as a result have been applied to a variety of uses. Three types of rock are recognized: the highly crystalline white marble of the eastern division of the Piedmont Plateau; the fine-grained, compact and variegated varieties of the western or semi-crystalline division of the Piedmont Plateau; the blue fossiliferous limestones of the Appalachian Region; and the limestone conglomerate or "Potomac marble" of Triassic age in the Frederick valley.

The most valuable of these rocks are the highly crystalline marbles of Baltimore county, which have an extensive development in a series of narrow belts to the north and west of Baltimore city. The most important of these areas is that which extends northward from Lake Roland to Cockeysville and which is traversed by the Northern Central Railway. Marble is quarried at Texas and to the west of Cockeysville, near the northern portion of this belt, but is only employed for building purposes to any extent in the latter locality, where the well-known Beaver Dam marble quarries have been successfully operated for over 75 years. The rock in this locality is a finely saccharoidal dolomite of great compactness and durability, in which small scales of phlogopite occur in horizontal bands, representing the original bedding of the rock. Other materials, such as quartz, tremolite, etc., occasionally occur. Blocks of great size can be obtained at the quarries. The rock has been extensively used in public structures in Baltimore, Washington and Philadelphia. Stone for the construction of the Washington monument was taken from this locality as early as 1814. It was also used in the construction of the Washington monument at Washington as well as in other buildings in that city. In Baltimore the City Hall, Maryland Club and several churches have been made from the same material. The Drexel and Penn Mutual Insurance buildings in Philadelphia and several buildings in New York are also constructed in whole, or in part, of the same material. The Texas quarries have also afforded materials for the Belt Line tunnel.

The fine-grained, compact and variegated marbles of the western portion of the Piedmont Plateau compare favorably in their quality, texture and beautiful veining with well-known marbles from Vermont and Tennessee, and are deserving of much more attention than they have heretofore received. These highly colored and variegated marbles are found chiefly in Carroll and Frederick counties. In the Wakefield valley, west of Westminster, a beautifully mottled red and white marble occurs; others with a black and white, gray and white or blue and white veining occur near New Windsor and Union Bridge, and still others of a warm yellow with lighter veining have been derived from the same area. These marbles have had little economic significance hitherto on account of the limited extent of the deposits, but are well adapted for purposes of interior decoration.

The blue limestones of the Appalachian district have been used to some extent for building purposes, more especially in Hagerstown, where several churches have been constructed of this material. This blue limestone changes its color rapidly on weathering, but has a pleasing effect. A quarry of very compact, even-grained and pure cream white marble has been opened just beyond Edgemont Station in Washington county on the eastern edge of the Hagerstown valley, but as yet has not been much developed.

Another stone which may be classed as a limestone, on account of the high percentage of lime which it contains, is the conglomerate or breccia of Triassic age found in the Frederick valley. It is known as "Potomac marble" or "calico rock," and has received noteworthy application as a decorative stone in the old Hall of Representatives at Washington, where it forms a series of beautiful columns. It occurs well exposed at Washington Junction, Frederick county, and extends northward along the base of the Catoctin Mountain. It consists of large and small angular and sub-angular fragments, mostly of the valley limestone, although many other rocks like quartz, slate, granite, porphyry, etc., also occur imbedded in the red ferruginous cement. When polished it presents a very beautiful appearance.

The total value of the marble and limestone employed as structural materials in 1896 was $110,500.

Slate.—One of the best known roofing slates in the United States is the so-called Peach Bottom slate of Lancaster and York counties, Pennsylvania, and Harford county, Maryland. The slate belt forms a narrow zone which begins a short distance east of the Susquehanna river in Lancaster county and passes in a southwest direction through the southeastern corner of York county, terminating near Pylesville on the Baltimore and Lehigh Railroad in Maryland. The age of this slate has been determined on fossil evidence to be that of the Hudson river shales of the lower Silurian. The slates of the Peach Bottom region were worked as early as Revolutionary times, and show almost no change after an exposure of a century. Several quarries are to-day worked in Harford county, although the business is largely operated by persons living in or near Delta, Pennsylvania. In 1896 the total output of Maryland had a value of $90,100.

The Sandstone.—Sandstones are found at many horizons in Maryland. Many of these are well suited to furnish valuable building stones, but as yet only one or two localities have furnished this material for more than local use. These sandstones are found in the Newark formation in the Frederick valley, in the quartzite belt of Deer creek in Harford county, in the Weverton formation of Cambrian age in the Blue Ridge district, and in the Silurian and Devonian formations of Allegany county.

The sandstones of Triassic age possess a recognized reputation in the market and have been extensively developed throughout the Triassic belt of the eastern United States, and large quarries have been opened in this formation in Massachusetts, Connecticut and New Jersey. A belt of this rock enters Maryland between Emmitsburg and Union Bridge, rapidly narrowing southward through Frederick county; while another area occupies the southwestern portion of Montgomery county. The most extensive quarries of this sandstone in Maryland are situated near the Potomac river, the largest at the mouth of Seneca creek in Montgomery county, and a somewhat smaller one near Washington Junction. Still smaller quarries for local uses are found at more northern points. The Seneca sandstone has been quarried in a more or less systematic way since 1774, when it was used in the construction of two locks on the old Potomac canal, built around the Great Falls of the Potomac. The red sandstone has always been highly regarded, not only on account of its great strength and durability, but also on account of the ease with which it is worked, and its beautiful colors. It is susceptible when first quarried of very delicate carving, but hardens on exposure. The Maryland rock is regarded as one of the best of the Triassic sandstones. It has been used in the construction of many important buildings, including that of the Smithsonian Institution in Washington.

The highly metamorphosed micaceous sandstone or quartzite of Deer creek in Harford county has been used to some extent as a building stone, and in quite recent years a company has been organized to work it. This stone is a pure quartz sandstone, in places plainly conglomeratic and contains more or less muscovite, chlorite and other minerals. The fire-proof qualities of this micaceous sandstone have long been recognized, and it is frequently employed for hearthstones and furnaces.

The Weverton sandstone of Cambrian age, which occurs in nearly unaltered condition in the Catoctin and Blue Ridge mountains, has been quarried for various building purposes and has been used by the railroads, canals and private individuals.

In the western portion of Maryland, particularly in Allegany county, considerable use has been made locally of the sandstones of the Tuscarora (Medina) and Monterey (Oriskany) formations. The white sandstone of the former has been extensively quarried in the narrows above Cumberland from detached boulders and has been much used for steps, curbs and architectural trimmings. The Monterey (Oriskany) sandstone has also been quarried at Cumberland and has been used to some extent both in public and private structures. Although oftentimes soft and yielding, the harder and more compact layers furnish a very good building stone, which is of yellowish color and presents excellent resistance to atmospheric action.

The foliate l quartz-schists which occur along the edge of the marble belts in the eastern or holocrystalline division of the Piedmont Plateau are quarried to some extent along the southern margin of the Green

Spring valley and are employed for foundations and as flagstones. This rock originally was probably a sandstone, but has been highly metamorphosed, so that its original clastic structure is no longer apparent. It is a hard resistant rock divided by parallel layers of mica into thin slabs.

The sandstone product in Maryland in 1896 aggregated $35,969.

The Serpentine.—Serpentine is employed both as a building stone and, when polished, for interior decoration. The chief deposits in Maryland are found in Harford and Cecil counties and are the product of alteration of the peridotite, which has been already described. The rock is very hard and is a rich emerald green in color, semi-transparent and clouded with darker streaks of included magnetite. Maryland serpentine has been used for interior decoration in several large buildings in New York, Philadelphia, Baltimore and Washington, and has great possibilities as a decorative stone. The attempts at developing the stone have been only partially successful hitherto, because of the hardness of the material, the expense of extracting and polishing it, and the manner of quarrying. Only $1,000 worth of serpentine was quarried in Maryland during 1896.

Miscellaneous Materials.—The black *gabbro*, which has been described already as a common rock in the eastern division of the Piedmont Plateau, is available to some extent as a building stone. The rock weathers to a deep red soil, in which rounded boulders of the unaltered rock are found. These are locally known as "niggerhead," and as they have to be cleared from the fields, they are extensively used in building stone fences, foundations, etc. They are rarely used in the construction of whole buildings, although that is sometimes done. The rock is so extremely hard and tough that it cannot be economically quarried and dressed, and is therefore seldom used in that form.

The *chlorite schist* found at Westminster, Carroll county, has been quarried to some extent as a local building stone. It is of a grayish green color, with even texture, and is easily worked. Several public and private structures have been made from this material.

THE LIME AND CEMENT PRODUCTS.

The limestone and marble deposits of Maryland have been extensively burned for building and agricultural purposes. In the earlier days the burning of lime was carried on largely over the state, but in later times, since transportation facilities have become so good, the old quarries and kilns scattered so widely over the country have been for the most part abandoned. There are still several large industries in the marble belt of the Piedmont area and in the semi-crystalline portion of the Frederick valley, and there are also many small local kilns for supplying lime for agricultural purposes, especially in the Frederick valley. Many of the largest companies now located in Maryland are deriving their supply from more favorably situated deposits outside the state.

The limestone and marble are also used as flux for blast furnaces. The coarse-grained marbles of Texas have furnished a large amount for this purpose, and also the limestone quarries at Cavetown on the Western Maryland Railroad. Hydraulic cement has been extensively manufactured from the limestone of the Lewistown (Niagara—L. Helderberg) formation of Silurian age at Cumberland and Hancock, as well as from the older Shenandoah limestone of the Hagerstown valley near Sharpsburg. The products from these industries have an excellent reputation and have been largely employed both within and without the state.

Another use to which the limestone of the state has been applied in recent years has been in the manufacture of asphalt blocks for street paving. These blocks are constructed of crushed and pulverized limestone, Trinidad asphalt and a residuum of petroleum heated separately and thoroughly mixed and then combined under heavy pressure. These blocks have been used extensively in Washington and Baltimore in recent years.

The total value of the lime and cement products of Maryland in 1896 was $472,392.

THE CLAYS.

The clays of Maryland suitable for economic purposes are widely extended, occurring in a great number of different formations. They are most widely distributed throughout the eastern and southern portions of the state and oftentimes underlie broad areas of country. Important clays also occur in the central and western portions of the state. The clays of Maryland are suitable for brick-making, terra-cotta work, fire-brick and pottery. Brick-making began in Maryland in the colonial days, scattered references to the industry being found in the earliest records. The clays most extensively used at the present time are from the Columbia and Patapsco formations, and the centre of the industry is at Baltimore. Residual clays in central and western Maryland are also employed, while the fire clays of Allegany county rank among the best in the United States.

The clays of the Columbia formation widely cover the surface at the lower levels in the region about Baltimore, and in the country to the south and east they generally consist of a yellowish or brownish clay or loam which grades downwards into coarse sands and gravels. They are highly regarded by the clay workers for certain classes of products. Much of the Columbia clay has been removed in the immediate vicinity of Baltimore, but is still capable of further development in the southern and southwestern portions of the city about Middle Branch, and in other sections of country in the adjacent counties.

The clays of the Patapsco formation are developed along a belt which extends from the northeast to the southwest across the state, passing through Baltimore. In this locality, as well as in the region adjacent to the city of Washington they have been extensively worked and afford many high-grade varieties. The highly carbonaceous iron-ore clays of the Arundel formation have also been used considerably to the south and southwest of the city. The clays of both of these formations have been employed for various purposes, but are capable of much larger use than that to which they have already been put.

The manufacture of fire-brick has been one of the characteristic industries of Maryland for 50 years, and the brick made from the fire-clays of the Pottsville formation in Allegany county are regarded as the best in this country. The oldest fire-brick concern in Allegany county, that at Mount Savage, was organized in 1841 and was the first of its kind in the United States. The main fire-clay deposit lies near the bottom of the coal measures and the clay bed ranges from 8 to 20 feet in thickness. It is divided into two varieties, designated as the hard and soft clay. The hard clay is of a gray color, shading almost to black; it is non-plastic, unless ground into an impalpable powder, and disintegrates but little upon exposure to the weather. The soft clay is very plastic, much lighter in color and crumbles rapidly under atmospheric influences. The impurities in this clay are fewer and smaller in amount than in most other fire clays. The two most valuable characteristics of this clay are its freedom from potash and the large proportion of silica to alumina.

The clay industry has grown rapidly in importance during recent years, and the value of the output during 1896 was $1,753,003.

THE SANDS.

The sand deposits of the state are widely extended both in the eastern and western sections, but have been but little developed hitherto. The sandy sediment which has been deposited upon the bottom of the Potomac river has been dredged in recent years and used extensively for building purposes in Washington.

The most important sand deposits in the eastern portion of the state are found in the Raritan formation in Anne Arundel county, and extensive openings have been made near the head of the Severn river, where a very pure grade of glass sand is taken out. The output of these diggings is transported on small schooners which are able at high tide to reach the head of the river.

The Tuscarora (Medina) and the Monterey (Oriskany) formations of the western portion of the state also afford very pure deposits of quartz which have been ground up and employed to some extent in glass-making.

The sandstones both in the eastern and western sections of the state are capable of much further development. The output from these formations during the year 1896 had a value of only $1,752.

THE PORCELAIN MATERIALS.

The state of Maryland is well provided with porcelain materials. The three principal requisites in the manufacture of porcelain are flint (vein quartz), feldspar, and china clay (kaolin).

The flint is widely distributed throughout the rocks of the holocrystalline portion of the Piedmont Plateau and is especially abundant in Cecil, Harford, Baltimore, Carroll and Montgomery counties. It occurs as vein fillings in the form of pure granulated or vitreous quartz. In Harford county, where the conditions are most favorable, this quartz has been quarried in large amounts. It is finely ground and bolted and then shipped in sacks to the potters. It is employed largely in Baltimore, but has also been shipped extensively outside the state. Flint has many uses, being employed in the manufacture of crockery-ware, wall and sandpaper, soap, tiles and paints.

The best feldspar and kaolin produced in the United States is obtained within a radius of 15 miles from the common corner of Maryland, Delaware and Pennsylvania. It has been worked extensively in all three of these states and shipped to potteries throughout the country.

The total value of these materials produced in Maryland during 1896 was $25,657.

THE MARLS.

The Eocene and Miocene formations of eastern and southern Maryland are rich in marl deposits, which have never been developed except for local uses. Their importance to the agricultural communities where they occur has not been up to the present time very generally recognized, although they have been worked to some extent since the early portion of the century.

The Eocene marls are glauconitic and are not unlike the famous greensand marls of New Jersey, which have been so extensively employed as fertilizers throughout the eastern and southern portions of that state. The Eocene marls of Maryland are found in Kent, Anne Arundel, Prince George's and Charles counties and increase in thickness southward. The greensand marls contain commonly a small percentage of phosphoric acid and some potash, while in some areas they are also highly calcareous. When properly used they prove of much value for certain crops. They are spread over the surface of the land, or are applied in the form of a compost with barnyard manure.

The Miocene marls are mainly shell accumulations and are never glauconitic. The proportion of shells is often very great, so that the Miocene marls are commonly known under the term of "shell marls." They occur abundantly in Queen Anne's, Talbot, Calvert and St. Mary's counties, but have never been used so largely as the greensand marls which lie to the north of them.

THE IRON ORES.

The iron industry in Maryland was developed early in colonial days and continued until a recent date to be one of the most important factors in the prosperity of the state. Numerous references are found in the earlier records to the iron ores, and early in the 18th century we find considerable activity in the manufacture of iron. The Principio Company, one of the most important commercial enterprises in the early days of Maryland, was organized in 1722 and began the erection of a furnace in Cecil county near the mouth of Principio creek. In 1761 the Governor and Council of Maryland reported to the Commissioners of the Board of Trade and Plantations in England that there were eighteen furnaces and ten forges in the state which made 2500 tons of pig iron per year. During the Revolutionary War the furnaces and forges of the Principio Company supplied bar iron and cannon balls to the Continental Army. The Principio Company during the war of 1812 produced cannon, cannon balls and hardware, and guns as large as 32 pounders were made for the government. Many furnaces were built in other sections of the state during the 18th and early portion of the present century, but nearly all of them have been abandoned. Among the most important of these furnaces is the Catoctin furnace in Frederick county, which was built in 1774 and furnished guns and projectiles to the Continental Army during the Revolutionary War. In more recent years several modern furnaces have been constructed near Baltimore, of which by far the largest is that at Sparrow's Point, built by the Maryland Steel Company, which, however, only employs ore obtained from sources outside of the state.

The only furnaces now manufacturing Maryland iron to any extent are the Muirkirk furnace in Prince George's county and the Stickney furnace at Canton. They employ very largely the carbonate iron ores which are obtained from the Arundel formation, mainly from Anne Arundel and Prince George's counties. These great lenses of carbonate ore have been worked since early colonial days, but an ample supply still remains. Two types of ore are found in these ore lenses known as the "white ore" or carbonate ore and the "brown ore" or hydrous oxide ore.

Ores of iron are found widely distributed in Maryland from the older crystalline rocks down to the more recent deposits, but the most extensive accumulations thus far discovered are the brown hematite and magnetite of Frederick county, the carbonate ore of Prince George's county, and the iron ores belonging to the coal measures of western Maryland. Under the present conditions of the iron industry the Maryland ores have not the value which they once had, although the excellent quality of the carbonate ores still makes it possible for them to compete with the cheaper materials of the west and south. This carbonate iron has been largely used by the U. S. government, it being guaranteed to stand 30,000 pounds to the square inch in the pig, many tests giving 40,000 pounds.

The great Maryland iron industries depend now to a very inconsiderable extent upon local iron ores. The discovery of extensive deposits in other sections of our country, particularly in Michigan, Minnesota and Alabama, coupled with the wonderful extension and cheapening of transportation, have resulted in the past few years in driving out the charcoal furnaces and thus leaving no place for the lean ores of Maryland.

The total value of pig iron produced from the Maryland carbonate ore during 1896 was $115,000. The other ores were not worked during the past year.

THE COALS.

The coal deposits of Maryland are confined to western Allegany and Garrett counties, and are a part of the great Appalachian coal field which covers large portions of Pennsylvania, Maryland, West Virginia, Kentucky, Tennessee and Alabama. In the northeastern portion of this area the rocks containing the coal have been thrown into a series of folds which increase in their sharpness toward the east. Three principal types of coal are distinguished as a result of the folding. Where the rocks have been but little disturbed the coal contains a high proportion of volatile gases, or less than 70 per cent of carbon. This coal, known as *bituminous coal,* is especially valuable for the manufacture of coke and gas. Where the rocks have been somewhat more disturbed, as along the northern and eastern edge of the Alleghany field in Pennsylvania, Maryland and West Virginia, the coal contains from 70 to 84 per cent of carbon. This is known as *semi-bituminous coal* and is superior to any other for generating steam. Where the coal-bearing slates are much more disturbed, as in eastern Pennsylvania, the amount of carbon exceeds 84 per cent and the coal is of a hard, glistening variety, called *anthracite.* This, on account of the cleanliness, is especially fitted for domestic use.

The Maryland coals belong entirely to the first two classes, and the only kind being worked to any extent is the latter or the semi-bituminous type. This coal basin is of comparatively small size, but constitutes by far the most important of the state's mineral resources. It is commonly called the "Cumberland basin," and sometimes also the "Frostburg" or "George's Creek" basin. It is situated in an elevated trough to the west of the city of Cumberland between two parallel ridges, known as Dan's and Savage Mountains, which are less than 4 miles apart. The most important coal seam in the Cumberland basin is known as the "Big Vein" or the "14-foot Vein," and belongs to the Elkgarden formation, which is the uppermost member of the Carboniferous series. This bed is very limited in extent, but once covered the entire basin, the continuity of the formation having been greatly reduced by the natural processes of erosion. Below the 14-foot vein are several other workable seams, viz., the 18-inch vein of the Fairfax formation, the 4-foot vein and the 3-foot vein of the Bayard formation, and the 6-foot vein of the Savage formation. These lower veins have not been as yet fully exploited, although several companies are to-day removing more or less coal from them. These seams become very important farther south in West Virginia. The Maryland coal is unsurpassed in quality and has been proved by numerous experiments to possess maximum efficiency, *i. e.*, yielding the highest temperature for a definite quantity of combustible material. This gives the Cumberland coal great value for steam generative purposes and it is regarded as the most valuable coal for locomotives, ocean steamers, and in manufacturing establishments. It finds a ready market in New York, Philadelphia, Baltimore and along the entire Atlantic coast.

Coal was first discovered in the Cumberland basin in 1804. The first company was organized in 1836, and to-day there are fourteen companies operating in the valley. The development of the Cumberland coal basin is closely associated with the extension of transportation facilities from the seaboard at Baltimore and Washington westward. The national road was opened between Cumberland and Frostburg about 1846; the Baltimore & Ohio Railroad reached Cumberland in 1842, and the Chesapeake & Ohio Canal in 1850. There was much rivalry between these corporations, as they were to pursue very nearly the same routes.

The total output of coal from Maryland mines during 1896 aggregates 3,756,066 tons, which, valued at the rate of 85 cents per ton at the mines, amounts to $3,192,656.10.

THE GOLD DEPOSITS.

The crystalline rocks of the Piedmont Plateau have been found to carry gold in Maryland, Virginia, North Carolina and Georgia. The gold occurs in quartz veins which occupy the old lines of fracture in the accompanying rocks. The gold occurs either in pure quartz, or in association with pyrite, or in the pyrite itself, and is also sometimes accompanied by lead (galena), silver and telluride of bismuth (tetradymite).

The first gold ever found in Maryland was discovered in 1849 near Sandy Springs, Montgomery county, a specimen being exhibited to the American Philosophical Society in that year. Most of the Maryland mines are located along the southern edge of Montgomery county, near the Great Falls of the Potomac. The oldest mine in this region was opened in 1867. Some wonderfully rich specimens have been obtained from this area, but the gold is so unevenly distributed that it has not yet been worked with profit. Reports are frequent of the discovery of gold in other portions of Maryland, but these finds are generally without foundation and none have as yet been proved to be of any value. At the time of the last census in 1890 the amount of gold produced in Maryland was valued at $16,885. Practically nothing is now being done in the development of the gold properties.

THE MINERAL PAINTS.

Mineral paint has been produced at several points in Maryland and in widely different geological horizons. Large quantities have been obtained in the past from the brown iron ore deposits in Frederick county, but nothing is being done at the present time in that region. Ochre mines have also been operated in Carroll and Howard counties, and something is being done in these regions at the present time.

Important deposits of paint ore have also been obtained from the Patapsco formation in Anne Arundel and Prince George's counties. This ore occurs in a fine and highly ferruginous clay and can be worked readily. There are several industries at the present time established in this belt and the opportunities for its further development are exceedingly good.

The value of the mineral paints produced in Maryland during 1896 aggregates $2,000.

THE DIATOMACEOUS EARTH.

Diatomaceous earth, known to the trade as Infusorial earth, or Tripoli, has been produced in larger quantities in Maryland than elsewhere in the United States. The Diatomaceous earth in Maryland is found at the base of the Chesapeake formation and consists of deposits, which in northern Calvert and Charles counties attain a thickness of 30 to 40 feet; the most extensively worked localities are situated near the mouth of Lyon's creek on the Patuxent river and at Pope's creek on the Potomac river.

Diatomaceous earth is made up of the microscopic shells of diatoms.

It is used as a polishing powder and likewise makes an excellent non-conducting cover for steam pipes; also from its extremely porous character it has been used for the shipment of dynamite. This material was first worked on the Patuxent river in 1882.

The value of the product mined in 1896 was only $3,500. Much larger amounts have been obtained in past years.

THE MINERAL WATERS.

The mineral waters of Maryland in the past have not attracted much attention, but there are several kinds which are being placed on the market at the present time with greater or less success, and two at least which are being exported in considerable quantities. A few are represented as having medicinal properties, but the majority are sold principally for table waters, mostly in the city of Baltimore. Nearly all of the well known waters come from the crystalline rocks of the Piedmont Plateau, only a few being reported up to the present time from the Appalachian Region and the Coastal Plain. According to the Eleventh Census report, based upon information obtained in 1890, Maryland ranked thirteenth among the states in the number of springs reported and twenty-first in the volume of product. The amount utilized in that year is stated to have had a market value of $12,057. Since then several new springs have been placed on the market, so that the importance of Maryland as a producer of mineral waters is gradually increasing. In 1896 the value of the output was $63,500.

Around many of the springs in the Piedmont region summer resorts have sprung up, in part as the result of the pure quality of the water and in part on account of the proximity of the localities to Baltimore and Washington. Among the more important may be mentioned the Chattolanee, Strontia, Lystra, Bentley, Takoma and Carroll Springs. Many other springs are found scattered over the Piedmont region, but little beyond local use has been made of them up to the present time.

The springs of the Appalachian Region are not as well known, although a thermal spring of saline mineral water at Flintstone, Allegany county, has for a long time been highly regarded. There are numerous cold chalybeate springs scattered throughout western Maryland, but there has been as yet no attempt to introduce the waters or develop the properties upon which they are situated.

Very few springs of mineral water of more than local reputation are reported from the Coastal Plain. The Mardella of Wicomico county is very well known and the waters have been placed upon the market. Several other springs, which have only a local value, are reported from the eastern and southern counties, among them a sulphur spring situated at St. Michael's, Talbot county.

THE ROAD MATERIALS.

The state of Maryland is well provided with road-building materials, although their character varies widely, some being far better adapted for the purpose than others. The question of transportation is, however, so important that the stone of greatest value cannot always be employed, yet there is no section of the state where there are not some materials sufficiently close at hand to render them available.

The best road-building materials in Maryland are the basic igneous rocks, which are found well developed throughout the area of the Piedmont Plateau. Of these there are several types, viz., the gabbro, the peridotite and pyroxenite, and the diabase. The gabbro or "niggerhead" rock, as it is locally called, is most widely distributed and occupies an extensive area throughout the eastern portion of the Piedmont belt in Cecil, Harford, Baltimore, Howard and Montgomery counties, the largest regions being found in central Harford and southern Baltimore counties. This rock is rather tough and difficult to work, but affords a valuable and permanent road metal. The peridotite and pyroxenite are not as extensively developed, but occupy very much the same area as the gabbro. These magnesian rocks are somewhat more easily worked than the gabbro, but do not have their wearing qualities. The most valuable of all these rocks is the diabase, which is so extensively used for road-building purposes in New England and New Jersey and which occurs in several long and narrow outcrops in Baltimore and Howard counties, but far better developed in Frederick county, where it occupies a considerable area near the northern border of the state in the vicinity of Emmitsburg. The chief cementing material in all of the igneous rocks is the hydrous oxide of iron.

The next group of road-building materials includes the marble, the limestone and the calcareous sandstones and shales. The carbonate of lime contained in these deposits acts as a valuable cement, but the materials have far less durability than the igneous rocks above described. They are found covering widely separated areas throughout the Piedmont Plateau and Appalachian Region, the most extensive and available deposits being found in the long, narrow valleys to the north of Baltimore city and in the Frederick and Hagerstown valleys farther west. These materials have already been considerably employed for road-building purposes.

The third group of road-building materials includes the gravels of the eastern and southern portions of the state, which belong to the late Mesozoic and Cenozoic formations. They cover extensive areas in Cecil, Kent, Queen Anne's, Talbot, Anne Arundel, Calvert, Prince George's and Charles counties, and with lessening importance extend into the more southern portions of the state. These gravels are rich in iron, which acts as the cementing material. They probably afford less permanent road metal than the igneous rocks which were first described, but when properly used are of great value in road construction.

Several of the other rocks, both in the Piedmont Plateau and the Appalachian Region, have been locally employed for road-building purposes, some of the schists and shales as well as some of the more quartzose rocks proving of value under certain conditions, but none of them have the valuable cementing qualities of the three groups of rocks above described.

THE MISCELLANEOUS PRODUCTS.

There are several other mineral substances of greater or less economic importance, which are either being worked to-day to some extent in Maryland or which have been earlier worked within the state, in some instances with great success. None of these products will probably give rise in the future to industries of great magnitude, either on account of the insufficient supply of the material or on account of the very limited use of the products themselves.

COPPER.—There are three veins of copper ore in Maryland, which before the opening of the Lake Superior copper region about 1844 and later of the Montana and Arizona mines, were considered of no mean prominence, and did actually make Maryland for a time one of the copper-producing states. The first of these veins runs along the Linganore Hills in Frederick county from New London northward to a point beyond Libertytown, the ore occurring in slates and limestones. The second vein runs northeast from near Sykesville through Carroll county to and beyond Finksburg, the ore being found in the slate. The third deposit is in the Bare Hills in Baltimore county, the ore occurring in hornblende gneiss. The Maryland copper mines were probably first opened in the 18th century, but operations ceased largely on the breaking out of the Revolutionary War and were not again taken up, to any great extent, until about the year 1835, from which time for the next few decades considerable ore was produced in the state.

CHROME.—The chrome industry in Maryland originated in the discovery in 1827 of chrome ore in the serpentine of the Bare Hills in Baltimore county. Subsequently to that, other deposits were found associated with the serpentine in Harford and Cecil counties, as well as at other points in Baltimore county. Between 1828 and 1850 Baltimore supplied most of the chrome ore consumed by the world, the remainder coming from the serpentine and platinum washings of the Ural Mountains. After 1850 the foreign demand for Baltimore ore declined gradually until 1860, since which time almost none has been shipped abroad. The reason for this was the discovery in 1848 of great deposits of chromite in Asia Minor. This region now supplies largely the world's demand. Since 1886 practically nothing has been done with the chrome deposits of Maryland, although Baltimore is still one of the most prominent centres for chromium salts.

Lead and Zinc.—Traces of galena and zincblende were early noted near the quarries at Jones' Falls in Baltimore county, but much more decided indications of these minerals occur in connection with the crystalline limestone in the western part of Carroll and the eastern part of Frederick counties, where attempts have been made to mine them in the region to the southwest of Union Bridge. In spite, however, of the frequent traces of both these minerals throughout central Maryland, it may be confidently asserted that neither will probably be found to occur in amounts that will repay mining.

Manganese, Antimony, Molybdenum.—The traces of these metals which have been detected in Maryland are even more insignificant than those of lead and zinc. Manganese was once mined a short distance west of Brookville in Montgomery county, but the deposit was not sufficiently extensive to be profitable. More recently manganese has been reported from Allegany county. Specimens of the sulphide of antimony have been obtained in the Middletown valley, but nothing is known of its occurrence or extent. The earliest discovery of molybdenite mentioned on this continent was made at the Jones' Falls gneiss quarries in 1811, but the deposit is not sufficient to be of economic value.

Soapstone.—Soapstone is a compact variety of talc and in composition is a hydrous silicate of magnesium. It has been worked to some extent in Carroll, Harford and Montgomery counties, the most extensive deposits being found a short distance to the northwest of Marriottsville in Carroll county, where for a time the stone was sawed into slabs for the manufacture of bath tubs. In later years the product has been ground and sold to manufacturers of fire-proof and acid-proof paints, although some slabs are sawed out occasionally for fire-brick and hearthstones.

Asbestos.—The crystalline rocks of Maryland contain several deposits of asbestos, most of which, however, is not true asbestos, although it passes under that name, but is the fibrous variety of serpentine known as chrysotile. These deposits are in both quality and quantity of production inferior and unimportant. In 1880 one mine in Harford county and three in Baltimore county produced a total of 40 tons valued at $1000; but the discovery of extensive deposits in other regions has now entirely stopped any operations for this mineral in Maryland.

MICA.—The coarse granite dikes which abound in many parts of the eastern Piedmont region afford good-sized plates of light-colored mica (muscovite), and attempts have been made to secure commercial quantities of this in both Harford and Howard counties, but they have not been successful.

GRAPHITE.—Traces of graphite have been found near Pylesville in Howard county at the edge of the Peach Bottom slate belt. Several deposits occur further northward in Pennsylvania, where they have been mined to some extent.

PART IV

BIBLIOGRAPHY AND CARTOGRAPHY OF MARYLAND

INCLUDING PUBLICATIONS RELATING TO THE

PHYSIOGRAPHY, GEOLOGY AND MINERAL RESOURCES

BY

EDWARD B. MATHEWS

BIBLIOGRAPHY AND CARTOGRAPHY OF MARYLAND,

INCLUDING PUBLICATIONS RELATING TO THE

PHYSIOGRAPHY, GEOLOGY AND MINERAL RESOURCES.

BIBLIOGRAPHY.

1612.

SMITH, JOHN. A Map of Virginia VVith a Description of the Covntrey, the Commodities, People, Government and Relegeon. VVritten by Captaine Smith, sometime Governour of the Covntrey. Oxford, printed by Joseph Barnes, 1612. 4to. 174 pp.

1620.

ANON. A Declaration of the State of the Colonies.

1624.

SMITH, JOHN. A Generall Historie of Virginia, New England, and the Summer Isles, etc. London, 1624. [Several editions.]

(Repub.) The True Travels, Adventures and Observations of Captaine John Smith in Europe, Asia, Afrika, and America, etc. Richmond, 1819, 2 vols.—from London edition of 1629.

Pinkerton's Voyages and Travels, vol. 13, 4to, London, 1812, pp. 1-253—from London edition of 1624.

Eng. Scholars Library No. 16. (For bibliography of Smith's works and their republication, see pp. cxxx-cxxxii.)

This work contains many interesting notes on the physiography of Chesapeake Bay and its tributaries, and briefly describes the clays and gravels along their shores.

1634.

ANON. A Relation of the Successefull beginnings of the Lord Baltemore's Plantation in Mary-Land; Being an extract of certaine Letters written from thence, by some of the Adventurers to their friends in England. Anno Domini 1634.

Shea's Early Southern Tracts, No. 1, 23 pp. 4to.

Mentions the shipment of a "good quantitie of iron-stone."

CALVERT, CECIL. Declaratio Coloniae Dominei Baronis de Baltimoro (. . .) in terra Mariae prope Virginiam: [etc.]

(Trans.) Force's Hist. Tracts, vol. iv, No. 12, 1846, pp. 3-7.

(Pub.) Woodstock Letters, 1872.

(Pub. and Trans.) Fund Publication, Md. Hist. Soc., No. 7, 1874, pp. 44-53.

Refers to the rivers, rich soils, plants, fish, and other animals.

WHITE, ANDREW. Relatio Itineris in Marylandiam.

(Trans.) Privately published by Nathan C. Brooks, 1847. Force's Hist. Tracts, vol. iv, No. 12, 1846, 47 pp.

(Pub.) Woodstock Letters, 1872. (Pub. and trans.) Md. Hist. Soc. Fund Pub., No. 7, Baltimore, 1874, 43 pp.

1635.

ANON. A Relation of Maryland; Together VVith A Map of the Countrey, The Conditions of Plantation, His Majesties Charter to the Lord Baltemore, translated into English. London, 1635.

(Repub.) Sabine's Reprints, 4to ser., No. 2, New York, 1865, pp. 1-65, with appendix pp. 67-73.

BLEAU, JOHANNEM and WILHELM. Tweede del van't Toouneel des aerdrucx, Ofte Nievwe atlas uytgegeven Door Wilhelm; en Iohannem Bleau. Amsterdam, 1635.

Two folio pages of description in Dutch. The authors noticed the northeast-southwest trend of mountains, the cutting through of the rivers, and also give a description of the prominent rivers flowing into the Chesapeake. The information is probably based on Smith's Explorations, since the accompanying map bears the crosses indicating the farthest points reached by Smith.

1656.

HAMMOND, JOHN. Leah and Rachel; or, the Two Fruitfull Sisters Virginia and Mary-Land: their Present Condition, Impartially stated and related. London, 1656.

(Repub.) in Force's Collection of Historical Tracts, vol. iii, No. 14, Washington, 1844, 30 pp.

1666.

ALSOP, GEORGE. A Character of the Province of Maryland.

(Repub.) Gowan's Bibliotheca Americana, New York, 1869, No. 5.

A curious and picturesque tract on Maryland by a "rollicking roysterer of the days of the Restoration," accompanied by a map of the Chesapeake.

1669.

Shrigley, Nathaniel. A True Relation of Virginia and Mary-Land; with the commodities therein, [etc.] London, 1669.

(Repub.) Force's Collection of Historical Tracts, vol. iii, No. 7, Washington, 1844, 51 pp.

Enumerates rivers and bays. "There is Fullers-Earth, Marle, Salt-peter, Iron, Stone, Lead, Tin and Silver Oar," p. 5.

1672.

Blome, Richard. A Description Of the Island of Jamaica; With other Isles and Territories in America, to which the English are Related. London, 1672. 12mo. 192 pp.

"Contains a brief history of all the British Isles and provinces in America, and their climate, production, population, trade, etc. and appears to embody the most authentic account extant at that date." Maryland, pp. 157-166.

1674.

Blome, R. Description de l'isle de la Jamaique et de toutes celles que possedent les Anglois dans l'Amerique. Recueil de divers Voyages faits en Afrique et en l'Amerique, [etc.] Paris, 1674.

1679.

Daniel, R. A new Map of the English Empire in America, viz: New England, New York, New Jersey, Maryland, Virginia, with an accurate description of those countries. London, (?) 1679.

1685.

B(lome), R. The English Empire in America: [etc.] By R. B. 12mo. London, 1685.

1687.

Anon. The Present State Of His Majesties Isles and Territories in America, viz. Maryland, With (New) maps of every Place. 8vo. London, 1687.

1688.

Blome, R. L'Amerique angloise ou Description des isles et terres du roi d'Angleterre dans l'Amerique. Amsterdam, 1688. 12mo. 332 pp.

Probably a translation of 'Anon. 1687,' which has not been seen.

1732.

BYRD, WM. A Progress to the Mines.

(Pub.) in Westover Papers, Petersburg, Va., 1841, vol. ii, pp. 41-82.

This is an account of a trip to the mines near Fredericksburg. It includes references to Maryland ore and many observations on the working of iron at that time.

1733.

ANON. Articles of Agreement made and concluded upon between The Right Honourable The Lord Proprietary of Maryland, and The Honourable The Proprietarys of Pensilvania, &c. touching the Limits and Boundaries of the Two Provinces. With The Commission, Constituting Certain Persons to Execute the same. Philadelphia: Printed by B. Franklin, at the New Printing Office near the Market. M,-DCC,XXXIII. Folio, 19 pp. Map.

1735.

ANON. A Letter to a Gentleman, containing the Boundaries of the Province of Maryland, wherein is shewn, that no part of the 40th degree of latitude is, or can be, any part thereof. London, for the author [about 1735], 12mo, 15 pp.

SENEX, I. A short account of the first settlement of the Provinces of Virginia, Maryland, New York and Pennsylvania by the English, to which is annexed a map of Maryland according to the bounds mentioned in the charter, and also of the adjacent country, anno 1632. London, 1735.

1755.

EVANS, LEWIS. Geographical, Historical, Political and Mechanical Essays. Phila. B. Franklin and D. Hall. 1755. 4to. 32 pp.

There are very interesting notes on the Atlantic slope (pp. 6-8) and on the rivers (pp. 22-24).

1768.

JEFFRYS, THOMAS. Topography of North America and the West Indies. London, 1768.

1770.

ANON. An Abstract of Sundry papers and proposals for improving the inland navigation of Pennsylvania and Maryland.

Trans. Amer. Phil. Soc., o. s. vol. i, 1770, pp. 357-364, map.

Gives early account of country and distances between Philadelphia and Susquehanna river.

1776.

POWNALL, T. Topographical description of such parts of North America as are contained in the (annexed) map of the British middle colonies, etc., in North America. London, 1776.

1778.

BURNABY, ANDREW. Travels through the Middle Settlements in North America in the years 1759 and 1760; with observations upon the State of the Colonies.

(Repub.) Pinkerton's Voyages and Travels, vol. xiii, London, 1812, pp. 701-752.

This is from the 3rd edition, London, 1798. Pages 725-727 deal particularly with his journey in Maryland.

HUTCHINS, THOS. A Topographic Description of Virginia, Pennsylvania, Maryland and North Carolina. London, Printed for the author in MDCCLXXVIII.

Less mention of Maryland than the title would indicate, chiefly deals with country west of Pittsburgh.

1784.

SWEDENBORG, EMANUAL. Regnum Subterraneum sive Minerale de Ferro. [etc.] Dresdae et Lipsiae. MDCCCLXXXIV.

Paragraphus XIII, entitled "Modus venam ferri coquendi, ferrumque crudam recoquendi Marylandiae & Pensilvaniae in India occidentali," contains references to the Principio furnaces, pp. 162-163. This volume is the second of three which deal with the official survey of Sweden.

1787.

SCHOEPF, JOHANN DAVID. Beiträge zur mineralogischen Kenntniss des östlichen Theils von Nord-Amerika und seinen Gebirge. 194 pp. Erlangen, 1787.

1788.

JEFFERSON, THOMAS. Notes on the State of Virginia. Phila. 1788. sm. 8vo. 244 pp.

The author gives many interesting facts and speculations concerning the geology about Harper's Ferry. Fully ten editions of this book were published in different places between 1782 and 1832, each with different number of pages.

1796.

CAREY, M. Carey's American Pocket Atlas containing the following maps, viz. . . . with a concise Description of each State. Phila. 1796. 12mo. 118 pp.

Contains a small map of Maryland with a short description, pp. 91-94.

1807.

SCOTT, JOSEPH. A Geographical description of the states of Maryland and Delaware. Phila., Kimber, Conrad & Co., 1807.

Contains brief enumeration of rivers, bays, islands; also description of its natural features, trade, education, counties and towns. A valuable little summary of Maryland's resources as then known, accompanied by a small map showing the location of twenty-one towns.

1809.

GODON, SILVAIN. Observations to serve for the Mineralogical Map of the State of Maryland. (Read Nov. 6, 1809.)

Trans. Amer. Phil. Soc., o. s. vol. vi, 1809, pp. 319-323.

Observations on the area about Washington and Baltimore.

LATROBE, B. H. An account of the Freestone Quarries on the Potomac and Rappahannock rivers. (Read Feb. 10, 1807.)

Trans. Amer. Phil. Soc., o. s. vol. vi, 1809, pp. 283-293.

Describes the geological formations below Mt. Vernon and the Piscataway river.

MACLURE, WM. Observations on the Geology of the United States, explanatory of a Geological Map. (Read Jan. 20, 1809.)

Trans. Amer. Phil. Soc., o. s. vol. vi, 1809, pp. 411-428.

Broad correlations and generalizations.

1810.

HAYDEN, H. H. ["Mineralogical and Geological Description of the Country surrounding Baltimore to the extent of about nine miles."]

Balt. Med. Phil. Lyc., vol. i, 1810, pp. 255-271.

A letter to Dr. Nathaniel Potter written in 1810. It contained a description of the Bare Hills, "which was subsequently republished in Dr. Bruce's Journal" (1814).

1811.

MACLURE, WM. Suite des observations sur la géologie des États-Unis. Journ. de phys., de chim. et d'hist. nat., vol. lxxiii. Paris, 1811. With map.

1814.

Gilmor, Robt., Jr. A Descriptive Catalogue of Minerals occurring in the vicinity of Baltimore, arranged according to the distribution méthodique of Hauy.

Bruce Min. Jour., vol. i, 1814, pp. 221-232.

Enumerates 43 minerals found within a range of 12 miles, "except in a few instances where the minerals were too interesting to pass unnoticed." Says Cathedral was built of granite from Falls of Patapsco about 10 miles out on the Frederick turnpike (p. 232).

1815.

Mitchill, Samuel L. A detailed Narrative of the Earthquakes of 1811, 1812 and 1813 [abbreviated title]. (Read April 14 and May 12, 1814.)

Trans. Lit. and Phil. Soc. N. Y., vol. i, 1815, pp. 284-307.

Describes the phenomena as observed in Maryland, and suggests that the effects did not extend northeast of Maryland.

1816.

Cleaveland, Parker. An elementary treatise on Mineralogy and Geology. 6 plates. 8vo. 668 pp. Boston, 1816.

Frequent reference to Maryland minerals.

1817.

Maclure, Wm. Observations on the Geology of the United States of America, with some remarks on the effect produced on the nature and fertility of soils by the decomposition of the different classes of rocks. With two plates. 12mo. Phila., 1817.

A classic work giving many references to the limits and character of the geological formations in Maryland. The text and map (120 m. to the inch) represent the Cretaceous extending southwest to the Susquehanna only. All land to the southeast of "Primitive" is "Alluvium" in Maryland. Pages 105-107 deal especially with Maryland.

1818.

Maclure, Wm. Observations on the Geology of the United States of America, with some remarks on the probable effect that may be produced by the decomposition of the different classes of Rocks on the nature and fertility of Soils. Two plates.

Republished in Trans. Amer. Phil. Soc., vol. i, n. s., 1818, pp. 1-91.

Mitchill, Samuel L. Cuvier's Essay on the Theory of the Earth. To which are now added Observations on the Geology of North America. 8vo. 431 pp. Plates. New York, 1818.

Numerous local references especially about Harper's Ferry (339-344), Eastern Shore (393-394), Washington (395-397). The book contains three figures of an elephant's tooth from Maryland.

1819.

Cornelius, Elias. On the Geology, Mineralogy, Scenery and Curiosities of Virginia, Tennessee and the Alabama and Mississippi Territories, etc., with miscellaneous remarks in a letter to the editor.

Amer. Jour. Sci., vol. i, 1819, pp. 214-226.

Refers to "Point of Rocks" breccia without mentioning exact locality.

Hayden, H. H. Red Pyroxene Augite. Extract of a letter to the editor from Dr. H. H. Hayden of Baltimore.

Amer. Jour. Sci., vol. i, 1819, p. 244.

This is an incidental reference in which no locality is given, and the description is insufficient to determine the true character of the mineral found.

1820.

Hayden, H. H. Geological Essays; or an Inquiry into some of the Geological Phenomena to be found in various parts of America and elsewhere. 8vo. pp. 412. Baltimore, 1820.

Cites Maryland localities, especially about Baltimore, in support of his theory. Cites the finding of numerous mastodon teeth in Maryland.

1821.

Nuttall, Thomas. Observations on the Geological Structure of the Valley of the Mississippi. (Read Dec., 1820.)

Jour. Acad. Nat. Sci. Phila., o. s. vol. ii, 1821, pp. 14-52.

Cites Annapolis as northern limit of the "second Calcareous formation," p. 35.

Troost, G. Description of a variety of Amber and of a Fossil Substance supposed to be the nest of an Insect discovered at Cape Sable, Magothy River, Anne Arundel County, Maryland.

Amer. Jour. Sci., vol. iii, 1821, pp. 8-15.

Besides the descriptions are notes on the geological occurrence and associated minerals and fossils.

1822.

Cleaveland, Parker. An elementary treatise on Mineralogy and Geology. 6 plates. 2nd Edit. in 2 vols. Boston, 1822.

Frequent references to Maryland minerals. Maclure's map is reproduced.

Seybert, Henry. Analysis of the American Chromat of Iron.

Amer. Jour. Sci., vol. iv, 1822, pp. 321-323.

The sample analyzed was obtained from the Bare Hills, Baltimore County, Md.

Struve, Baron von. Beiträge zur Mineralogie und Geologie des nordlichen Amerikas. 12mo. Hamburg, 1822.

1823.

ANON. Report by the Maryland Commission on a Proposed Canal from Baltimore to Conowago, with maps and profiles. Baltimore, 1823.

(Rev.) N. A. Rev., vol. xviii, 1824, p. 217.

Gives many figures on Maryland elevations based on lines of level run from Baltimore to York and to Havre de Grace.

1824.

FINCH, JOHN. Geological Essay on the Tertiary Formations in America. (Read Acad. Nat. Sci. Phila., July 15, 1823.)

Amer. Jour. Sci., vol. vii, 1824, pp. 31-43.

Objects to Maclure's use of Alluvium and shows that the formations so called are mostly Tertiary. Several Maryland localities studied.

HARPER, GENERAL [R. S.]. Speech to the Citizens of Baltimore on the expediency of promoting a connexion Between the Ohio, at Pittsburg and the waters of the Chesapeake at Baltimore by a Canal through the District of Columbia, with his reply to some of the objections of Mr. Winchester.

Delivered at a meeting held at the Exchange on the 20th day of December, 1823. Baltimore, 1824, 78 pp., map.

(Rev.) N. A. Rev., vol. xviii, 1824, p. 217.

SAY, THOMAS. An Account of some of the Fossil Shells of Maryland.

Jour. Acad. Nat. Sci. Phila., vol. iv, 1824, pp. 124-155. Plates 7-13.

Tentatively correlates Maryland deposits with those of South Carolina and then discusses and figures 38 new species.

SHRIVER, JAMES. An Account of the Examination and Surveys, with Remarks and Documents relative to the projected Chesapeake and Ohio and Lake Erie Canals. Baltimore, 1824, pp. 116, map.

Contains an account of surveys and observations made along the summit of Alleghany mountain during a location survey of the Chesapeake and Ohio Canal. Includes remarks on the minerals and geological formations of the area traversed.

1825.

BERNARD, S., and TOTTEN, JAS. E. Report of the Board of Internal Improvement on the Chesapeake and Ohio Canal. Feb. 2, 1825.

See Merrill, 1874.

CHAMBERS, E. F. Report of the Commissioners concerning the Western Limits of the State. Annapolis. n. d. 8vo. 7 pp. [1825].

Md. Public Documents.*

* There seems to be no standard title for these publications, as they are variously named even in the sets of the State Library. They are also bound up differently.

Robinson, Samuel. A Catalogue of American Minerals, with their localities. Boston, 1825.

Pages 195-201 are devoted to minerals from Maryland. Retiuasphaltum is mentioued in the Appendix, p. 302.

Sparks, Jared. Baltimore.

N. A. Review, vol. xx, 1825, pp. 99-138.

The article contains a discussion ou the intercourse of Baltimore with the western country by means of canals and turnpikes. Reference to irou ore in abuudance, copper works with 600,000 pounds capacity; copper sulphuret mines in Frederick Couuty, the source of copper for Capitol dome at Washington (p. 130).

Troost, G. Description and Chemical Analyses of the Retinasphalt discovered at Cape Sable, Magothy River, Anne Arundel County, Md. (Read Dec. 19, 1823.)

Trans. Amer. Phil. Soc., n. s. vol. ii, 1825, pp. 110-115.

Describes retinasphalt, earthy retinasphalt and amber occurring intermixed with wood and pyrites at Cape Sable.

Van Rensselaer, Jer. Lectures on Geology; being outlines of the science, delivered in the New York Atheneum in the year 1825. 8vo. pp. 358. New York, 1825.

Only general refereuces to Maryland.

1826.

Bernard, S., Poussin, Wm. Tell, Howard, W. Report of the Board of Internal Improvement.

See Merrill, 1874.

Dekay, J. E. Anniversary Address on the Progress of the Natural Sciences in the United States, delivered before the Lyceum of Natural History of New York, Feb. 1826. New York, 1826.

Only general references to Maryland.

Dunlop, J. Memoir on the Controversy between William Penn and Lord Baltimore respecting the boundaries of Pennsylvania and Maryland. 38 pp.

Mem. Penn. Hist. Soc., vol. i, 1826, pp. 159-196.

Pierce, James. Practical remarks on the shell marl region of the eastern parts of Virginia and Maryland, and upon the bituminous coal formations of Virginia and the contiguous region.

Amer. Jour. Sci., vol. xi, 1826, pp. 54-59.

Extracts from a letter; economic in character. Meutions exposures at Marlboro and discusses the relative value of marls.

1827.

Bernard, S., and Poussin, W. T. Letter from the Postmaster General transmitting report of General Bernard on surveys of routes for a Post Road from Baltimore to Philadelphia. Washington, 1827.

Gives a map and notes on the geological formations and soils along the different routes.

Disbrow, Levi. Notice of some recent experiments in boring for fresh Water, and of a pamphlet on that subject.

Amer. Jour. Sci., vol. xii, 1827, pp. 136-143.

Gives sections passed through at Washington and Baltimore.

Morton, S. G. Description of a new species of Ostrea; with some Remarks on the O. convexa of Say. Read May 1, 1827.

Jour. Acad. Nat. Sci. Phila., vol. vi, 1827, pp. 50-51.

Describes and figures Ostrea falcata, from the Delaware and Chesapeake Canal near St. George's.

1828.

Anon. First Annual Report of the Board of Engineers to the Board of Directors of the B. & O. R. R. 43 pp. Map of route from Baltimore to Ellicott's Mills.

Reviewed by Peter H. Cruse in N. A. Rev., vol. xxviii, 1829, pp. 166-186.

Anon. Report of the Engineers, on the Reconnaissance and Surveys made in reference to the Baltimore and Ohio R. R. 8vo. 188 pp. 1828.

Reviewed by Peter H. Cruse in N. A. Rev., vol. xxviii, 1829, pp. 166-186.

Carpenter, George W. On the Mineralogy of Chester County, with an account of some of the Minerals of Delaware, Maryland and other Localities.

Amer. Jour. Sci., vol. xiv, 1828, pp. 1-15.

Also published separately, 12mo, pp. 16, Phila., 1828 (Md. ref., p. 14).

Gives brief lists of minerals occurring near the Falls of North East Creek (Cecil County) near Cooperstown (Harford County). Reference to the Magnesite of the Bare Hills (Baltimore County) then employed in the manufacture of Epsom Salts. Includes only schorl, actinolite, magnetite, talc, and mangesite (p. 13).

Morton, S. G. Description of two new species of Fossil Shells of the genus Scapphites and Crepidula: with some observations on the Ferruginous Sand, Plastic Clay, and Upper Marine Formations of the United States. (Read June 17, 1828.)

Jour. Acad. Nat. Sci. Phila., vol. vi, 1828, pp. 107-119.

Gives list of Maryland fossils from "Upper Marine Beds" and discusses the European correlation.

——— Description of the Fossil Shells which characterize the Atlantic Secondary Formation of New Jersey and Delaware; including four new species. (Read Dec. 11, 1827, Jan. 1, 1828.)

Jour. Acad. Nat. Sci. Phila., vol. vi, 1829, pp. 72-100. Plates iii-vi.

This paper is intended as a supplement to the Vanuxem-Morton paper, and while the individual forms described are not from Maryland, this is included because of its relation to the first paper and the fact that the forms here described are highly developed in Maryland. This folio was printed January, 1828.

VANUXEM, L., and MORTON, S. G. Geological Observations on Secondary, Tertiary, and Alluvial formations of the Atlantic coast of the United States arranged from the notes of Lardner Vanuxem. (Read Jan. 1828.)

Jour. Acad. Nat. Sci. Phila., vol. vi, 1829, pp. 59-71.

Reference to Maryland Tertiary formations and a number of fossils cited on pp. 67-68. Objects to Say's genus "Dispotea." This folio was printed January, 1828.

1829.

ANON. Third Annual Report of the President and Directors to the Stockholders of the B. & O. R. R. 8vo. 105 pp.

Map embracing various routes and profiles of the two principal routes surveyed for the B. & O. from Baltimore to Williamsport.

LIVERMORE & DEXTER. A collection of fossil earths, and minerals from the deep cut of the Delaware and Chesapeake Canal, with memoir and profile of geological strata developed in progress of work.

Proc. Amer. Phil. Soc., vol. xxii (2), 1884, p. 594.

Mentioned in Minutes Proc. Amer. Phil. Soc., 1743-1838.

1830.

ANON. Fourth Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Railroad Company. 8vo. 153 pp. 1830.

Engineer's Report. Map [same as in 3rd Ann. Rept.].

ANON. Gold in Maryland.

Amer. Jour. Sci., vol. xvii, 1830, p. 202.

Brief note on its recent discovery. "It is known to exist in Virginia, and these localities, with those of North Carolina, appear to form a straight line parallel or nearly so, it is believed, with the Alleghany range. Quartz is abundant in the region about that (locality not given) discovered in Maryland, as is the case also in that of North Carolina."

BYRENS, DANIEL. Suggestions as to a union of effort to obtain a correct account of the variation of the magnetic needle.

Amer. Jour. Sci., vol. xviii, 1830, pp. 380-381.

Declination determined as ten to fifteen minutes west variation.

CONRAD, T. A. On the Geology and Organic Remains of a part of the Peninsula of Maryland.

Jour. Acad. Nat. Sci. Phila., vol. vi, pt. 2, 1830, pp. 205-230, with two plates.

Appendix contains figures of 29 new species of fossil shells noticed in the preceding pages. Describes the geological occurrence at St. Mary's, Charlotte Hall and Piscataway and correlates with London clay, upper Marine.

——— Description of Fifteen New Species of Recent and Three of Fossil Shells, chiefly from the Coast of the U. S.

Jour. Acad. Nat. Sci. Phila., vol. vi, 1830, pp. 256-268, plate.

Includes Cardium laqueatum, Arca maxillata (cast), Venus alveata.

MORTON, SAMUEL G. Synopsis of the Organic Remains of the Ferruginous Sand Formation of the United States, with Geological remarks.

Amer. Jour. Sci., vol. xvii, 1830, pp. 274-295; vol. xviii, 1830, pp. 243-250.

Remarks on the section of the Deep Cut of the Chesapeake and Delaware Canal, with brief description of several fossils and references to Algonium from the greensand below Annapolis (p. 228).

SHEPARD, C. U. On the Mineralogical and Chemical characters of Deweylite [etc.]

See Tyson, P. T. 1830.

TYSON, PHILIP T. Notice of some Localities of Minerals in the counties of Baltimore and Harford, Md., with an Appendix by C. U. Shepard (on Deweylite).

Amer. Jour. Sci., vol. xviii, 1830, pp. 78-84.

Localities for the following minerals are given: Fine-grained dolomite, chalcedony, tourmaline, precious garnet, common garnet, white augite, talc, magnesian hydrate of silica, precious serpentine, compact asbestus, flexible asbestus, graphite (lamellar), pyritous copper, iron pyrites and magnetic oxide of iron. The appendix by Charles U. Shepard is "On the Mineralogical and Chemical character of Deweylite and the probable identity of Magnesian hydrate of Silica with this species," pp. 81-84.

1831.

ANON. Fifth Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Rail Road Company. 8vo. 130 pp. 1831.

Folded map and profile of the route of the B. & O. from Baltimore to Point of Rocks; and of the lateral road to Frederick. Second Annual Report of the Chief Engineer.

Map of a route from Baltimore to Washington.

BRONGNIART, ALEX. Rapport sur un Mémoire de M. Dufresnoy, Ingenieur des Mines, ayant pour titre: Des Caracteres particuliers que presente le terrain de Craie dans le Sud de la France et sur les pentes des Pyrenees. Fait à l'Acad. roy. d. Sci., Apr. 1831.

Annales des Sc. Naturelles, t. xxii, 1831, pp. 436-463, Plate XIV.

Pages 460-461 the author refers to Dufresnoy's correlation of the New Jersey and Maryland deposits and accepts the views of Dufresnoy. The conclusions are based on the work of Morton.

Hayden, H. H. Notices of the Geology of the Country near Bedford Springs in Pennsylvania, and the Bath, or Berkeley Springs in Virginia, with remarks upon the waters.

Amer. Jour. Sci., vol. xix, 1831, pp. 97-104.

Numerous notes on the geology of the narrow portion of Maryland about Hancock.

Owen, J. S. Fossil remains, found in Anne Arundel County, Maryland.

Amer. Jour. Geol., Phila., vol. i, 1831, pp. 114-118.

Columnar section at Anne Arundel in a well 72 feet deep where several vertebrae of whales were found.

1832.

Anon. Communication from the President of the Baltimore and Ohio Rail Road Company to the Legislature of Maryland, enclosing surveys and estimates of the railroad from Baltimore to Washington. 8vo. 13 pp. 1832.

Anon. Correspondence between the Executive of Maryland and the President of the United States and Secretary of War relative to a Survey of the Sea Coast between the Chesapeake and Delaware Bays. Annapolis, 1832. sm. 8vo. 7 pp.

Md. Pub. Doc., Dec. Sess., 1831.

Conrad, T. A. Fossil Shells of the Tertiary Formations of North America illustrated by figures drawn on Stone from Nature. Phila. 46 pp. [vol. i, pt. 1-2 (1832), 3-4 (1833).

(Repub.) by G. D. Harris, Washington, 1893.

Contains plates and descriptions of many of the typical fossil species of Maryland. (Part 3 was republished with plates, March 1, 1835.)

Durand, Elias. On the Green Color and Nature of the coloring Agent of the Water of the Delaware and Chesapeake Canal, near the first lock on the Chesapeake side.

Jour. Phila. Col. of Pharmacy, vol. iii, 1832, pp. 276-277.

Shows color is not due to copper in solution, but to sulphate of iron which results from the decomposition of iron pyrites found in the banks.

Johnson, W. C. Report of the Committee on Internal Improvement to the Legislature of Maryland. W. C. Johnson, Chairman. 8vo. 32 pp. 1832.

Md. Pub. Doc., Dec. Sess., 1831.

Completion of the road to the Potomac, and engineer's report on Washington Branch Road.

MORTON, S. G. On the analogy which exists between the Marl of New Jersey, &c., and the Chalk formation of Europe.

Amer. Jour. Sci., vol. xxii, 1832, pp. 90-95.

Published separately.

Includes extracts from the Reports on the Memoir of M. Dufresnoy, &c. Read before the French Institute, April 25, 1831. Reference to Dr. Morton's work on the Cretaceous of Maryland, pp. 93, 95 (see Brongniart, 1831).

PIGMAN. Report and Resolution relative to the Southern and Western Limits of this State. Annapolis, 1832. sm. 8vo. 22 pp.

Md. Pub. Doc., Dec. Sess., 1831.

POMEROY, SAM. WHYLLYS. Remarks on the Coal Region between Cumberland and Pittsburgh, and on the Topography, Scenery, etc., of that portion of the Alleghany Mts. [Letter written Nov. 1831.]

Amer. Jour. Sci., vol. xxi, 1832, pp. 342-347.

RUFFIN, ED. An Essay on Calcareous Manures.

(See Ruffin, 1842.)

1833.

ANON. Seventh Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Rail Road Company. 8vo. 194 pp. 1833.

Folded map and profile of the projected lateral railroad to the city of Washington in connection with the first nine miles of the B. & O. R. R., showing the entire route from Baltimore to Washington. Scale, one mile to the inch.

BERTHIER, P. Analysis of Fer Titané of Baltimore.

Amer. Jour. Sci., vol. xxiv, 1833, pp. 375-376.

Extracted from Annales des Mines, tom. iii, p. 39.

——— Analyse de divers Mineraux Metalliques. Fer Titané de Baltimore en Maryland.

Ann. des Mines, 3me serie, tome iii, 1833, pp. 41-43.

Brief account of the minerals, their occurrence and properties.

DURAND, E. On the Alum and Copperas Manufactury of Cape Sable, Md.

Jour. Phila. Col. Pharmacy, vol. v, 1833, p. 12.

A letter written in 1817 describing the works formerly carried on by Dr. Troost.

FINCH, I. Travels in the United States of America and Canada. 8vo. 455 pp. London, 1833.

Has a chapter devoted to Fort Washington and St. Mary's; also other incidental references to geology.

HAYDEN, H. H. Description of the Bare Hills near Baltimore.

Amer. Jour. Sci., vol. xxiv, 1833, pp. 349-360, map.

The position of various localities for minerals occurring here is carefully described and indicated on the accompanying map.

JENKINS, L. W., Chairman. Report of the Select Committee relative to the Expediency of procuring a Map of the State.

Md. House of Delegates, Dec. Sess., 1832, Annapolis, 1833, 8vo, 10 pp.

Contains a few remarks on the mineralogical features of the State by Ducatel.

LEA, ISAAC. Contributions to Geology. 237 pp. 6 plates. Phila. 1833.

(Rev.) Amer. Jour. Sci., vol. xxv, 1834, pp. 413-423.

General discussion of the Tertiary of Alabama. New Tertiary fossil shells from Maryland and New Jersey, and description of new forms from New Jersey and of the Turfaceous Lacustrine formation of Syracuse, N. Y. The descriptions and figures include the new forms Balanus finchii, Mactra clathrodon, Rotella uana, Fusus pumilus, Milliola marylandica from St. Mary's; Fort Washington deposits are correlated with those of Claiborne, Ala.

MORTON, SAMUEL G. Supplement to the "Synopsis of the Organic Remains of the Ferruginous Sand Formation of the United States," contained in vols. xvii and xviii of this Journal.

Amer. Jour. Sci., vol. xxiii, 1833, pp. 288-294; vol. xxiv, pp. 128-132, plate ix.

Traces the southern extension of the greensand districts of New Jersey, Delaware and Maryland.

Discusses the general stratigraphic position and accepts the term Cretaceous for the group.

1834.

ANON. Eighth Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Rail Road Company. 8vo. 57 pp. 1834.

Contains Fifth Annual Report, Chief Engineer.

Map and Profile of the Sixth Division, extending from Point of Rocks to Harper's Ferry Bridge.

AIKIN, WILLIAM E. A. Some notices of the Geology of the Country between Baltimore and the Ohio River, with a section illustrating the superposition of the rocks.

Amer. Jour. Sci., vol. xxvi, 1834, pp. 219-232, plate.

The most complete description of the geology of Central and Western Maryland published up to the time of its appearance.

BLAKISTON, WM. I. Report of the Joint Committee on the Boundary Lines between Virginia and Maryland. Annapolis, 1834. 8vo. 11 pp.

Md. Pub. Doc., Dec. Sess., 1833.

Includes a report by Thos. Cresap.

CLEMSON, THOS. G. Extract of Observations on the Geology of York County, Pa.

Trans. Geol. Soc. Penn., vol. i, pt. 1, appendix 13 pp.

Advocate of Sci. & Amer. Nat. Hist., vol. i, 1834, pp. 163-175.

CONRAD, T. A. Observations on the Tertiary and more recent formations of a portion of the Southern States.

Jour. Acad. Nat. Sci., Phila., vol. vii, 1834, pp. 116-129.

States the Eocene as extending southwest from Maryland, and regards the Mt. Washington bluff as younger than that at Claiborne.

Appendix to above, pp. 129-157.

Describes shells from St. Mary's (135), Choptank (136, 144, 150, 151, 152, 155).

DUCATEL, J. T., and ALEXANDER, J. H. Report on the Projected Survey of the State of Maryland, pursuant to a resolution of the General Assembly. 8vo. 39 pp. Annapolis, 1834. Map.

Md. House of Delegates, Dec. Sess., 1833, 8vo, 39 pp.

Another edition, Annapolis, 1834, 8vo, 58 pp., and map.

Another edition, Annapolis, 1834, 8vo, 43 pp., and folded table.

Amer. Jour. Sci., vol. xxvii, 1835, pp. 1-38.

Results of a preliminary survey of the State. The area and formations of the State are divided into three divisions corresponding to the present Coastal Plain, Piedmont Plateau and Appalachian areas. Many local descriptions and references are given with marked tendency towards economic point of view.

HACHEWELDER, JOHN. Names which the Lenne Lenape or Delaware Indians, who once inhabited this country, have given to Rivers, Streams, Places, etc.

Trans. Amer. Phil. Soc., vol. iv, 1834, pp. 351-396.

(Repub.) Trans. Moravian Soc., vol. i, Nazareth, 1876, pp. 225-282.

Gives the derivation and signification of some twenty-five local names, especially those of rivers.

HARLAN, R. Critical Notices of Various organic remains hitherto discovered in North America. (Read May 21, 1834.)

Trans. Geol. Soc. Pa., vol. i, part 1, 1834, pp. 46-112.

Med. Phy. Researches, 1835, [with a few additions].

The author mentions specimens of Equus callabus "found in excavating for the Chesapeake and Ohio Canal near Georgetown, D. C., not far from the Potomac River" (p. 61).

MERCER, CHAS. FENTON. Report of the Hon. Charles Fenton Mercer [on the Chesapeake and Ohio Canal].

House Misc. Doc., 23rd Cong., 1st Sess., Doc. 414. Washington, 1834, 378 pp.

Appendix Z and pages 248-301 are particularly interesting and give many facts on the coal and iron.

Merrick, Wm. D., Chairman. Report of the Committee on Internal Improvement relative to a Map and Survey of the State of Maryland. Annapolis, 1834, 8vo, 6 pp.

Md. House of Delegates, Dec. Sess., 1833.

Morton, S. G. Synopsis of the organic remains of the Cretaceous group of the United States. To which is added an appendix containing a tabular view of the Tertiary fossils hitherto discovered in North America. 8vo, 88 pp. Phila. 1834.

(Abst.) Amer. Jour. Sci., vol. xxvii, 1835, pp. 377-381.

Pigman. Mr. Pigman's Second Report relative to the Southern and Western Boundaries of this State, with the accompanying Documents. 8vo. 11 pp. [Annapolis, 1834.]

Md. Pub. Doc., Dec. Sess., 1833.

1835.

Alexander, J. H. Engineer's report 1834 (issued separately).

(See Ducatel and Alexander.)

——— Report on the New Map of Maryland 1834. n. d. 8vo. 15 pp.

Md. Pub. Doc., Dec. Sess., 1834.

Anon. Ninth Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Rail Road Company. 8vo. 174 pp. 1835.

Contains as appendix A, Sixth Annual Report of the Chief Engineer.

Folded map of the country between Cumberland and the Ohio.

Bache, A. D., and Courtenay, E. H. Observations to determine the Magnetic Dip at Baltimore, Philadelphia, New York [etc.]. (Read Nov. 7, 1834.)

Trans. Amer. Phil. Soc., vol. v, n. s., 1835, pp. 209-215.

Conrad, T. A. Observations on a portion of the Atlantic Tertiary Region.

Trans. Geol. Soc. Penn., vol. i, 1835, pp. 335-341, pl. 13.

Upper Marlboro and Piscataway, Md., deposits considered; also those of City Point, Va.

Includes figures and descriptions of Panopea elongata, Modiola cretacea, and Turritella humerosa. Considers the formations to be either Eocene or Neocene and not Miocene, as there is no general transition. The Marls he regards as Tertiary, not Cretaceous.

——— Observations on the Tertiary Strata of the Atlantic Coast.

Amer. Jour. Sci., vol. xxviii, 1835, pp. 104-111, 280-282.

This paper includes a list of Newer Pliocene fossils from Benner's plantation, on the Neuce river, below Newbern, N. C., and from the Potomac river, with a description of their occurrence and a discussion of the Pliocene. Cites St. Mary's river as Medial Pliocene, pp. 104-111.

Reference to the Newer Pliocene of Eastern Maryland, pp. 280-282.

Ducatel, J. T. Geologist's report 1834.

——— Another edition. Report of the Geologist to the Legislature of Maryland, 1834. n. d. 8vo, 50 pp. 2 maps and folded tables.

Discusses the source of the shell marl deposits on the Eastern Shore and the geology along the Potomac in Prince George's and Charles Counties. (See following.)

Ducatel, J. T., and Alexander, J. H. Report on the New Map of Maryland, 1834, [Annapolis] n. d. 8vo, 59, i, pp. Two maps and one folded table.

Md. House of Delegates, Dec. Sess., 1834.

Harlan, Richard. Notice of a Pleseosaurian and other fossil Reliquiae from the State of New Jersey.

Med. and Phys. Researches, 1835, pp. 383-385.

Describes a Manatus from western shore of Maryland (p. 385). See also Harlan, 1834.

Morton, S. G. Additional Observations (to Synopsis). 8vo. 4 pp. Phila., June, 1835.

Apparently published as a leaflet without pagination. Adds Gryphaea vomer to the Eocene forms of Upper Marlboro and Piscataway.

Ruffin, Edmund. An Essay on Calcareous Manures. 8vo. 2nd Edit. 116 pp. Shellbanks, Va., 1835.

See Ruffin, 1842.

Taylor, Richard C. Review of Geological Phenomena and the deductions derivable therefrom, in two hundred and fifty miles of sections in parts of Virginia and Maryland.

Trans. Geol. Soc. Penn., vol. i, 1835, pp. 314-325 (with colored sections).

The paper describes various sections, one of which extends from Winchester to Harper's Ferry and thence east to within 30 miles of Baltimore. This section is plate xvii, fig. I.

1836.

Alexander, J. H. Report on the New Map of Maryland, 1835. 8vo, 34 pp. 6 maps.

Also 8vo, 42 pp. 6 maps.

Separate publications (see Ducatel and Alexander).

ANON. Charter, &c., of the George's Creek Coal and Iron Company, containing a detailed account of the Geology, &c., of this locality. 1836.

BOOTH, JAS. C. Report of the Examination and survey of the Coal lands, etc., belonging to the Boston Purchase, near Cumberland, in the State of Maryland. New York, D. Fanshaw, 1836.

A small pamphlet of 8 pp., containing an account of the coal seams, iron ore, limestone, fire-clay, and cost of production.

DUCATEL, J. T. Report of the Geologist. n. d. 8vo, pp. 35-84. Plate.

Separate publication (see Ducatel and Alexander).

DUCATEL, J. T., and ALEXANDER, J. H. Report on the New Map of Maryland, 1835. 8vo, 84, 1 pp. [Annapolis, 1836.]

Md. Pub. Doc., Dec. Sess., 1835.

Another edition, 96, 1 pp. and maps and plate.

Engineer's Report, pp. 1-34.

Contains three maps for canals on Eastern Shore, one triangulation map of bay, and large scale contour maps of southern part of Western and Eastern Shores, with explanations.

Report of the Geologist, pp. 35-84.

Physical geography, geology and resources of Dorchester, Somerset, Worcester and St. Mary's counties.

——— Report of the Engineer and Geologist in relation to the New Map to the Executive of Maryland.

Md. Pub. Doc., Dec. Sess., 1835 [Annapolis, 1836], 8vo. 84, 1 pp., 6 maps and plates.

(Rev.) Amer. Jour. Sci., vol. xxx, 1836, pp. 393-394.

Jour. Franklin Inst., vol. xviii, n. s. 1836, pp. 172-178.

Shows the report to be economic and preliminary. Its appearance is the occasion for remarks on the organization and appropriations of the other then existing surveys.

FEATHERSTONHAUGH, G. W. 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. 169 pp. 4 plates. Washington, 1836.

GREEN, DUFF. A Letter addressed to the General Assembly of Maryland, by Duff Green, on the Bill incorporating the Union Company. 1836.

HUGHES, GEORGE W. Report of an Examination of the Coal Measures including the Iron-ore deposits, belonging to the Maryland Mining Company, in Allegany County, &c. &c. 1836.

Johnson, Wm. Cost. Report of the Hon. Wm. Cost Johnson to Congress.

House Misc. Doc., 26 Cong., No. 168, Washington, 1836.

Purvis, M. On the use of Lime as a Manure.

Translated for Farmer's Register, Shellbanks, Va., 1835.

(Rev.) Amer. Jour. Sci., vol. xxx, 1836, pp. 138-163.

Reference to the occurrence of the greensand formations in Maryland, p. 160.

1837.

Alexander, J. H.

(See Ducatel and Alexander.)

Bache, A. D., and Courtenay, E. H. Observations to determine the magnetic dip at Baltimore, Philadelphia, New York, West Point, Providence, Springfield, and Albany. (Read before Amer. Phil. Soc., Nov. 7, 1834.)

Trans. Amer. Phil. Soc., n. s. vol. v, 1837, pp. 209-211.

Observations taken opposite Holliday Street Theater in July, 1834, give mean dip 70° 58.6′.

Ducatel, J. T. Outline of the Physical Geography of Maryland, embracing its prominent Geological Features.

Trans. Md. Acad. Sci. and Lit., vol. ii, 1837, pp. 24-54, with map.

General discussion with many local features and details.

Ducatel, J. T., and Alexander, J. H. Report on the New Map of Maryland, 1836. 8vo, 104 pp. and 5 maps. [Annapolis, 1837.]

Md. House of Delegates, Sess. Dec., 1836.

Another edition, 117 pp.

Report of the geologist deals with the geology of Frostburg and of Calvert, Anne Arundel, St. Mary's, Charles and Prince George's counties. Several maps and sections in black and white (pp. 1-60).

Engineer's report includes several small maps and their explanation, together with estimates on the location of certain canals and railroads (pp. 61-104).

Eldredge, N. T. Report of the Special Agent sent to examine the Mines of the Company. sm. 8vo, 13 pp. New York, 1837.

This is a report to the Boston and New York Coal Company, which is usually appended to the "Charters and By-Laws." It contains considerable information regarding the coal and iron deposits. There are opinions quoted. One analysis of the coal and 15 of the iron are given.

Humphreys, H. The Latitude of Annapolis.

Trans. Md. Acad. Sci. and Lit., vol. i, part 1, 1837, pp. 135-137.

Notices some variations in compass needle and barometer during auroral displays of January 25, April 3 and 21 and 24, 1837. Also gives the magnetic variation at Annapolis; needle set up on the college green, St. John's College, as being 2° 41′ west. Latitude is determined as 38° 58′ 35.617″ north.

KERR, J. BOZMAN. Report of the Select Committee appointed to inquire into the expediency of repealing the act to provide for completing a New Map and Geological Survey of this State.

Md. Pub. Doc., Dec. Sess., 1837, Document [R], n. d., 8vo, accompanied by a letter from Alexander, 8 pp. [Annapolis, 1838].

METEOROLOGICAL COMMITTEE'S REPORT.

Trans. Md. Acad. Sci. and Lit., vol. i, part 1, 1837, pp. 138-147.

Besides a description of a barometer made for the Academy, there are given "Meteorological Observations made by the Maryland Academy of Science and Literature" on the 21st and 22d of June, 21st and 22d of September, 21st and 22d of December, 1836, on the 21st aad 22d of March, 1837, at Baltimore. See pp. 174-186 for daily Meteorological Observations for year 1836 at Baltimore, Md.

ROGERS, W. B. and H. D. Contributions to the Geology of the Tertiary Formations of Virginia. (Read May 5, 1835.)

Trans. Amer. Phil. Soc., vol. v, n. s. 1837, pp. 319-341.

Objects to Conrad's considering the deposits on St. Mary's river under a new division called Middle Pliocene (p. 335).

TRIMBLE, ISAAC. Report of the Engineer on the Subject of the Maryland Canal. Baltimore, Lucas & Deaver, 1837.

Gives various routes for Maryland canal; gauging of various streams; monthly rainfall, etc. The report is accompanied by map (1/125,000) and profile.

TYSON, PHILIP T. A description of the Frostburg Coal Formation of Allegany County, Maryland, with an account of its geological position.

Trans. Md. Acad. Sci. and Lit., 1837, pp. 92-98, plate.

Gives a detailed section from Dug Hill to George's Creek; also records the finding of Glassopteris phillipsii, calamites, etc. Believes the elevation of Wills Mt. took place before the coal series was deposited.

——— A descriptive Catalogue of the principal minerals of the State of Maryland.

Trans. Md. Acad. Sci. and Lit., 1837, pp. 102-117.

Divides the state into six divisions and enumerates the minerals for each, but does not give the full list of minerals from the western counties.

1838.

ANON. Report upon the Surveys for the Extension of the Baltimore and Ohio Rail Road from its Present Termination near Harper's Ferry, on the Potomac, to Wheeling and Pittsburg on the Ohio river. 8vo. pp. 138.

ALEXANDER, J. H. Communication from the Topographical Engineer. 8vo. pp. 5-8. [Annapolis, Feb. 19, 1838.]

Md. Pub. Doc., Dec. Sess., 1837.

Deals with the expense of the New Map.

CONRAD, T. A. Fossils of the Medial Tertiary of the United States. No. 1, 1838. [Description on cover 1839 & '40.] 32 pp. Plates I-XVII.

(Repub.) by Wm. H. Dall, Washington, 1893.

The description of many type forms characteristically developed in Maryland.

DAUBENY, CHAS. Sketch of the geology of North America, being the substance of a memoir read before the Ashmolean Society, November 26, 1838. 78 pp. 1 plate. Oxford, 1839.

(Absts.) Amer. Jour. Sci., vol. xli, 1842, pp. 195-199; Bull. Soc. Geol. France, vol. xi, 1840, pp. 221-225.

Few general references only.

DOUGLAS, D. B. Report on the Coal and Iron Formation of Frostburg and Upper Potomac in the states of Maryland and Virginia. Brooklyn (?) 1838, with map.

Results of three weeks' investigation. Gives section beginning near Westernport, in which are enumerated twenty coal veins, ten very workable. Remarks on structure and several analyses of coal with reference to generation of heat.

DUCATEL, J. T. Annual Report of the Geologist of Maryland. 1837. [Annapolis, 1838.] 8vo. 39, 1 pp. and 2 maps.

Md. Pub. Doc., Dec. Sess., 1837.

Includes discussion of the geology of Kent, Cecil and Montgomery counties, with remarks on coal in Frederick County.

LOOMIS, ELIAS. On the Variation and Dip of the Magnetic Needle in different parts of the United States (with map).

Amer. Jour. Sci., vol. xxxiv, 1838, pp. 290-307.

Many observations and records, including some made in Maryland.

MACKUBIN, GEO. Report of the Treasurer of the Western Shore to the House of Delegates, Respecting the Expenses incurred in making the Geographical and Geological surveys of the State. 8vo. 3 pp. [Annapolis, 1838.]

Md. Pub. Doc., Dec. Sess., 1837.

SILLIMAN, B. Extracts from a report made to the Maryland Mining Company, 1838.

WAGNER, WILLIAM. Description of five new Fossils, of the older Pliocene formation of Maryland and North America. (Read Jan. 1838.)

Jour. Acad. Nat. Sci., Phila., vol. viii, 1838, pp. 51-53, with one plate.

Describes and figures Pecten marylandicus, Venus tuoceriformis, Trochus eboreus from Maryland, Panopea goldfusi, Mysia nucleiformis from North Carolina.

1839.

ANON. Report of the Treasurer of the Western Shore to the House of Delegates of Maryland. In obedience to their order of the 28th ultimo stating the Expenses incurred in making the Geographical and Geological Surveys of the State. n. d. 8vo, 2 pp. [Annapolis, 1839.]

Md. Pub. Doc., Dec. Sess., 1838.

BOOTH, JAS. C. First and Second Report of the Geological Survey of Delaware. 25 pp. Dover, 1839.

CONRAD, T. A. Notes on American Geology. Observations on characteristic Fossils, and upon a fall of Temperature in different geological epochs.

Amer. Jour. Sci., vol. xxxv, 1839, pp. 237-251.

Reference to the Eocene deposits at Upper Marlborough and Piscataway, Md., as illustrations of deposition by gentle currents.

See also Conrad, 1838, and Dall, 1893.

DUCATEL, J. T. Annual Report of the Geologist of Maryland, 1838. 8vo, map and illustrations. 33 pp. [Annapolis, 1839.]

Md. Pub. Doc., Dec. Sess., 1838.

Considers the geology and mineral resources of Harford and Baltimore counties; also contains a treatise on Lime (map of Cecil County).

ERICKSON, CAPTAIN. Report of Captain Erickson, Civil Engineer, London, showing the cost of the coal of the *Maryland Mining Company* per ton, delivered at the several cities of Washington, Baltimore, Philadelphia and New York. 1839.

SHEPPARD, F. Report to the Potomac and Allegany Coal and Iron Manufacturing Company. 1839.

SILLIMAN, B. Extract from a report made to the Maryland and New York Coal and Iron Company. 1839.

WELD, HENRY THOMAS. A Report made by Henry Thomas Weld, Esq., of the Maryland and New York Iron and Coal Company's Land, &c.

WHARTON. Report of the Select Committee appointed by the House of Delegates to Report a Bill to abolish the Office of State Geologist. n. d. 8vo. 3 pp. (1839).

Md. Pub. Doc., Dec. Sess., 1838 [L].

1840.

ALEXANDER, J. H. Report on the Manufacture of Iron addressed to the Governor of Maryland by J. H. Alexander. Printed by order of the Senate. Annapolis, 1840, 8vo, 369 pp., 3 plates.

Deals particularly with the iron industry in Maryland, and gives many analyses.

ANON. Charters of the Union Potomac Company and the Union Company, with a description of their Coal and Iron Mines, &c. 1840.

CONRAD, T. A. Fossils of the Medial Tertiary of the United States. No. 2. 1840. [Description on cover 1840-1842.] pp. 33-56. Plates XVIII-XXIX.

(Repub.) by W. H. Dall, Washington, 1893.

The descriptions of many typical Maryland forms. See also 1838.

DUCATEL, J. T. Annual Report of the Geologist of Maryland, 1839. 8vo, 45 pp. [Annapolis, 1840.]

Md. House of Delegates, Dec. Sess., 1839.

This gives a history of the survey, and deals with the geology and physical geography and mineral resources of Frederick and Carroll counties. Maps of northern part of State in hachure.

LOOMIS, ELIAS. On the Variation and Dip of the Magnetic Needle in the United States.

Amer. Jour. Sci., vol. xxxix, 1840, pp. 41-50.

Gives determinations made at Baltimore.

1841.

ALEXANDER, J. H. Trigonometrical Survey for the New Map of Maryland. 1841. n. d. 8vo. 8 pp. [Dated Feb. 2nd, 1841.]

Md. House of Delegates, Dec. Sess., 1840.

——— Trigonometrical Survey for the New Map of Maryland. 1841. n. d. 8vo. 4 pp. [Dated Feb. 19, 1841.]

Md. House of Delegates, Dec. Sess., 1840.

BOOTH, J. C. Memoir of the Geological Survey of the State of Delaware; including the application of the Geological Observations to Agriculture. I-XI, 9-188 pp. Dover, 1841.

Part I.—General view of the Geology of the State.

Part II.—Special Geology.

Part III.—Economical Geology. This includes numerous analyses and is followed by chapters on agriculture, arts of construction and chemical arts.

CONRAD, T. A. Description of Twenty-six new Species of Fossil Shells discovered in the Medial Tertiary Deposits of Calvert Cliffs, Md.

Proc. Acad. Nat. Sci., Phila., vol. i, 1841, pp. 28-33.

Ducatel, J. T. Annual Report of the Geologist of Maryland. 1840. 8vo. 46 pp. [Annapolis, 1840.] Map and sections.

Another edition, 8vo, 59 pp. and 3 plates; also Md. House of Delegates, Dec. Sess., 1840, n. d. 8vo, 43 pp., 3 plates.

Considers the physical geography and geology of Allegany and Washington counties, with notes on the copper mining about Frederick.

Vanuxem, L. On the Ancient Oyster Shell Deposites observed near the Atlantic Coast of the United States. [Read April 7, 1841.]

Proc. Assoc. Amer. Geol. Nat., pp. 21-23.

Cites several observations to prove the human origin of shell heaps.

1842.

Alexander, J. H. Report of the Topographical Engineer to the Governor of Maryland. 8vo. 5 pp.

Md. Pub. Doc., Dec. Sess., 1841. (J)

Conrad, T. A. Observations on a portion of the Atlantic Tertiary Region, with a description of new species of organic remains.

2nd Bull. Proc. Nat. Inst. Prom. Sci., 1842; plates, pp. 171-192.

The deposits of Upper Marlboro, Piscataway and Fort Washington, Md., are referred to the Eocene or Lower Tertiary, and correlated with the London Clay, Calcaire Grossier, Claiborne beds, etc. Columnar sections and lists of fossils with many localities along the bay.

——— Description of twenty-four new species of Fossil Shells chiefly from the Tertiary Deposits of Calvert Cliffs, Md. (Read June 1, 1841.)

Jour. Acad. Nat. Sci., Phila., vol. viii, 1842, pp. 183-190.

——— Descriptions of new Tertiary Fossils.

2nd Bull. Proc. Nat. Inst. Prom. Sci., 1842, pp. 192-194, two plates.

Plates show Ostrea sellaeformis, Pholadomya marylandica, Pholas petrosa, Isocardia markoei, Pecten humphreydii, Dispoteae constricta, Scalaria expansa, Buccinum integrum, Scutella alberti (the last is not figured, but described).

Ehrenberg, C. G. Verbreitung des Mikroskopischen Lebens als Felsmassen im centralen Nord Amerika und im westlichen Asien.

Bericht. k. p. Akad. der Wiss., Berlin, 1842, pp. 187-188.

Discusses the Polythalamas of the Cretaceous and infers similar conditions to those existing off Northern Africa. No direct reference to Maryland.

Harlan, R. Description of a New Extinct Species of Dolphin from Maryland.

2nd Bull. Proc. Nat. Inst. Prom. Sci., 1842, pp. 195-196, 4 plates.

The fossil is Delphinus calvertensis, which was found in the Calvert Cliffs.

——— Notice of two New Fossil Mammals from Brunswick Canal, Georgia; with observations on some of the fossil quadrupeds of the United States.

Amer. Jour. Sci., vol. xliii, 1842, pp. 141-144, 2 plates.

Tooth of Mastodon longirostris from the Miocene of Maryland, hitherto found only in Europe, mentioned incidentally, p. 143.

LOOMIS, ELIAS. On the Dip and Variation of the Magnetic Needle in the United States.

Amer. Jour. Sci., vol. xliii, 1842, pp. 93-116.

Differs from Courtenay in the value for the dip at Baltimore.

MARKOE, FRANCIS, JR. [Remarks and list of fossils from Miocene.]

2nd Bull. Proc. Nat. Inst. Prom. Sci., 1842, p. 132.

Enumerates several new forms found with Mr. Conrad, which were later described by the latter.

ROGERS, HENRY D. An Inquiry into the Origin of the Appalachian Coal Strata—Bituminous and Anthracitic.

Trans. Assoc. Amer. Geol. and Nat., 1842, pp. 433-474.

A comprehensive general paper in which the author considers both the bituminous and anthracite formations to be continuous with each other, and that they extended form Pennsylvania to Alabama and eastward to the Appalachian valley. Such an extent is explicable only on assumption of the oceanic origin of coal

——— W. B. & H. D. On the Physical Structure of the Appalachian Chain as Exemplifying the Laws which have Regulated the Elevation of great Mountain Chains.

Repts. Amer. Assoc. Geol. and Nat., 1842, pp. 474-531.

(Absts.) British Assoc. Repts., 1824, Pt. II, pp. 40-42; Proc. Assoc. Amer. Geol. and Nat. 1840-42, pp. 70-71; Amer. Jour. Sci., vol. xliii, 1842, pp. 177-178; vol. xliv, 1843, pp. 359-362.

Part I deals with a description of the area, its divisions; their structure, especially inverted dip, length, persistence and parallelism of axes and the increasing interval between them to the northwest.

Part II deals with a theory of the flexure and elevation of the strata, which are due to a combined undulatory and tangential movement.

RUFFIN, ED. An Essay on Calcareous manures. 8vo. 316 pp. Petersburg, Va., 1842. 3rd Edit.

General discussion of the tidewater marls, pp. 194-234. First use of marl in Maryland in Talbot County, 1805, by Mr. Singleton. (1st Edit. 1832, 2nd Edit. 1835.)

1843.

CONRAD, T. A. Description of a new Genus, and Twenty-nine new Miocene and one Eocene Fossil Shells of the United States.

Proc. Acad. Nat. Sci., Phila., vol. i, 1843, pp. 305-311.

Eleven of the specimens were found in Maryland.

Ducatel, Julius T. [Physical History of Maryland.]

Proc. Amer. Phil. Soc., vol. iii, 1843, pp. 157-158.

Abstract of a paper presented before the Society, dealing with the physical features, geology, resources, etc.

Nicollet, J. N. Observations of the Magnetic Dip, made in the United States in 1841. (Read Sept. 16, 1842.)

Trans. Amer. Phil. Soc., vol. viii, 1843, pp. 315-326.

Magnetic dip determined at several stations in Baltimore and Washington.

Silliman, Benj. Lecture VII. Coal, its Origin and Organic remains. Pittsburg, 1843.

Lectures on Geology delivered before the Wirt Institute and citizens of Pittsburgh in the Third Presbyterian Church.

The author on page 25 mentions fossil evidences near Cumberland of an abundance of marine plant life at epochs much earlier than the coal formation.

Thomson, Thomas. Notice of Some New Minerals.

Phil. Mag., 3rd ser., vol. xxii, 1843, p. 191.

Describes the hydrous magnesium silicate called Gymnite (Hintze) as "Baltimoreite," and gives an analysis.

1844.

Anon. Report of the Committee on Agriculture relative to the Application of Lime to the different Qualities of Soil and the use of calcareous Matter for agricultural Purposes. In obedience to an order of the House of the 27th of January.

Md. House of Delegates, Dec. Sess., 1843. Annapolis, 1844. 8vo, 15 pp.

B(ailey), J. W. Account of some new Infusorial Forms discovered in the Fossil Infusoria from Petersburg, Va., and Piscataway, Md.

Amer. Jour. Sci., vol. xlvi, 1844, pp. 137-141, plate iii.

Describes some ten species and gives over thirty figures. There is appended to this paper an extract from a letter by Wm. B. Rogers, including notes on the Tertiary infusorial formation of Maryland.

Ehrenberg, C. G. Ueber zwei neue Lager von Gebirgsmassen aus Infusorien als Meeres-Absatz in Nord Amerika und eine Vergleichung derselben mit den organischen Kreide-Gebilden in Europa und Afrika.

Bericht. k. p. akad. Wiss., Berlin, 1844, pp. 57-97.

(Rev.) Amer. Jour. Sci., vol. xlviii, 1845, pp. 201-204. J. W. Bailey.

Enumerates sixty-eight species from Piscataway, including the following new ones: Asterolampra marylandica, Denticella tridentata, Dicladia cervus, Dictyocha triacantha, D. ubera, Discoplea americana, Lithobotrys quadriloba, Mesocena diodon, M. elliptica, Pyxidicula (?) actinoptychus, P. aculeata, P. gemmifera, P. hirsuta, P. limbata, P. oculus chamaeleontis, Rhaphoneis amphiceros, R. gemmifera, R. pretiosa, Rhizosolenia americana, Symbolophora trinatates, Lithasteriscus tuberculosus, L. reniformis.

JOHNSON, W. R. A Report to the Navy Department of the United States on American Coals applicable to steam navigation and to other purposes.

Exec. Doc. House, 28th Cong., 1st Sess., vol. vi, 1844. No. 276, pp. 1-607.
Sen. Doc. No. 386, 28th Cong., 1st Sess., vol. vi, June 6, 1844, 607 pp.

A classic paper, including a study of a few Maryland coals, showing their great evaporating power.

ROGERS, H. D. Address delivered at the Meeting of the Association of American Geologists and Naturalists.

Amer. Jour. Sci., vol. xlvii, 1844, pp. 137-160, 247-278.

General historical review and geological outline of the areas studied up to that time.

———, WM. B. [Tertiary Infusorial formation of Maryland.]

Amer. Jour. Sci., 2nd ser., xlvi, 1844, pp. 141-142.

Extract from letter to editor.

SHEPARD, CHAS. UPHAM. A Treatise on Mineralogy. 2nd Edit. 12mo. Boston, 1844.

Mentions many Maryland minerals and mineral localities. (1st edit., 1832.)

1845.

ALGER, FRANCIS. Beaumonite and Lincolnite identical with Heulandite.

Jour. Boston Soc. Nat. Hist., vol. iv, 1843-4, p. 422. Boston, 1845.

BAILEY, J. W. Notice of some New Localities of Infusoria, Fossil and Recent.

Amer. Jour. Sci., vol. xlviii, 1845, pp. 321-343, plate iv.

In Part III of this paper Bailey describes "Fossil Infusoria of Virginia and Maryland." The account includes a table showing the species of Infusoria, etc., found fossil at "Bermuda" and at various localities in the Tertiary of Virginia and Maryland.

——— [Summary and Review of Ehrenberg's Observations on the Fossil Infusoria of Virginia and Maryland, and a comparison of the same with those found in the Chalk Formations of Europe and Africa.]

Amer. Jour. Sci., vol. xlviii, 1845, pp. 201-204.

This is probably a review of "Ueber zwei neue Lager von Gebirgsmassen aus Infusorien," although the titles are different.

CONRAD, T. A. Fossils of the (Medial Tertiary or) Miocene Formation of the United States. No. 3. 1845. pp. 57-80. Plates xxx-xlv.

(Repub.) by W. H. Dall, Washington, 1893.

Original description of several Calvert Cliffs and St. Mary's fossils. See Conrad, 1838, 1840.

FORBES, EDW.
(See Lyell, Chas.)

HUGHES, JER. A Brief Sketch of Maryland, its Geography, Boundaries, History, Government, Legislation, Internal Improvements, &c. [By Jeremiah Hughes, Annapolis.] Printed for the Publisher, 1845. 18mo. pp. 41, 156.

LONSDALE, W.
Appendix Quart. Jour. Geol. Soc. London, vol. i, 1845, pp. 427-429.
(See Lyell, Chas.)

LYELL, CHAS. Travels in North America, with Geological Observations on the United States, Canada and Nova Scotia. 2 vols. 12°. New York, 1845. Another edit. 2 vols. 12°. London, 1845. Second English edit. London, 1855. German edit. translated by E. T. Wolff, Halle, 1846.

Vol. ii, pp. 17-22 (London, 1845) gives observations on the Cumberland-Frostburg area, including a list of flora found. This volume has a geological map of the United States.

LYELL, CHAS. Notes on the Cretaceous Strata of New Jersey and other Parts of the United States bordering the Atlantic.

Proc. Geol. Soc. London, vol. vi, 1843-1845, pp. 301-306.

Quart. Jour. Geol. Soc. London, vol. i, 1845, pp. 55-60.

(Abst.) Amer. Jour. Sci., vol. xlvii, pp. 213-214.

Deals principally with the New Jersey formations and correlates with the Maestricht-Gault. Appendix "On the Fossil Shells collected by Mr. Lyell from the Cretaceous Formations of New Jersey," by Edward Forbes, Charles Lyell and Wm. Lonsdale.

——— On the Miocene Strata of Maryland, Virginia and of North and South Carolina.

Quart. Jour. Geol. Soc. London, vol. i, 1845, pp. 413-427.

Discusses numerous fossils which are correlated with European and recent forms. Mentions a Mastodon longirostus tooth from Greensburgh, Caroline County, Md.

Appendix by W. Lonsdale on "Indications of Climate afforded by Miocene Corals of Virginia."

1846.

ANON. Report of the Committee on Agriculture in Relation to the appointment of an agricultural Chemist. n. d., 8vo, 8 pp.

Md. House of Delegates, Dec. Sess., 1846 [T].

BUNBURY, C. J. F. On some remarkable Fossil Ferns from Frostburg, Md. collected by Mr. Lyell. (Read Dec. 3, 1845.)

Quart. Jour. Geol. Soc., London, vol. ii, 1846, pp. 82-91, 2 plates.

(Abst.) Amer. Jour. Sci., 2nd ser., vol. ii, 1846, pp. 427-428.

Describes and figures Pecopteris emarginata and P. elliptica (n. sp.). Also enumerates 18 more fossil plants found at Frostburg.

Conrad, T. A. Observations on the Eocene formation of the United States, with descriptions of species of Shells, &c., occurring in it.

Amer. Jour. Sci., 2nd ser., vol. i, 1846, pp. 209-221, 395-405; plate i, ii, iii, iv.

Descriptions of species of Pholas, Pholadomya and Panopaea from Piscataway, Md.

Descriptions of species of Crassatella and Corbula from Piscataway, Upper Marlborough and the post Pliocene of Maryland.

Locke, John. Observations made in the years 1838, '39, '40, '41, '42, and '43 to determine the Magnetical Dip and Intensity of Magnetical Force in several parts of the United States. (Read April 19, 1844.)

Trans. Amer. Phil. Soc., vol. ix, 1846, pp. 283-328.

Determines these constants at Baltimore, Washington, Cumberland and Emmitsburg.

Sabine, E. Contributions to Terrestrial Magnetism No. VII Containing a Magnetic Survey of a Considerable portion of the North American Continent.

Phil. Trans. Roy. Soc. London, vol. cxxxvi, pt. i, 1846, pp. 237-336.

1847.

Conrad, T. A. Observations on the Eocene formation and descriptions of one hundred and five new fossils of that period from the vicinity of Vicksburg, Mississippi. With appendix.

Proc. Acad. Nat. Sci., Phila., vol. iii, 1847, pp. 280-299.

The author regards the Fort Washington, Piscataway and Upper Marlboro deposits as lower Eocene. (See Conrad, 1848.)

Hall, James. Paleontology, Vol. I. Geological Survey of New York. Albany, 1847. Containing descriptions of organic remains of the lower division of the New York system.

Description and figures of numerous forms from Cumberland and vicinity.

Knight, Jonathan. Letter to T. Parkin Scott—advantages of the several termini on the Ohio river for the B. & O. R. R. 8vo. pp. 29.

Loomis, E. Notice of some recent Additions to our knowledge of the Magnetism of the United States and its Vicinity.

Amer. Jour. Sci., 2nd ser., vol. iv, 1847, pp. 192-198.

Gives determinations by Prof. Locke.

1848.

Conrad, T. A. Observations on the Eocene Formation and descriptions of 105 new fossils of that period from the vicinity of Vicksburg, Miss. With an Appendix. [Descriptions of New Eocene Fossils in the cabinet of Lardner Vanuxem.]

Jour. Acad. Nat. Sci., Phila., 2nd ser., vol. i, 1848, pp. 111-134, plates 11-14.

Maryland and Virginia deposits are considered as "Lower or older Eocene" and equivalent to the fossiliferous sands of the Claiborne and St. Stephens, Ala., chiefly from the presence of Ostrea sellaeformis. Also gives a number of shells from Upper Marlboro, Md. (See Conrad, 1847.)

Gibbes, R. W. Monograph of the fossil Squalidae of the United States.

Jour. Acad. Nat. Sci., Phila., 2nd ser., vol. i, 1848, pp. 139-148.

Gives Carcharoden megaloden from Maryland (p. 143).

Lea, Henry C. Catalogue of the Tertiary Testacea of the United States.

Proc. Acad. Nat. Sci., Phila., vol. iv, 1848, pp. 95-107.

Gives references to descriptions but does not state localities. The list includes many Maryland forms.

Taylor, R. C. Statistics of Coal. The geographical and geological distribution of Mineral Combustibles or Fossil Fuel. 8vo. 745 pp. Phila. 1848.

Pages 65-71 deal with the "Maryland Division of the great Alleghany coal field," and give a geological profile of the Coal Basins of Maryland (p. 70).

A second edition was revised to 1854 by S. S. Haldeman, Philadelphia, 1855, pp. 316-325 for Maryland.

1849.

Bailey, J. W. New Localities of Infusoria in the Tertiary of Maryland.

Amer. Jour. Sci., 2nd ser., vol. vii, 1849, p. 437.

Short paper citing localities where Infusoria have been found.

De Verneuil, Ed. Parallelism of the Paleozoic Formations of North America, with those of Europe.

Amer. Jour. Sci., 2nd ser., vol. vii, 1849, pp. 45-51. (Continued from pp. 183 and 370, vol. v, and p. 218, vol. vii.)

Abridged translation by James Hall of "Sur le parallelisme dans depots, etc." Bull. Geol. Soc. d. Fr., 2me ser., t. iv. The first two parts deal especially with general problems and the strata of New York. In the present paper there is a reference to Carboniferous Species occurring near Bloomsburg, Pa., and in Maryland (p. 47).

The last paper deals with the correlation of the fossils.

Gibbes, R. W. Monograph of the fossil Squalidae of the United States.

Jour. Acad. Nat. Sci., Phila., 2 ser., vol. i, 1849, pp. 191-206. (Continued from p. 147 of same volume.)

Gives a number of species from Maryland specimens, pp. 192-196, 201.

Owen, Robert Dale. Hints on Public Architecture, containing among other illustrations views and plans of the Smithsonian Institution; together with an appendix relative to building materials. 1849. 4to. pp. 140-199. Woodcuts, 15 plates. (No. P.)

Gives many facts and figures concerning Maryland sandstones, marbles and granites, in the appendix.

1850.

Anon. Twenty-fourth Annual Report of the President and Directors to the Stockholders of the Baltimore and Ohio Rail Road Company. 8vo. 54 pp. 1850.

Folded map, showing route between Baltimore and St. Louis, together with the other principal lines on the Eastern, Middle and Western States, 30 miles to the inch.

Graham, J. D. Message of the Governor of Maryland transmitting reports of the Joint Commissioners and of Lt. Col. Graham, U. S. Eng., in relation to the intersection of the boundary lines of the States of Md., Pa., and Del. Washington, 1850. 8vo. 87 pp.

(Little map on the scale 1/15,840, showing location of "tg point.")

Higgins, Jas. Report of James Higgins, M. D., State Agricultural Chemist, to the House of Delegates. 8vo. 92 pp. Annapolis, 1850.

Md. House of Delegates, Dec. Sess. [G].

Deals principally with Eastern Shore, and includes several analyses, especially of marl.

1851.

Anon. Field notes of the Surveyors employed to run the Transpeninsular Line in 1751. 40 pp. 8vo.

Gilmor Md. Papers, vol. ii, Div. 3, No. 1. Md. Hist. Soc. Misc. Pub.

Bailey, J. W. Miscellaneous Notices. 3 Fossil Infusoria of Maryland.

Amer. Jour. Sci., 2nd ser., vol. xi, 1851, pp. 85-86.

Johnson, W. R. A Comparison of Experiments on American and Foreign Building stones to determine their relative strength and durability.

Amer. Jour. Sci., 2nd ser., vol. xi, 1851, pp. 1-17.

Gives pressure tests, analyses and the geological occurrence of the Cockeysville and Texas marbles and "alum" stones.

——— Some observations on the Gold Formations of Maryland, Virginia and North Carolina.

Proc. Amer. Assoc. Adv. Sci., vol. iv, 1851, pp. 20-22.

Gives the general trend of the formation near Rockville and Brookville, Md. W. B. Rogers, in the discussion which follows, describes the geological position of the auriferous belt and calls attention to the difference in character of the ore near the surface and that found at a depth.

1852.

DESOR, E. Post Pliocene of the Southern States and its relation to the Laurentian of the North and the Deposits of the Valley of the Mississippi.

Amer. Jour. Sci., 2nd ser., vol. xiv, 1852, pp. 49-59.

Pages 50-51 deal more directly with Maryland.

FABER, WM. L. On Carrollite, a new Cobalt Mineral.

Amer. Jour. Sci., 2nd ser., vol. xiii, 1852, pp. 418-419.

Gives the geological occurrence, the physical properties and chemical behavior of a cobalt linnaeite from Finksburg, Carroll Co., Maryland, which he calls Carrollite.

FISHER, R. S. Gazetteer of the State of Maryland compiled from the returns of the Seventh Census of the United States. New York and Baltimore, 1852, 8vo, 122 pp.

Pages 7-11 give a succinct statement of the geology of the State.

HIGGINS, JAMES. The Second Report of James Higgins, M. D., State Agricultural Chemist, to the House of Delegates of Maryland. 8vo. 118 pp. Annapolis, 1852.

Md. House of Delegates, Jan. Sess., 1852 [C], 8vo, 126 pp.

Devoted to the geology and the soils of the Third District (Southern Maryland), giving several analyses of soils of that area.

JOHNSON, ALEXANDER S. Notice of some undescribed Infusorial Shells.

Amer. Jour. Sci., 2nd ser., vol. xiii, 1852, p. 33.

Several new species from Piscataway are briefly described, including Asterodiscus nonarius, Asterolampra septenaria.

LOCKE, JOHN. Observations on Terrestrial Magnetism.

Smithsonian Contrib. to Knowledge, vol. iii, 1st art., 30 pp. Washington, 1852.

Quotes observations at Baltimore and gives values for Finley's Station, Md.

1853.

ANON. Prospectus of the Springfield Copper Mine, Carroll County, Maryland. 8vo. Baltimore, 1853.

Contains brief reports by Diffenbach and Chas. T. Jackson.

——— Prospectus of the Dolly-Hide Copper Mine in Frederick County, Maryland. Baltimore. 12 pp. 1853.

Contains brief reports by Chas. T. Jackson, Tyson and Diffenbach.

Conrad, T. A. Descriptions of New Fossil shells of the United States.

Jour. Acad. Nat. Sci. Phila., 2nd ser., vol. ii, 1853, pp. 273-276.

A few fossils from Chesapeake and Delaware Canal cited.

——— Monograph on the genus Fulgur.

Proc. Acad. Nat. Sci. Phila., vol. vi, 1853, pp. 316-319.

Describes a number of species from Maryland (St. Mary's).

Higgins, James. The Third Report of James Higgins, M. D., State Agricultural Chemist, to the House of Delegates of Maryland. 8vo. 160 pp. Baltimore, 1853.

Md. House of Delegates, Jan. Sess., 1853, 8vo, 160 pp.

A treatise on manures, with a few analyses of soils and limestones, especially from Washington County.

Marcou, Jules. A Geological Map of the United States and the British Provinces of North America, with an explanatory text, [etc.] 8vo, Boston, 1853.

Represents no Cretaceous on Western Shore, most of the Eastern Shore as alluvium, and the rest of the State covered successively by bands of Metamorphic, New Red, Metamorphic, Silurian and Devonian. No Carboniferous is represented within the limits of the State (?).

Smith, J. Lawrence. Re-examination of American Minerals. Part III.

Amer. Jour. Sci., 2nd ser., vol. xvi, 1853, pp. 365-368.

Gives several new analyses of the original material from Finksburg and shows the natural isomorphism of cobalt and copper (p. 366).

1854.

Anon. First Annual Report of the President and Directors to the Stockholders of the Metropolitan Railroad Company. 8vo. 43 pp. 1854.

Folded map of the Metropolitan Railroad, showing the connecting lines leading from the seat of Government to the Western States.

Emmons, Ebenezer. Geology of Gold-bearing slates in Montgomery county, Maryland.

Proc. Amer. Phil. Soc., vol. v, 1854, p. 85.

Extract from a letter on the geology of the locality, with references to the presence of gold.

Higgins, James. The Fourth Annual Report of James Higgins, M. D., State Agricultural Chemist, to the House of Delegates of the State of Maryland. 8vo. 92 pp. Baltimore, 1854.

Also Md. House of Delegates, Jan. Sess., 1853.

Contains a paper on the relations between soils and crops, giving many analyses; also a paper on Allegany county.

WHITNEY, J. D. The Metallic Wealth of the United States. 8vo. 510 pp., illustrated. Lippincott. Phila. 1854.

Refers to Maryland gold (p. 124), copper (pp. 17-19), and iron (p. 472).

1855.

ANON. Second Annual Report of the President and Directors of the Metropolitan Railroad Company, to which are appended the Charter, By-Laws, etc. 8vo. 64 pp. 1855.

Map of the located route of the Metropolitan Railroad Company and the adjacent country, comprising District of Columbia and the counties of Montgomery, Frederick and Washington in the state of Maryland.

DIEFFENBACH, OTTO. Das Vorkommen von Chrom-Erzen und ihre Verarbeitung in den Vereinigten Staaten von Nord Amerika.

N. J. B., vol. ii, 1855, pp. 533-539.

Describes the occurrence of the ore, the mode of working, and an analysis from Bare Hills, Maryland.

HALDEMAN, S. S. See Taylor, 1848.

MARCOU, J. Resumé explicatif d'un carte géologique des États-Unis et des provinces anglaises de l'Amérique.

Bull. Soc. Géol. Fr., 2 ser., tome xii, 1855, pp. 813-936; colored geological map.

Explanation of map itself, so far as related to Maryland, apparently based on Maclure.

——— Ueber die Geologie der Vereinigten Staaten und der englischen Provinse von Nord Amerika.

Petermann's Mitth., 1855, pp. 149-159.

Allows no Cretaceous on the Western Shore.

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BAILEY, J. W. On the Origin of Greensand, and its formation in the oceans of the present epoch.

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Casts of Polythalamia in Eocene greensand from Mt. Washington, p. 364.

EHRENBERG, C. G. Zur Mikrogeologie. 2 vols. and atlas, roy. folio, forty-one plates. Leipzig, 1854-56.

Gives history of the determination of forms from Maryland, vol. ii, pp. 65-67.

The text on North America was published in 1856. One plate on Richmond and "Bermuda" forms.

HIGGINS, JAMES. Fifth Agricultural Report of James Higgins, State Chemist, to the House of Delegates of the State of Maryland. 8vo. 91 pp. Annapolis, 1856 (published separately).

Also Md. House of Delegates, Jan. Sess., 1856.

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Another edition, pp. 15-18 omitted, 8vo, 90 pp.

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HITCHCOCK, E. Outline of the Geology of the Globe and of the United States in particular, with geological maps, etc. 8vo. Boston, 1856 (3rd Edition).

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——— Illustrations of Surface Geology.

Smithsonian Cont. Knowledge, vol. ix, 1856, 164 pp., twelve plates.

(Rev.) Amer. Jour. Sci., 2nd series, vol. xxiv, 1857, pp. 430-433. J. D. Dana.

Page 105 is a reference to the rocks at Great Falls on the Potomac and the gorge which has been cut below them.

LESLEY, J. P. Manual of Coal and its Topography, or Geology of the Appalachian Region of the United States of America. Phila. Lippincott, 1856.

Incidental reference to Cumberland area, with an extended discussion of the general section and its characteristics.

ROGERS, H. D. Geological Map of the United States and British North America.

Extract from "The Physical Atlas," by A. K. Johnson, 2d edition, fol. Edinburgh, 1856.

ROGERS, W. B. Remarks on a series of Fossils from the Secondary belts of North Carolina, Virginia, Pennsylvania and Massachusetts.

Proc. Boston Soc. Nat. Hist., vol. v, 1856, pp. 14-18.

Discusses the Cypridae and regards rocks as Jurassic.

1857.

Ansted, D. T. On Some Remarkable Mineral Veins. 2. On some Copper lodes near Sykesville in Maryland.

Quart. Jour. Geol. Soc. London, vol. xiii, 1857, pp. 240-254.

Describes with sections the Springfield and Carroll mines, where the ore is first iron ore and then iron pyrites and lastly copper pyrites. Mentions deposit near Point of Rocks, which he believes to be the top of another copper pyrites body (pp. 242-245). Mine visited in 1854.

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Hall, James. Observations on the Cretaceous Strata of the United States with reference to the Relative Position of the Fossils collected by the Boundary Commission.

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Dieffenbach, Otto. Bemerkungen über den Kupferbergbau in den Vereinigten Staaten von Nord-Amerika.

Berg- und Hütt. Zeit, 1858, pp. 47-48, 66-68, 75-76 (not seen).

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Also State Chemist's Report, n. d. (1858), 8vo, 96, xxii pp.

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ANON. The Western Maryland Railroad, its Agricultural and Mineral Resources . . . its future Importance to . . . Baltimore. Baltimore, 1859. 16mo. pp. (2), xii, 39 pp.

GABB, W. M. Description of some new Species of Cretaceous Fossils.

Jour. Acad. Nat. Sci., Phila., 2nd ser., vol. iv, 1858-1860, pp. 299-305.

Refers to several fossils from Delaware and Chesapeake Canal, pp. 300, 302, 303.

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Gives analyses and results of pressure tests on Cockeysville rock, also gives few facts on iron ore near Whitehall.

JOHNSTON, CHRISTOPHER. Notes on Odontology.

Amer. Jour. Dental Sci., Phila., n. s. vol. ix, No. 3, 1859, pp. 337-343.

Description of Astrodon (afterwards called Astrodon johnstoni) from Bladensburg.

ROGERS, H. D. Classification of the Metamorphic Strata of the Atlantic Slope of the Middle and Southern States. (Read Feb. 18, 1857.)

Proc. Boston Soc. Nat. Hist., vol. vi, 1859, pp. 140-145.

Discusses the gneisses, semi-crystallines and Paleozoic rocks, mentioning the limits between the first two on the B. & O. R. R. and elsewhere in Maryland.

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FORDYCE, W. A History of Coal, Coke, Coal Fields, [etc.] London: Sampson, Low, Son & Co., 1860.

Deals mostly with British coals, but refers to the state of trade in America in 1858.

LEE, THOS. J. Southern Boundary of Maryland.

Laid down in conformity with the agreement of Philip Calvert and Edmund Scarbrugh (1668). Map by John de la Camp. Annapolis, 1860.

PIGGOTT, A. SNOWDEN. Prospectus of the Mineral Hill Mine, Carroll County, Maryland. 8vo. 8 pp. Baltimore, 1860.

Brief report on mine by the author.

TYSON, P. T. First Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, Jan. 1860. 8vo. 145 pp. Annapolis, 1860. Maps.

Md. Sen. Doc. [E]. Md. House Doc. [C].

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——— Report of Chemist. n. d. (1860), 8vo, 4 pp.

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(Repub.) by W. H. Dall, Washington, 1893.

Original descriptions of several Maryland forms.

HALL, JAMES. Paleontology. Vol. III, Part I. Geological Survey N. Y., Albany, 1861. Containing Descriptions and figures of the Organic Remains of the Lower Helderberg group and the Oriskany Sandstone. 1855-1859.

Description and figures of numerous forms from Cumberland and vicinity.

JOHNSTON, CHRISTOPHER. Upon a Diatomaceous Earth from Nottingham, Calvert Co., Maryland.

Proc. Amer. Assoc. Adv. Sci., vol. xiv, 1860, pp. 159-161.

Shows that "Bermuda earth" must have come from this deposit or its southward prolongation. Corroborative letters by A. M. Edwards and Chas. Stodder.

NORMAN, GEORGE. On some Undescribed Species of Diatomaceae. (Read Nov. 14, 1860.)

Trans. Microscopical Soc. of London, n. s. vol. ix, 1861, pp. 5-9.

Describes and figures Aulacodiscus sollittianus (n. sp.) from Nottingham, Maryland. (p. 7.)

ROGERS, W. B. Infusorial earth from the Tertiary of Virginia and Maryland. (Read May 4, 1859.)

Proc. Boston Soc. Nat. Hist., vol. vii, 1861, pp. 59-64.

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TRYON, GEO. W., JR. List of American Writers on Recent Conchology. New York, 1861. 8vo. 68 pp.

The author gives a bibliography of the works of these writers, which includes many references to Maryland.

TYSON, P. T. [Letter from Mr. Tyson of Maryland on Tripoli.] (Read Dec. 1860.)

Proc. Acad. Nat. Sci., Phila., vol. xii, 1861, pp. 550-551.

Describes occurrences and distribution of "Tripoli," which he considers Miocene.

WHEATLEY, CHARLES M. Remarks on the Mesozoic Red Sandstone of the Atlantic Slope, and notice of the Discovery of a Bone Bed therein at Phoenixville, Penn.

Amer. Jour. Sci., 2nd ser., vol. xxxii, 1861, pp. 41-48.

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Proc. Acad. Nat. Sci. Phila., vol. xiv, 1862, pp. 559-582.

Gives reference to original descriptions, but no localities.

——— Description of New, Recent and Miocene Shells.

Proc. Acad. Nat. Sci. Phila., vol. xiv, 1862, pp. 583-586.

Describes a Busycon alveatum from St. Mary's river.

Genth, F. A. Contributions to Mineralogy.

Amer. Jour. Sci., 2nd ser., vol. xxxiii, 1862, pp. 190-206.

Gives a paragraph on the non-occurrence of chrysolite in Md., pp. 201-202. Analysis of kerolite from Harford Co., pp. 203-204.

Tyson, Philip T. Second Report of Philip T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, Jan. 1862. 8vo. 92 pp. Annapolis, 1862.

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Bache, A. D. Records and results of a Magnetic Survey of Pennsylvania and parts of adjacent states in 1834, '35, '41, '43, '62.

Smithsonian Contrib. Knowledge, vol. xvii, 1863, 88 pp.

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Rep't Supt. Coast and Geodetic Survey, 1862, Washington, 1864, appendix 19, pp. 212-229.

See Schott, C. A., 1896.

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Proc. Acad. Nat. Sci. Phila., vol. xvi, 1864, pp. 211-21[illegible].

See p. 213 for description of Dosiniopsis meekii found six miles east of Washington, D. C.

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Contains short reports on the property by Thos. Paynter and Eug. Gaussoin.

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ANON. Report of the Select Committee appointed to prepare a statement in Relation to the Resources of Maryland. Annapolis, 1865. 8vo. 52 pp.

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Amer. Jour. Conch., vol. i, 1865, pp. 1-35.

A list of forms from the Middle Atlantic Slope. See also corrections in Amer. Jour. Conch., vol. i, 1865, p. 191.

——— Observations on the Eocene Lignite Formation of the United States.

Proc. Acad. Nat. Sci. Phila., vol. xvii, 1865, pp. 70-73.

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Brief description of the Cape Sable beds based on Durand.

——— Descriptions of new Eocene shells and references with figures to published series.

Amer. Jour. Conch., vol. i, 1865, pp. 210-212, plates 20 and 21.

Describes Lunatia marylandica, but gives no locality.

LEIDY, JOSEPH. Cretaceous Reptiles of the United States.

Smithsonian Contrib. Knowledge, No. 192, vol. xiv, 1865, 135 pp. and twenty plates.

Description and figures of a tooth of Astrodon johnstoni from Bladensburg, Md.

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ANON. Description of the Property of the Maryland Marble Company of Baltimore. Baltimore: Cushing & Medairy, 1866. 16mo. 15 pp.

ANON. Mining Summary.

Amer. Jour. Mining, vol. ii, 1866, p. 21.

Notes on Montgomery gold mines copied from Rockville Sentinel.

ANON. Report of Select Committee on the Resources of the State. Annapolis, 1866. 8vo. 2 pp.

Md. House Jour. and Doc., 1866 [O].

COLE, WM. R. Report of William R. Cole, Esq., Chief Clerk of House of Delegates, in Relation to the Distribution of the Report of the Select Committee on the Resources of Maryland. Annapolis, 1866, 8vo, 16 pp.

Md. House Jour. and Doc., 1866 [C].

CONRAD, T. A. Check List of the Invertebrate Fossils of North America (Eocene and Pleiocene).

Smithsonian Misc. Col., vol. vii, Art. 6, 1866, 46 pp.

Includes Eocene from Middle Atlantic Slope.

——— Illustrations of Miocene Fossils, with Descriptions of New Species.

Amer. Jour. Conch., vol. ii, 1866, pp. 65-74, plates 3 and 4.

Describes and figures several new forms from St. Mary's and Calvert Cliffs.

DADDOW, S. H., and BANNON, BENJ. Coal, Iron and Oil; or the Practical American Miner. 8vo. 808 pp. Maps, sections, illustrations. B. Bannon, Pottsville, Pa., 1866.

Written in a popular style from an economic standpoint, this book contains discussions of the formation of the Appalachians and of the coal, the history of the use of coal, and the distribution of the known coal fields. The more detailed discussion of Maryland (pp. 317-338) contains map of Frostburg coal field about 4 miles to inch and sections.

DUNLOP, JAMES. A Memoir on The Controversy between William Penn and Lord Baltimore, respecting the Boundaries of Pennsylvania and Maryland, by James Dunlop, Esq. Read at a meeting of the Council, Nov. 10, 1865.

Memoirs Hist. Soc. Penn., vol. i, 1866, pp. 165-204.

PARRISH, R. D. A Statistical and Geological Report upon the Slate trade of the United States.

Amer. Jour. Mining, vol. ii, 1866-7, pp. 233, 250, 278.

Gives general remarks on history, etc., stating that a quarry was opened near Frederick about 1812.

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CONRAD, T. A. Descriptions of New Genera and Species of Miocene shells, with notes on other fossil and recent species.

Amer. Jour. Conch., vol. iii, 1867, pp. 257-270.

Describes and figures several new forms from Calvert Cliffs and Charles Co.

COPE, E. D. An addition to the Vertebrate Fauna of the Miocene Period, with a Synopsis of the Extinct Cetacea of the United States.

Proc. Acad. Nat. Sci. Phila., vol. xix, 1867, pp. 138-156.

The forms described come from Charles Co., not far from the Patuxent and include several new forms and many previously described species.

HALL, JAS. Paleontology, Vol. IV, Part I. Containing Descriptions and Figures of the Fossil Brachiopoda of the Upper Helderberg, Hamilton and Chemung Groups, 1862-1866. Geological Survey of N. Y. Albany, 1867. 4to. 427 pp. 63 plates.

Description and figures of numerous forms from Cumberland and vicinity.

HIGGINS, JAMES. A Succinct Exposition of the Industrial Resources and Agricultural advantages of the State of Maryland.

Md. House of Delegates, Jan. Sess., 1867 [DD], 8vo, 109, iii pp.
Md. Sen. Doc., Jan. Sess., 1867 [U].

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ANON. Mining Summary for Maryland.

Amer. Jour. Mining, vol. vi, New York, 1868, p. 53.

Quotes the Frederick City Union regarding the discovery of gold in the Blue Ridge Mountains near Frederick. (5 lines.)

COPE, E. D. (On the discovery of the fresh-water origin of certain deposits of sand and clays in west New Jersey.)

Proc. Acad. Nat. Sci. Phila., vol. xx, 1868, pp. 157-158.

"The whole formation indicates the existence of an extended body of fresh water, having a direction and outline similar to that which deposited the red sandstones and shales of the Triassic belt, which extends parallel to its northwest margin."

——— Second Contribution to the History of the Vertebrata of the Miocene Period of the U. S.

Proc. Acad. Nat. Sci. Phila., vol. xx, 1868, pp. 184-194.

Written after a visit to the Charles Co. locality, and includes the description of several new species.

——— [Remarks on extinct Reptiles.]

Proc. Acad. Nat. Sci. Phila., vol. xx, 1868, p. 313.

Describes a fossil of the genus Thecachampsa from the Miocene of Maryland.

JONES, ISAAO D. Report of the Commissioners appointed by the Legislatures of Maryland and Virginia to run and mark the Division Line between Maryland and Virginia on the Eastern Shore of Chesapeake Bay. Annapolis, 1868. 36 pp.

A paper referring to many of the old charters, charts and state papers with reference to the boundaries.

1869.

ANON. Cumberland Bituminous Coal.

Eng. & Min. Jour., vol. viii, 1869, p. 153.

Comparison of Cumberland and Nova Scotia coals in relation to tariff question.

COPE, E. D. The Fossil Reptiles of New Jersey.

Amer. Nat., vol. iii, Salem, 1870, 84-91.

Refers to the occurrence of the genus Thecachampsa in the Mioceue of Southern Maryland (p. 91) as found by Mr. Tyson.

HODGE, JAS. T. Report of the Coal Properties of the Cumberland Coal Basin in Maryland, from surveys and examinations made during the summer of 1868. New York, 1869. 65 pp.

Discusses coal region, property lines, coal bed, drainage and access, system of mining, and product to the area. One of the most valuable papers yet published on the subject.

LEIDY, J. The Extinct Mammalian Fauna of Dakota and Nebrasqa, including an account of some allied forms from other localities, [etc.]

Jour. Acad. Nat. Sci., Phila., n. s. vol. vii, 1869, pp. 255-256.

Describes elephants' teeth from Talbot Co.

LOGAN, WM. E. Geological map of Canada and the Northern United States.

(Rev.) Amer. Jour. Sci., 2nd ser., vol. xlix, 1870, pp. 394-398.

Bears date of 1866, but was not published until 1869.

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ANON. Report of the Joint Standing Committee on Jones Falls to the First Branch of the City Council of Baltimore (etc.) Baltimore, 1870. 178 pp.

CARRUTHERS, WM. On Fossil Cycadean Stems from the Secondary Rocks of Britain. (Read 1868.)

Trans. Linn. Soc., vol. xxvi, 1870, p. 708.

In a postscript to the above memoir the author mentions a photograph of specimen discovered by Tyson in 1859 in Maryland.

GARRETT, J. W. Proceedings of Railway Meetings held in relation to the Baltimore and Ohio and its Extensions, Branches and Connections, at Pittsburg, Uniontown, Chicago, Louisville, and elsewhere and the Remarks of John W. Garrett, President, at those points. 8vo. 31 pp. 1870.

Folded map of the B. & O. and its connections.

ROESSLER, A. R. Mining Summary. Maryland.

Eng. and Min. Jour., vol. ix, New York, 1870, p. 37.

Describes the occurrence of gold and the mineral resources of Montgomery county.

1871.

CREDNER, HERMANN. Die Geognosie und der Mineralreichtum des Alleghany Systems.

Petermann's Mitth., vol. xvii, pp. 41-50.

General discussion of economic resources. Map.

HARDEN, J. W. The Brown Hematite Ore Deposits of South Mountain. (Read August, 1871.)

Trans. Amer. Inst. Min. Eng., vol. i, 1871, pp. 136-144.

Eng. and Min. Jour., vol. xii, pp. 386-387, and vol. xiii, 1871-72, p. 10, 1873, pp. 136-144.

Economic account of the Clinton ores occurring in the portion of South Mountain adjacent to Maryland.

HUNT, T. S. Geognosy of the Appalachians and the Origin of Crystalline Rocks.

Amer. Nat., vol. v, 1871, pp. 451-509.

Proc. Amer. Assoc. Adv. Sci., vol. xx, 1871, pp. 135-159.

(Abst.) Amer. Jour. Sci., 3rd ser., vol. ii, 1871, pp. 205-207.

Discussion of the crystalline rocks of the Appalachian belt. General references to Maryland.

SHALER, N. S. On the Causes which have led to the Production of Cape Hatteras.

Proc. Boston Soc. Nat. Hist., vol. xiv, 1871, pp. 110-121.

Many of the conditions are related as to the state of the Chesapeake and of Maryland in late geologic time.

——— Some Physical Features of the Appalachian System and the Atlantic Coast of the U. S., especially near Cape Hatteras. (Read Feb. 1, 1871.)

Amer. Nat., vol. v, 1871, pp. 178-183.

The origin of Delaware and Chesapeake Bays attributed to erosion by glacial ice streams.

TYSON, P. T. Section of Cumberland Coal Basin.

Proc. Amer. Phil. Soc., vol. ix, 1871, pp. 9-13.

Gives a section from gray limestone of xi (Dug Hill near Lonaconing) of 2050 feet or from Devonian to 2000 feet above "Main Coal Seam."

1872.

AYDELOTT, W. J. Report of Eastern shore boundary between Maryland and Virginia.

Md. Senate Jour., Sen. and House Doc., 1872 [G], 11 pp.

Gives account of running the lines, etc.

HITCHCOCK, C. H. Description of the Geological Map.

Ninth Census, vol. iii, Washington, 1872, pp. 754-756.

Gives authorities (Tyson for Maryland) and some statistics on the area.

HUNT, T. STERRY. Presidential Address. The Geognosy of the Appalachian System.

Proc. Amer. Assoc. Adv. Sci., vol. xx, 1872, pp. 1-35.

This is a general paper dealing more particularly with New York and New England, with only incidental remarks on Maryland.

McDonald, A. Extract from the report of Col. A. McDonald in March, 1861, to the Governor of Virginia, of the results of his mission to England to obtain maps and documents relating to the boundary between Virginia and Maryland. 13 pp.

Md. Senate Jour., Senate and House Doc., 1872, W.

This is a general paper, dealing more particularly with New York and New England, giving only incidental remarks on Maryland.

Schott, Chas. A. Tables and Results of the precipitation in Rain and Snow in the United States.

Smithsonian Contrib. Knowledge, vol. xviii, 1872, pp. 1-173. (See Md. in Index, p. 163.)

2nd Edit. Smithsonian Contrib. Knowledge, vol. xxiv, 1881, pp. 1-249.

Stephens, Thomas. Mining Summary. Maryland.

Eng. and Min. Jour., vol. xiv, 1872, p. 411.

Notes on the fire-brick clays at Mt. Savage and upon the Frostburg coal mines.

1873.

Anon. [Geology of Maryland.]

New Topographic Atlas of Maryland by Martenet, Walling and Gray. Baltimore, 1873, pp. 12-16.

Blodget, L. The Climate of Maryland.

In A New Topographic Atlas of Maryland by Martenet, Walling and Gray, Baltimore, 1873, p. 19 (with map).

Gibbes, George. The "Glades" of Maryland.

Amer. Nat., vol. vii, 1873, p. 636.

Short note suggesting that the valleys near Oakland are due to glacial action.

Hitchcock, C. H. The Coal Area of the United States of America.

Geol. Mag., vol. x, 1873, pp. 99-101.

Gives the coal area of Maryland as 550 square miles (based on Tyson).

Macfarlane, James. The Coal Regions of America, their Topography, Geology, and Development. New York, 1873.

Wise, Henry A., Dejarnette, D. C., and Watts, Wm. Report and accompanying documents of the Virginia Commissioners appointed to ascertain the Boundary Line between Maryland and Virginia. Richmond, 1873. 146 pp. Appendix 314 pp.

Refers to old authors and contains many depositions. Accompanied by fac-similes of old maps.

1874.

Anon. Final Reports of the Virginia Commissioners on the Maryland and Virginia Boundary to the Governor of Virginia. Richmond, 1874.

Dunlap, Thos. (Editor). Wiley's American Iron Trade Manual. New York, 1874.

A Directory giving furnaces and ores used, also a description of the iron ores of Maryland, p. 460.

Hagen, H. A. On Amber in North America.

Proc. Boston Soc. Nat. Hist., vol. xvi, 1874, pp. 296-301.

Discusses Troost's paper (1821) on the Cape Sable locality and compares the various sources of amber.

Hall, Jas. The Niagara and Lower Helderberg Groups; their relations and geographical distribution in the United States.

Proc. Amer. Assoc. Adv. Sci., vol. xxiii, 1874, pp. 321-335.

27th Rept. N. Y. State Museum, Albany, 1874, pp. 117-131.

Brief remarks on Cumberland area. The map to accompany this paper was not published till the next year in the 28th Ann. Rept.

Jones, I. D. Report and Journal of Proceedings of the Joint Commissioners to Adjust the Boundary Line of the States of Maryland and Virginia. Annapolis, 1874.

Md. House Doc. 1874 J; Senate Doc. E.

Gives many facts on old maps, charts and state lines.

Latrobe, H. B.

(See Merrill, Wm. E.)

Lesley, J. P.

(See Merrill, Wm. E.)

Merrill, Wm. E. Extension of the Chesapeake and Ohio Canal to the Ohio River. Including reports by J. S. Sedgwick, Totten, Poussin, Lesley and Latrobe.

House Doc. No. 208, 43rd Cong., 1st Sess., 59 pp.

Discussion of country between Cumberland, Md., and Pittsburgh, Pa.

Sedgwick, J. S. Report of Instrumental reconnaissance and examination for the Extension of the Chesapeake and Ohio Canal.

(See Merrill, Wm. E.)

1875.

ANON. The Maryland Coal Company's Cumberland Coal.

Eng. and Min. Jour., vol. xix, 1875, p. 1.

Partial table of production from 1842 to 1874. Approximate area of field is given.

FONTAINE, WM. M. On some Points in the Geology of the Blue Ridge in Virginia.

Amer. Jour. Sci., 3rd ser., vol. ix, 1875, pp. 14-22, 93-101.

(Abst.) Geol. Record, 1875, London, 1877, p. 119.

Includes a few notes on Catoctin Mt., and the argillites of Point of Rocks and Harper's Ferry, pp. 15-17. The first paper deals with some of the general problems involved in a study of the Blue Ridge, and the illustrations are mostly taken from that portion of the range, near the Potomac river. The second paper deals with the area about Lynchburg and southward.

——— On the Primordial Strata of Virginia.

Amer. Jour. Sci., 3rd ser., vol. ix, 1875, pp. 361-369, 416-428, 3 figures.

(Abst.) Geol. Record, 1875, London, 1877, p. 119.

Refers briefly to the geology of Harper's Ferry (p. 362) and to the folds at "Cement Mill" near Hancock (p. 364). Geology of the Harper's Ferry region, pp. 422-423.

GENTH, F. A. Geological Report of the Maryland "Verde Antique" Marble and Other Minerals on the Lands of the Havre Iron Co., in Harford County, Maryland. Univ. of Penn., 1875, 9 pp.

Description including sketch map of property.

GILLMORE, Q. A. Report on the Compression Strength, Specific Gravity, and ratio of Absorption of the Building stones in the United States.

Rept. Chief of Engineers U. S. Army, part ii, appendix II, pp. 819-851.

Same separately, 8vo, 37 pp., New York, Van Nostrand, 1876.

JOHNSTON, CHRISTOPHER. About the rediscovery of the "Bermuda Tripoli" near Nottingham, on the Patuxent, Prince George's County, Md.

Proc. Boston Soc. Nat. Hist., vol. xvii, 1875, pp. 127-129.

Short account of forms found and the correlation of the old "Bermuda earth" with the newly found locality.

MACFARLANE, JAMES. The Coal Regions of America. 8vo. 3rd edit. 1875. (1st 1873.)

The author gives a compilation of the available data ou the Cumberland coal area, pp. 237-261.

PRIME, F., JR. On the Occurrence of the Brown Hematite Deposits of the Great Valley.

Trans. Amer. Inst. Min. Eng., vol. iii, 1875, pp. 410-422.

Eng. and Min. Jour., vol. xx, 1875, pp. 285-298.

Relations and origin of the iron ores in the so-called damourite slates associated with the Auroral limestones of Pennsylvania. Conclusions equally applicable to Maryland and Virginia. "Brown hematites were probably formed by the oxidation of iron pyrites, but the former are not in the same place that the latter were" (p. 415). Discussion by T. Sterry Hunt (pp. 417-421) and Persifor Frazer (pp. 421-422). The latter agrees in general with the author, but takes exception to his view that the ore is "from pyrite disseminated in the overlying limestones."

SULLIVANT, J. [Letter to Professor Christopher Johnston on Bermuda Tripoli in Maryland.]

Proc. Boston Soc. Nat. Hist., vol. xvii, 1875, pp. 422-423.

TONER, JOSEPH M. Contributions to the Medical History and Physical Geography of Maryland.

Trans. Med. and Chirurgical Faculty of Md., Baltimore, 1875.

Associates vital statistics with topography and gives thirteen topographic sections of different parts of the state.

1876.

FONTAINE, WM. M. The Conglomerate Series of West Virginia.

Amer. Jour. Sci., 3rd ser., vol. xi, 1876, pp. 276-284, 374-384.

In a foot-note there is a reference to Mr. Tyson's section of the Cumberland Basin, with inferences therefrom, p. 375.

FRAZER, PERSIFOR, JR. Origin of the Lower Silurian limonites of York and Adams Counties. (Read Mar. 19, 1875.)

Proc. Amer. Phil. Soc., vol. xiv, 1876, pp. 364-369.

Believes the limonite originated from pyrite, the action possibly being aided by the pressure of limestones.

HACHEWELDER, JOHN (W. C. Reichil, editor). Names which the Lenni Lennapi or Delaware Indians gave to Rivers, Streams and Localities within the states of Penn., New Jersey, Maryland and Virginia, with their signification. Nazareth, 1872.

Trans. Moravian Hist. Soc., vol. i, Nazareth, 1876, pp. 225-282.

Originally published 1834, Trans. Amer. Phil. Soc. (title spelled differently).

Gives the derivation and signification of some 25 local names, especially those of rivers.

HUNT, T. STERRY. Geology of Eastern Pennsylvania.

Proc. Amer. Assoc. Adv. Sci., vol. xxv, 1876, pp. 208-212.

Considers the Blue Ridge in Maryland to be Montalban and Huronian with no Laurentian.

1877.

ANON. Assessed Valuation of Coal and Mining Corporations in Allegany County, Maryland.

Eng. and Min. Jour., vol. xxiii, 1877, pp. 242.

Valuation of Maryland coal companies for 1866 and 1876 taken from the Cumberland Alleghanian of April 3, 1877.

FRAZER, PERSIFOR, JR. The Position of the American New Red Sandstone.

Trans. Amer. Inst. Min. Eng., vol. v, 1877, pp. 494-501.

See also Polytechnic Review, vol. iii, 1877, p. 170.

A general paper correlating the red sandstones of the middle Atlantic Slope with those of Germany and England.

LEWIS, H. C. On the Optical Characters of some Micas.

Printed from Proc. Min. and Geol. Sect. Acad. Nat. Sci., Phila., Oct. 22, 1877.

Gives the optic angle of talc from Harford county (15°) and refers to Cecil county Vermiculites.

PLATT, F. & W. G. Report of Progress in the Cambria and Somerset District of the Bituminous Coal-Fields of Western Penn.

Rept. Second Geol. Survey Pa., HIII, 1877, 348 pp., plates and maps.

Deals with the geological formations along the border of the state and their extension into Maryland.

ROGERS, WM. B. On the Gravel and Cobble stone Deposits of Virginia and the Middle States. (Read May 19, 1875.)

Proc. Boston Soc. Nat. Hist., vol. xviii, 1877, pp. 101-106.

Description of the formation, which the author correlates with the Purbeck beds of England.

SCHOOT, CHAS. A. Tables, Distribution, and variations of the Atmospheric Temperature in the United States.

Smithsonian Contrib. Knowledge, vol. xxi, 1876, 360 pp., nine diagrams, two plates, three charts.

Had several stations in Maryland, with varying length of record.

1878.

ANON. Papers relating to the Boundary Dispute between Pennsylvania and Maryland.

Pennsylvania Archives, 2nd ser., vol. iii, Harrisburg, 1878, pp. 300-400.

HUNT, T. STERRY. Special Report on the Trap Dykes and Azoic Rocks of Southeastern Pennsylvania.

Rept. Second Geol. Survey Pa., E, 1878, p. 253.

An historical paper on the Pre-Silurian rocks discussing the theories which had been proposed and suggesting various modifications.

JONES, I. D. Report upon the boundary line award between Maryland and Virginia. 1878. 8 pp.

Md. House and Senate Doc., 1878 [N].

LESLEY, J. P. [On Orthoceras from Frazer Point on the Susquehanna.]

Proc. Amer. Phil. Soc., vol. xvii, 1878, p. 312.

LOWDERMILK, WILL H. History of Cumberland, [etc.] with maps and illustrations, by Will H. Lowdermilk. 8°. Washington, D. C., 1878.

RUSSELL, I. C. The Physical History of the Triassic Formation of New Jersey and the Connecticut Valley.

Annals N. Y. Acad. Sci., vol. i, No. 8, 1878, pp. 220-254.

(Review) Amer. Jour. Sci., 3rd ser., vol. xvii, pp. 328-330, J. D. Dana.

The author concludes that "the detached areas of Triassic rocks occurring along the Atlantic border from New England to North Carolina seem fragments of one great estuary formation now broken up and separated through the agency of upheaval and denudation."

STEVENSON, JOHN J. On the Surface Geology of Southwest Pennsylvania, and adjoining portions of Maryland and West Virginia.

Amer. Jour. Sci., 3rd ser., vol. xv, 1878, pp. 245-250.

He distinguished twenty horizontal benches and river terraces ranging in elevation from 580-1100 feet above the sea, which he regards as "sea beaches marking stages of the withdrawal of the ocean." No specific localities are given in Maryland.

——— The Upper Devonian Rocks of Southwest Pennsylvania.

Amer. Jour. Sci., 3rd ser., vol. xv, 1878, pp. 423-430.

Includes brief reference to the Devonian of the Alleghany and Negro mountains in Maryland, pp. 425-426.

1879.

ANON. Review of the Coal Trade of 1878.

Eng. and Min. Jour., vol. xxvii, 1879, pp. 1-10.

Output of the Cumberland coal fields for 1876, '77, '78.

BLANDY, J. F. The Lake Superior Copper rocks in Pennsylvania.

Trans. Amer. Inst. Min. Eng., vol. vii, 1879, pp. 331-339.

A correlation based on two days' work, which is sharply criticised by T. Sterry Hunt, who regards the rocks as Huronian and not Keweenian, and by Persifor Frazer, who claimed that the "porphyry shows no character of igneous action."

CAIN, PETER. Second Annual Report of Peter Cain, Inspector of Mines. Annapolis, 1878. 8vo. 16 pp.

Gives workings and conditions of the mines for the year.

FONTAINE, W. M. Notes on the Mesozoic of Virginia.

Amer. Jour. Sci., 3rd ser., vol. xvii, 1879, pp. 25-39, 151-157, 229-239.

Distinguishes seven different belts, two or three of which extend across Maryland, dipping usually to the southeast. Considers the "Potomac marble" boulders to have come from the northwest, from Maryland and Pennsylvania, sometimes a distance of 40 miles, with the boulders increasing in coarseness to the southward. Reference to the "iron ore clays" of Maryland, pp. 155-157. The papers also include numerous observations on the overlying gravels, with a correlation.

FRAZER, PERSIFOR, JR. Classification of Coals. (Read May, 1877.)
Trans. Amer. Inst. Min. Eng., vol. vi, 1879, pp. 430-451.

The ratios of volatile to fixed combustible matter is given for several Cumberland coals (after W. R. Johnson).

——— [The Lake Superior Copper Rocks in Pennsylvania.]
Trans. Amer. Inst. Min. Eng., vol. vii, 1879, pp. 336-339.

Quotes from Report CC (Second Geological Survey of Pennsylvania) and other articles. Holds that South Mountain is separate from Primal of Rogers and that the rocks found there are not igneous.

——— The Mesozoic Sandstone of the Atlantic Slope.
Amer. Nat., vol. xiii, 1879, pp. 284-292.

Review of three papers—Heinrich, Mesozoic formations of Va., Trans. Amer. Inst. Min. Eng., 1878; Fontaine, Notes on Mesozoic of Va., Amer. Jour. Sci., 1879; Russell, On the Physical History of the Triassic, Annals N. Y. Acad. Sci., 1878.

FRAZER, PERSIFOR, JR. Fossil (?) Forms in the Quartzose Rocks of the Lower Susquehanna, with plate. (Read Apr. 4, 1879.)
Proc. Amer. Phil. Soc., vol. xviii, 1880, pp. 277-279.

Deals with some curious indeterminate forms from Frazer's Point, Cecil county. Letters by Whitfield and Hall.

HEINRICH, OSWALD J. The Mesozoic formation in Virginia. (Read Feb. 1878.)
Trans. Amer. Inst. Min. Eng., vol. vi, 1879, pp. 227-274.

The author recognizes four divisions very nearly parallel running from S. 30° to W. 37°, which are described. Distinguishes conglomerates, sandstones, slates, shales, limestones and coal. Apparently considers that the formation extended to New Market, Westminster and Strassburg (p. 250). Maps and sections.

HUNT, T. STERRY. (On the Geology of the Eozoic Rocks of North America.)
Proc. Boston Soc. Nat. Hist., vol. xix, 1879, pp. 275-279.

McCREATH, ANDREW A. Second Report of Progress in the Laboratory of the Survey at Harrisburg.
Rept. 2nd Geol. Surv. Pa. MM, Harrisburg, 1879.

Contains analyses of Maryland materials, pp. 29, 266, 269.

PRIME, FREDERICK. A Catalogue of Official Reports upon Geological Surveys of the United States and Territories and of British North America.
Trans. Amer. Inst. Min. Eng., vol. vii, 1879, pp. 455-525.

A partial list of publications relating to Maryland, corrected in 1881, which see.

Russell, I. C. On the Physical History of the Triassic Formation in New Jersey and Connecticut Valley.

Annals N. Y. Acad. Sci., vol. i, 1879, p. 79, also pp. 220-254.

Several references to particular Triassic areas in Maryland.

Scharf, J. T. History of Maryland from the Earliest Period to the Present Day. 3 vols., 4to, Baltimore, 1879.

Contains many references to the early maps, histories and industries of the state.

1880.

Brown, Thomas. The Maryland Union Coal Company.

Eng. and Min. Jour., vol. xxx, 1880, p. 3.

Several facts on the size, character and extent of the coal veins in the property of the company.

Dana, J. D. Manual of Geology. 3rd edit.

Maryland, pp. 236, 243, 419, 455, 490, 494-5.

Frazer, Persifor, Jr. The Geology of Lancaster County, Pa.

Rept. 2nd Geol. Surv. Pa. CCC, Harrisburg, 1880, atlas.

Deals with the geological formations along the border of the state and their extension into Maryland.

Jeffries, W. W. Menaccanite and Talc from Maryland.

Proc. Acad. Nat. Sci., Phila., 1880, p. 292.

J. C. K. Maryland Mining Notes.

Eng. and Min. Jour., vol. xxix, 1880, p. 48.

Notes on iron and gold prospects from various parts of the state. Also reference, p. 306, to gold found near Mr. Appold's estate on land owned by Mr. F. M. Hay; assayed at $30 per ton.

Lesley, J. P. On a slab of roofing slate covered with casts of *Buthotrephis flexuosa* from the Peach Bottom Slate Quarries. (Read Dec. 1879.)

Proc. Amer. Phil. Soc., vol. xviii, 1880, pp. 364-369.

This paper gives the history of the find, its determination by Lesquereux, analysis of slate and remarks by Frazer.

——— A Hudson River fossil plant in the Roofing slate that is associated with the chlorite slate and metamorphic limestone in Maryland, adjoining York and Lancaster Counties, Pennsylvania.

Amer. Jour. Sci., 3 ser., vol. xix, 1880, pp. 71-72.

Buthotrephis flexuosa (determined by Lesquereux) in the Peach Bottom slates, Silurian age inferred. Extract from a letter.

Riordan, O. Second Annual Report of Owen Riordan, Inspector of Mines for Allegany and Garrett Counties. For year ending Dec. 1879. 8vo. 31 pp.

Md. House and Senate Doc., 1880 [J].

Russell, I. C. On the former extent of the Triassic Formation of the Atlantic States.

Amer. Nat., vol. xiv, 1880, pp. 703-712.

The author concludes "that the Triassic rocks in the Atlantic states were formed in one estuary, in the northern end of which sandstone and shales were deposited, being subjected to a greater subsidence than the southern extremity, where the shores were low and favorable for the accumulation of carbonaceous mud and peat" (p. 711).

Stevenson, J. J. Surface Geology of Southwest Pennsylvania and adjacent portions of West Virginia and Maryland. (Read Apr. 1879.)

Proc. Amer. Phil. Soc., vol. xviii, 1879, pp. 289-316.

A study of the terraces in Garrett and Allegany counties. The present physiography is considered due to the erosion which accompanied the submergence and emergence of Glacial time.

Wysong, Thomas Turner. The Rocks of Deer Creek, Harford County, Maryland; Their Legends and History. Baltimore, 1880. Printed by A. J. Conlon.

The author devotes one page (86) to the chrome pits and two to the slate series (87-88). A popularly written account.

1881.

Brown, T. Report of T. Brown, Inspector of Mines for Allegany and Garrett counties.

Md. House and Senate Doc., 1881, F.

Frazer, P., Jr. Some Copper Deposits of Carroll County, Maryland.

Trans. Amer. Inst. Min. Eng., vol. ix, 1881, pp. 33-40.

Maps and sections are given, also several analyses and an estimate of the amount of ore available. The deposits are situated near New Windsor. The workings are now abandoned and the shaft filled up.

Heilprin, Angelo. On the Stratigraphical Evidence Afforded by the Tertiary Fossils of the Peninsula of Maryland.

Proc. Acad. Nat. Sci., Phila., vol. xxxii, 1880, pp. 20-33.

Holds that the Medial Tertiary is not synchronous with the South Carolina deposits (Conrad), and that deposits intermediate between the Eocene of Fort Washington and the Pliocene of the southeast extremity of the peninsula belong to two different periods of formation; the later belonging to the Miocene, the older to the Oligocene.

Johnson, George. History of Cecil County, Maryland. 8vo. 548 pp. I-XII. map. Elkton, 1881.

Contains data indicating the gradual recognition and utilization of the natural resources of the area.

Leidy, Joseph. Description of Vertebrate remains chiefly from the Phosphate beds of South Carolina.

Jour. Acad. Nat. Sci., Phila., 2nd ser., vol. viii, 1881, pp. 209-261.

Gives Myliobates gigas, M. pachyodon and Aetobatis arcuatus from Charles county, Md., pp. 241-243, 245.

Lewis, H. C. On Jurassic Sand.

Proc. Acad. Nat. Sci., Phila., vol. xxxii, 1881, p. 279.

Describes sands from Elkton which he correlates with the "Hasting sand." Also mentions a capping of "Bryn Mawr gravels" in the same area.

Miller, S. A. North American Mesozoic and Cenozoic Geology and Paleontology. 8vo. 338 pp. Cincinnati, 1881.

See also Jour. Cinn. Soc. Nat. Hist., vol. ii, 1879, pp. 140-161, 223-244; vol. iii, 1880, pp. 9-32, 79-118, 165-202, 245-288; vol. iv, 1881, pp. 3-46, 93-144, 183-234.

Brief general statements regarding the Eocene Deposits of the Middle Atlantic Slope are made by the author.

Prime, Frederick. Supplement II to a catalogue of official Reports upon Geological Surveys of the United States and Territories and of British North America.

Trans. Amer. Inst. Min. Eng., vol. ix, 1881, pp. 621-632.

A list of reports upon the geology of Maryland to replace the list given in the catalogue referred to in the present title (1879).

Scharf, J. T. History of Baltimore City and County. 4to. Phila. 1881.

Topography and geology of the country, by Prof. P. R. Uhler, pp. 13-32.

1882.

Anon. Pennsylvania and Maryland Boundaries.

Pennsylvania Mag. Hist., vol. vi, 1882, pp. 412-434.

Garretson, Frederick. Vibration of Rocks in Patapsco Valley, Md.

Pop. Sci. Mo., vol. xx, 1882, pp. 541-543.

Description of certain intermittent earth tremors which arise not from the impact of falling water, but which are "due to a definite relation between the vibrations of the river and what may be called the key-note of the bed-rock over which it flows."

Heilprin, Angelo. Note on the Approximate Position of the Eocene Deposits of Maryland.

Proc. Acad. Nat. Sci., Phila., vol. xxxiii, 1881, pp. 444-447.

Correlates the Eocene between the Piscataway sands and the Marlborough rock with the Thanet sands of England, and the Poracheux sands of Paris, and near the base or lower than the Buhrstone of Alabama.

——— On the relative ages and classification of the Post-Eocene Tertiary Deposits of the Atlantic Slope.

Proc. Acad. Nat. Sci., Phila., vol. xxxiv, 1882, pp. 150-186.

(Abst.) Amer. Jour. Sci., 3 ser., vol. xxiv, 1882, pp. 228-229. Amer. Nat., vol. xvii, 1883, p. 308.

Treats especially of the deposits in Maryland, Virginia, North Carolina and South Carolina, and concludes that the South and North Carolina deposits represent approximately the same geological horizon. 2. That the Virginia deposits indicate a horizon lower (older) in the geological scale than that of either of the formations just mentioned. 3. That the Maryland deposits indicate two well-marked horizons, of which the upper one is the correspondent of the Virginian.

Hitchcock, C. H. The Crystalline Rocks of Virginia compared with those of New England.

Trans. Amer. Inst. Min. Eng., vol. x, 1882, 477-480.

The correlation of the pre-Cambrian rocks of Virginia and Maryland with those of New Hampshire. The author regards the helt between Washington and Harper's Ferry on the Potomac as Huronian.

Jones, Howard Grant. Notes on the Cumberland or Potomac Coal Basin. (Read Sept. 11, 1880.)

Proc. Amer. Phil. Soc., vol. xix, 1882, pp. 11-110.

Section along Georges Creek from the Lower Barren Measures to the Pocono Sandstone.

Lesley, J. P. (The Cumberland or Potomac Coal Basin.) Remarks on the paper by Mr. Jones.

Proc. Amer. Phil. Soc., Phila., vol. xix, 1882, p. 110.

Scharf, J. T. History of Western Maryland, being a history of Frederick, Montgomery, Carroll, Washington, Allegany, and Garrett Counties from the earliest period to the present day. 2 vols. 4to. Phila. 1882.

Topography and Geology by P. R. Uhler, pp. 13-46.

White, I. C. Notes on the Geology of West Virginia. A Rectification of the Section made by Mr. Howard Grant Jones, M. S. (Read June 17, 1881.)

Proc. Amer. Phil. Soc., vol. xix, 1882, pp. 438-446.

Gives a detailed columnar section along the north Potomac 1520 feet high, extending from the Medina slates to the upper Coal Measures above Pittsburgh Coal.

1883.

Anon. Mining Notes.

Eng. and Min. Jour., vol. xxxvi, 1883, p. 315.

Chronicles the finding of three strata of marl-hearing shells and a large jaw-bone near Cambridge.

Ashburner, Chas. A. Anthracite.

Mineral Resources U. S., 1882, Washington, 1883, pp. 58-60.

Statistics of shipments from 1873-1882 and price per ton.

Bailey, J. Trowbridge. The Copper Deposits of Adams County, Pennsylvania.

Eng. and Min. Jour., vol. xxxv, 1883, pp. 88-89.

Origin and geological occurrences of the South Mountain ores in Adams county, Pa., and Washington county, Md.

BRANTLY, W. T. Maryland.

Encyclopedia Britannica, vol. xv, New York, 1883, pp. 602-605.

Short general description of the topography and geology of the state (Uhler's?).

BURNHAM, S. M. History and Uses of Limestones and Marbles. 8vo. Ill. 392 pp. Boston, 1883.

Maryland, pp. 57-58.

CHESTER, F. D. On Boulder Drift in Delaware.

Amer. Jour. Sci., 3rd ser., vol. xxv, 1883, pp. 18-21.

——— Observations upon Stratified Drift in Delaware.

Amer. Jour. Sci., 3rd ser., vol. xxv, 1883, pp. 436-440.

(Rev.) Science, vol. ii, 1883, p. 380 (W. M. D.).

Considers Champlain depression more than 330 feet, possibly as much as 1000 feet.

CLERK, F. L. The Mining and Metallurgy of Zinc in the United States. Mineral Resources U. S. 1882. Washington, 1883. p. 365.

Mentions zinc ores in Silurian of Maryland which have been worked and abandoned.

COOK, GEORGE H. The change of Relative Level of the Ocean and the Uplands of the Eastern Coast of North America.

Proc. Amer. Assoc. Adv. Sci., vol. xxxi, 1883, pp. 400-408.

A general paper with reasoning applicable to Maryland. Writer regards oscillation connected with ice movements as the principal factors.

DAY, D. T. Chromium.

Mineral Resources U. S., 1882, Washington, 1883, p. 428.

Cites new discovery in North Carolina, and gives statistics as to the amount mined and the price paid per ton in Baltimore.

D'INVILLIERS, E. V. The Geology of the South Mountain Belt of Berks County.

Rept. 2nd Geol. Surv. Pa. DDD, vol. ii, part 1, Harrisburg, 1883, pp. 17-18.

FONTAINE, WM. M. The Older Mesozoic Flora of Virginia.

Mono. U. S. Geol. Surv. No. 6, 1883, 144 pp., 54 plates.

House Misc. Doc., 47th Cong., 2nd Sess., vol. xiv, No. 43.

Reference to Mesozoic beginning on the Palisades. In Maryland it contains no coal, and no plants have been found, though search would probably reveal them. It is characterized by the large amount of red strata that it contains.

HUNT, T. STERRY. A historical account of the Taconic question in geology, with a discussion of the relations of the Taconic series to the older crystalline and to the Cambrian rocks.

Trans. Royal Soc., Canada, vol. i, sec. 4, 1883, pp. 217-270.

LECONTE, JAS. Elements of Geology. 2nd edition, New York, 1883.

Pages 451 and 471 contain certain references to Maryland.

LESLEY, J. P. The Geology of Chester County, Pennsylvania.
Rept. 2nd Geol. Surv. of Pa. C-4, Harrisburg, 1883.
Deals with the geological formations along the border of the state and their extension into Maryland.

McGEE, W J (Note on buried forest of Washington, D. C.)
Amer. Nat., vol. ii, 1883, p. 724.
Tells of the finding of remains of a prequaternary forest near Washington.

SMOCK, J. C. The Useful Minerals of the United States.
Mineral resources U. S.. 1882, Washington, 1883, pp. 664, 690-693.
Gives list of minerals, their localities and the present state of workings in Maryland.

SWANK, J. M. Iron Ore and its Products.
Mineral Resources U. S., 1882, Washington, 1883, pp. 128-137.
Statistics showing marked increase in the output from Maryland in the years following 1876.

UHLER, P. R. Geology of the Surface Features of the Baltimore Area.
Johns Hopkins Univ. Cir. No. 21, vol. ii, 1883, pp. 52-53.
(Abst.) Science, vol. i, 1883, pp. 75-76, 277.
Describes the general features of the area and considers Archean to have been metamorphosed during Jurassic Period.

WILBUR, F. A. Marls.
Mineral Resources U. S., 1882, Washington, 1883, p. 522.
Mentions belt of Cretaceous and Tertiary marls extending across the state.

——— Clay.
Mineral Resources U. S., 1882, Washington, 1883, pp. 465-475.
Mentions fire-clay found at Mt. Savage, Allegany county, with analyses (p. 468); also pottery clay or kaolin in Harford and Cecil counties (p. 470).

WILLIAMS, ALBERT, JR. (Editor). Building Stones.
Mineral Resources U. S., 1882, Washington, 1883, pp. 451-452.
Statistics of the stone industry in Maryland for 1882.

1884.

ADAMS, W. H. The Pyrites Deposits of Louisa County, Va.
Trans. Amer. Inst. Min. Eng., vol. xii, 1884, pp. 527-535.
Bare mention of the pyrites deposits of Cecil county, Md.

ANON. Mining Notes.
Eng. and Min. Jour., vol. xxxviii, 1884, New York, 1884.
Granite quarries at Lapidum, Harford county, p. 9.
Alleged discovery of zinc ore in Anne Arundel county, p. 400.

AYDELOTT, WM. T. Report of Commissioner of Maryland for Surveying and Marking the Boundary Line between the States of Maryland and Virginia. Annapolis, 1884. 22 pp.

Md. House and Senate Doc., 1884, K.

BROWN, T. Report of T. Brown, Inspector of Mines for Allegany and Garrett counties. Annapolis, 1884. 64 pp.

Md. House and Senate Doc., 1884, D.

CHESTER, FREDERICK D. The Quaternary Gravels of Northern Delaware and Eastern Maryland, with map.

Amer. Jour. Sci., 3rd ser., vol. xxvii, 1884, pp. 189-199.

The author divides the formations into the Philadelphia Clay and the Red Gravels and concludes that at the close of the Glacial period the land was depressed at least 350 feet.

——— Preliminary notes on the Geology of Delaware—Laurentian, Paleozoic, and Cretaceous Areas.

Proc. Acad. Nat. Sci., Phila., vol. xxxiv, 1884, pp. 237-259.

This paper describes the area adjoining Maryland and shows the relationship of the Maryland deposits to those of New Jersey.

CLARKE, F. W. Report of work done in the Division of Chemistry and Physics. 1883-84.

Bull. U. S. Geol. Survey No. 9, Washington, 1884, p. 9.

Also House Misc. Doc., 48 Cong., 2nd Sess., vol. xvi, No. 41.

Analysis by T. M. Chatard of gahnite from near Colesville, Montgomery county.

FRAZER, P., JR. The Peach Bottom Slates of Southeastern York and Southern Lancaster Counties.

Trans. Amer. Inst. Min. Eng., vol. xii, 1884, pp. 355-358. Plates and section.

(Abst.) Amer. Jour. Sci., 3 ser., vol. xxix, 1884, p. 70.

Discussion of a section along the Susquehanna river northward from the Maryland line. Also a letter from Prof. James Hall regarding the probable age of the slates, which he considers are either the Hudson river or the Quebec group from the presence of forms allied to Holymenites, Lamnantes lagranger and graptolithus.

——— An Hypothesis of the Structure of the Copper Belt of the South Mountain.

Trans. Amer. Inst. Min. Eng., vol. xii, 1884, pp. 82-90, map.

GANNETT, HENRY. A Dictionary of Altitudes in the United States.

Bull. U. S. Geol. Survey No. 5, Washington, 1884, pp. 129-132.

House Misc. Doc., 48th Cong., 2nd sess., vol. xvi, No. 41.

A large number of altitudes is given.

HEILPRIN, ANGELO. Contributions to the Tertiary Geology and Paleontology of the United States. 4to. 117 pp., map. Phila. 1884.

——— The Tertiary Geology of the Eastern and Southern United States.

Jour. Acad. Nat. Sci., Phila., vol. ix, 2nd ser., 1884-95, pp. 115-154, pl. iv.

Gives a systematic review and analyses of the formation taken as a whole, and a concise statement of the geology of the Tertiary period in all of those states of the Atlantic and Gulf border where the formation has been determined; each of these states then is considered separately. The second division treats of the age and classification of the post-Eocene Tertiary deposits of the Atlantic Slope, and contains carefully prepared faunal lists of Md., Va., N. C., and S. C. Md. references, pp. 10-14, 48-49, 52, 58, 59, 69-78.

——— North American Tertiary Ostreidae.

4th Ann. Rept. U. S. Geol. Surv., 1882-83, Washington, 1884, pp. 309-316. (Appendix I to C. A. White's Fossil Ostreidae of North America).

Gives Ostrea compressirostra, Say (309), O. eversa, Melville (310), O. borealis, Lamarck (312), O. virginica, Gmelin (314).

——— The Tertiary Geology of the Eastern and Southern United States.

Jour. Acad. Nat. Sci., Phila., 2 ser., vol. ix, 1884, pp. 115-154, map.

A monographic study of the formations and a correlation of the different areas, among themselves and with those of Europe. Description of the Eocene and Miocene formations with name of fossils. Pages 124-128 refer especially to Maryland, although frequent mention is made throughout the entire paper. Introduces terms Marylandian, Virginian, etc.

Henderson, C. Hanford. The Copper Deposits of the South Mountain.

Trans. Amer. Inst. Min. Eng., xii, 1884, pp. 85-90, map.

Description of the area dealing with the properties, in Pennsylvania more especially.

Huntington, J. H., Monroe, Chas. E., Singleton, H. K. Descriptions of Quarries and Quarry Regions compiled from notes of Messrs. Huntington, Monroe and Singleton.

Tenth Census, vol. x, Washington, 1884, pp. 175-179.

Gives the occurrence and characteristics of many of the state building stones.

This is a separate division of the Report on the Building Stones of the United States.

McCreath, Andrew S. The Mineral Wealth of Virginia, tributary to the Norfolk and Western and Shenandoah Valley Railroad Companies. Harrisburg, Pa., 1884.

Contains several references to Maryland localities and their economic resources.

Marcou, Jules. Mapoteca Geologica Americana—A catalogue of geological maps of America (North and South), 1752-1881.

Bull. U. S. Geol. Surv. No. 7, 1884.

House Misc. Doc., 48th Cong., 2nd sess., vol. xvi, No. 41.

Reference to maps of Tyson, Daddow and Bannon et als.

MERRILL, GEO. P. (Notes on the Building stones of Washington, D. C.)

Tenth Census, vol. x, Washington, 1884, p. 357.

——— Preliminary note on the Crystalline schists of the District of Columbia.

Proc. U. S. Nat. Mus., vol. vi, 1884, pp. 159-161.

(Abst.) Science, vol. ii, 1883, pp. 829-830.

The prevailing indigenous rock of the District is an extremely variable hornblende, chlorite or micaceous schist.

PHILLIPS, HENRY, JR. Early Proceedings of the American Philosophical Society (1744-1838).

Proc. Amer. Phil. Soc., vol. xxii (2), 1884.

Contains references to early papers and early discoveries.

RAU, CHAS. Prehistoric Fishing in Europe and North America.

Smithsonian Contrib. Knowledge, vol. xxv, 1884, 360 pp.

Pages 235-239 are devoted to a discussion of the shell heaps of Maryland (based on notes of Dr. E. R. Raynolds and J. D. McGuire which have proved liable to confusion with Tertiary deposits. (See Conrad and Vanuxem.)

ROGERS, WILLIAM BARTON. A reprint of Annual Reports and other papers, on the Geology of the Virginias. sm. 8vo. Appleton, 1884.

Contains pocket maps and sections along the Potomac.

SMOCK, J. C. Geologico-geographical Distribution of the Iron Ores of the Eastern United States.

Eng. and Min. Jour., vol. xxxvii, New York, 1884, pp. 217-218, 230-232.

Trans. Inst. Min. Eng., vol. xii, 1884, pp. 130-144.

Reference to occurrence of iron ores in Maryland, including the Allegany county occurrence of siderite, the Washington county ores which are of Silurian age, and magnetite at Deer Creek, Harford county.

SPENCER, F. W., and KELLY, THOS. C. Statistics of Building Stones.

Tenth Census, vol. x, Washington, 1884, pp. 45-105 of Report on Building Stones.

Maryland references, pp. 46, 48, 50, 74-75.

SWANK, JAMES M. History of the Manufacture of Iron in all Ages. Phila. 1884.

Special chapter entitled "Early enterprises in Maryland," pp. 182-197. The first works were at North East and Principio. See also pp. 202-203.

WALLING, H. F. Topographical Indications of a Fault near Harper's Ferry. (Abst.)

Bull. Phil. Soc., Washington, vol. vi, 1884, pp. 30-32.

Mentions the discontinuous extension of the Blue Ridge at Harper's Ferry in support of increased corrugation and steepness of dip eastward with reversed folding. The downthrow to the west.

WEBSTER, A. L. On an excursion Map of Baltimore and its neighborhood.

Johns Hopkins Univ. Cir. No. 30, vol. iii, 1884, p. 80.

Gives an account of the sources and formation of the Field Club map.

WEEKS, JOSEPH D. Report on the Manufacture of Coke.

Tenth Census, vol. x, Washington, 1884.

For manufactnre and use of coke in Maryland, see p. 25.

WHITE, C. A. A review of the Fossil Ostreidae of North America, and a comparison of the Fossil with Living Forms. Appendix I by Angelo Heilprin: North American Tertiary Ostreidae. Appendix II by John A. Rider: A Sketch of the Life History of the Oyster.

4th Ann. Rept. U. S. Geol. Surv., 1882-83, Washington, 1884, pp. 281-430.

(See Heilprin.)

WILLIAMS, GEORGE H. Preliminary notice of the Gabbros and Associated Hornblende rocks in the vicinity of Baltimore.

Johns Hopkins Univ. Cir. No. 30, vol. iii, 1884, pp. 79-80.

Distinguishes and describes "Anorthite amphibolite" and olivine bronzite gabbro.

——— Note on the so-called Quartz Porphyry at Hollins Sta. north of Baltimore.

Johns Hopkins Univ. Cir. No. 32, vol. iii, 1884, p. 131.

Shows Tyson's "quartz porphyry is an autoclastic rock formed from adjacent gneiss during dynamic metamorphism."

WINSOR, JUSTIN (Editor). A Narrative and Critical History of America. Vol. iii. English Explorations and Settlements in North America, 1497-1689. Houghton, Mifflin & Co., Boston, 1884. pp. 127-169, 517-562.

Contains interesting notes on the gradual recognition of the resources and physical features of the state. Chapter on Maryland by W. T. Brantly; that on Virginia by R. A. Brock.

1885.

ANON. General Mining News—Maryland.

Eng. and Min. Jour., vol. xl, 1885, p. 422.

Purchase of Frederick county property by a California mining company.

——— General Mining News—Maryland.

Eng. and Min. Jour., vol. xl, 1885, p. 294.

Search for silver ore in the vicinity of Cumberland.

ARMSTRONG, S. C. (compiler). Coal.

Mineral Resources U. S., 1883-84, Washington, 1885.

General remarks on George's Creek Coal field, pp. 49-50; statistics on coal product, 1880-1884, p. 12.

Brock, R. A. Early Iron Manufacture in Virginia, 1619-1776.

Proc. U. S. Nat. Mus., vol. viii, 1885, pp. 77-80.

The author refers, p. 79, to the purchase of iron from Maryland in early times.

Chester, Frederick D. The Gravels of the Southern Delaware Peninsula.

Amer. Jour. Sci., 3rd ser., vol. xxix, 1885, pp. 36-44.

Post Glacial bowlders of Snow Hill, Md., pp. 41-43. This deals especially with the Quaternary and modern deposits, though discussing the surface deposits of the whole area.

——— A Review of the Geology of Delaware, Results of a survey in progress. (Abst.)

Proc. Amer. Assoc. Adv. Sci., vol. xxiii, 1885, pp. 400-401.

Clarke, F. W. Mica.

Mineral Resources U. S., 1883-84, Washington, 1885, pp. 906-912.

Mentions the mica mines of Howard and Montgomery counties which are not at present worked, p. 908.

Day, D. T. Chromium.

Mineral Resources U. S., 1883-84, Washington, 1885.

Gives short history of chromium industry in Maryland, p. 567.

——— Cobalt.

Idem, p. 544.

Mentions linnaeite and niccolite from Finksburg and Sykesville, Carroll county.

——— Manganese.

Idem, p. 551.

Black oxide of manganese formerly mined at Brookville, Montgomery county, but now abandoned.

Gannett, Henry. Administrative Reports. Topographic work in Maryland.

5th Ann. Rept. U. S. Geol. Surv., 1883-84, Washington, 1885, pp. 7-8.

Notes on the topographic work done in Western Maryland and about Washington.

——— Administrative Reports. Topographic work in Maryland.

6th Ann. Rept. U. S. Geol. Surv., 1884-85, Washington, 1885, p. 8.

——— Boundaries of the United States and of the several states and territories with a historical sketch of the territorial changes.

Bull. U. S. Geol. Surv. No. 13, 1885, pp. 79-90.

House Misc. Doc., 48th Congress, 2nd sess., vol. xli.

Contains history of the grants and the determinations of the location of the boundary lines between Maryland and Pennsylvania, Delaware, Virginia and West Virginia.

Kunz, G. F. Precious Stones.

Mineral Resources U. S., 1883-84, Washington, 1885.

Mentions Harford county serpentine, p. 776; and also amber from Cape Sable and Chesapeake and Delaware Canal based on Troost's paper in Amer. Jour. Sci. 1832, p. 780.

McGee, W J The Geology of the District.

Evening Star, Washington, July 11, 1885.

Regards the Potomac as the American equivalent of the European Neocomian.

Robinson, T. The Strata exposed in the East Shaft of the Water Works Extension. (Abst.)

Bull. Phil. Soc., Washington, vol. vii, 1885, pp. 69-71.

Scharfe, Walter R. The Boundary Dispute between Maryland and Pennsylvania.

Pennsylvania Mag. Hist., vol. ix, 1885, pp. 241-271.

Spencer, J. W. Occurrence of Boulders of Decomposition at Washington, D. C., and elsewhere.

Amer. Nat., vol. xix, 1885, pp. 163-165.

Considers the bearing of decomposition boulders upon the glacial drift.

Swain, Geo. F. Report on the water power of the Middle Atlantic Water-shed.

Tenth Census, vol. xvi, Washington, 1885, pp. 513-660.

Describes the topography, flow, and fall of the principal rivers of Maryland, etc., p. 142.

Swank, Jas. M. Iron ores in the United States.

Mineral Resources U. S., 1883-84, Washington, 1885.

Statistics of pig iron, 1880-84, p. 252. Simply says, "Very little Bessemer pig iron has been made in Maryland."

Wilbur, F. A. Clays.

Mineral Resources U. S., 1883-84, Washington, 1885.

Mentions clay belt. "Brick made from this clay are noted for their great hardness and cherry-red color," p. 696. Gives characteristics of pottery made from clays of Howard and Anne Arundel counties, p. 700.

Williams, Jr. A. (Editor). Infusorial Earth.

Mineral Resources U. S., 1883-1884, Washington, 1885, p. 720.

Gives occurrence and analysis of "tripoli" from near Dunkirk, Calvert county. Subsequent remarks (M. R., 1885) show that the output was not over 250 tons in 1885.

Williams, George H. Dykes of apparently Eruptive Granite in the neighborhood of Baltimore.

Johns Hopkins Univ. Cir. No. 38, vol. iv, 1885, pp. 65-66.

Describes the pegmatic dykes at Jones Falls, Orange Grove, Ilchester, Relay and Avalon.

——— Amphibole-Anthophyllite from Mt. Washington, Baltimore Co.

Amer. Nat., vol. xix, 1885, 1884.

Chemical analyses and description of a monoclinic hornblende with the composition of anthophyllite occurring as the gauge of chalcophyrite ore.

——— Hornblende aus St. Lawrence Co., N. Y.; amphibol-anthophyllit aus Gegend von Baltimore (etc.).

N. J. B., 1885, ii, p. 170.

1886.

——— General Mining News—Maryland.

Eng. and Min. Jour., vol. xlii, 1886, p. 29.

The quarrying of large blocks of marble at the Beaver Dam quarries.

Ibid. p. 29.

Ashburner, Chas. A. Coal.

Mineral Resources U. S., 1885, Washington, 1886, pp. 33-34.

Gives statistics on shipments, production, prices and wages in George's Creek coal field.

Benton, Edward R. Notes on the samples of iron ore collected in Maryland.

Tenth Census, vol. xv, Mining Industries of the U. S., Washington, 1886, pp. 245-260.

Notes, geological sections and analyses (p. 544).

Chester, F. D. Results from a study of the Gabbros and associated Amphibolites in Delaware.

Proc. Amer. Assoc. Adv. Sci., vol. xxxiv, 1886, pp. 215-216.

Clarke, F. W. Report of work done in Division of Chemistry and Physics, 1884-85.

Bull. U. S. Geol. Survey No. 27, 1886, p. 72.

House Misc. Doc., 49th Cong., 2nd sess., vol. viii, No. 163.

Analysis by R. B. Briggs of brown iron ore from near Timonium, Maryland.

Cook, R. S. The Manufacture of Fire-Brick at Mount Savage, Maryland.

Trans. Amer. Inst. Min. Eng., vol. xiv, 1886, pp. 698-706.

Occurrence and composition of the clay used aud description of the processes employed.

Day, D. T. Chromium.

Mineral Resources U. S., 1885, Washington, 1886, p. 358.

"At Soldier's Delight, Maryland, chrome was mined to the extent of 100 tons."

Frazer, Persifor, Jr. General Notes. Sketch on the Geology of York County, Pennsylvania. (Read Dec. 4, 1885.)

Proc. Amer. Phil. Soc., Phila., vol. xxiii, 1886, pp. 391-410.

Discussion on the general structures, equally applicable to Maryland.

Goode, G. Brown. Presidential address. Beginnings of Natural History in America.

Proc. Biol. Soc., Washington, vol. iii, 1886, pp. 35-105.

Gives account of early scientific explorations.

McGee, W J Geological Formations underlying Washington and Vicinity.

Rept. Health Officer of the District of Columbia for the year ending June 30, 1885, by Dr. S. Townsend, pp. 19-21, 23-35.

(Abst.) by author in Amer. Jour. Sci., 3rd ser., vol. xxxi, 1886, pp. 473-4.

Describes the composition and distribution of the Columbia and underlying Potomac formations and something of the Crystalline rocks.

——— Geography and Topography of the head of Chesapeake Bay. (Read to Amer. Assoc. Adv. Sci. 1886.)

(Abst.) Amer. Jour. Sci., 3 ser., vol. xxxii, 1886, p. 323.

Describes the drainage and topographic features.

Peale, A. C. Lists and analyses of the mineral Springs of the U. S.

Bull. U. S. Geol. Surv. No. 32, 1886, pp. 51-53.

House Misc. Doc., 49th Cong., 2nd sess., vol. viii, No. 164.

A number of springs are given in a tabulated list. These springs are not used as much as formerly, and some reports of springs of this character do not mention Maryland in the list.

Prime, Frederick, Jr. The Coals of the United States.

Tenth Census, vol. xv, Mining Industries of the U. S., Washington, 1886.

Maryland references, p. 855, coal, 895-6, 935-946; copper, 978; zinc, 983, 985, 987-8.

Pumpelly, R. (Editor). Directory of Mines and Metallurgical Establishments East of the 100th Meridian.

Tenth Census, vol. xv, Mining Industries of the U. S., Washington, 1886.

Maryland references, p. 855, coal, 895-6, 935-946; copper, 978; zinc, 983, 985, 987-8.

——— Geological and Geographical distribution of the Iron Ores of the United States.

Tenth Census, vol. xv, Mining Industries of the U. S., Washington, 1886, pp. 3-36.

Maps, sections. Maryland ores, classed as Cambrian, Silurian, Cretaceous, and Quaternary.

Swank, James M. Twenty-one years of progress in the manufacture of Iron and Steel in the United States.

Mineral Resources U. S., 1885, Washington, 1886, pp. 180-195.

Gives statistics on pig iron, rails, rolled iron and steel in Maryland.

WEEKS, T. D. Manganese.

Mineral Resources U. S., 1885, Washington, 1886, p. 344.

Refers to deposits of black oxide of manganese "at Brookville, Montgomery county, and another on the Maryland side of the Potomac across from Harper's Ferry. None at present mined in the state."

WILLIAMS, G. H. The Gabbros and Associated Hornblende Rocks occurring in the neighborhood of Baltimore, Md.

Bull. U. S. Geol. Surv. No. 28, 1886, 78 pp., 4 pls.

House Misc. Doc., 49th Cong., 2nd sess., vol. viii, No. 163.

A petrographic study of these rocks accompanied by many photomicrographs, analyses and a map showing the position of actual outcrops and the distribution of rocks inferred therefrom.

——— On a remarkable crystal of pyrite from Baltimore County, Maryland.

Johns Hopkins Univ. Cir. No. 53, vol. vi, 1886, p. 30.

Found west of Cromwell's Bridge road, opposite Summerfield Station. Peculiar luster, color and merohedrism suggest columbite.

1887.

ASHBURNER, CHAS. A. Coal.

Mineral Resources U. S., 1886, Washington, 1887, pp. 224-279.

Statistics, notes, and companies of George's Creek coal district and also the shipments from 1842-1886.

BIRKINBINE, J. The Iron Ores East of the Mississippi river.

Idem, p. 77.

Analysis of brown hematite from central Maryland.

DAY, D. T. Infusorial Earth.

Idem, p. 587.

States that "the production for the year amounted to 1200 short tons with a spot value of $6000." The source is "near Dunkirk, Calvert county."

DUNCAN, P. MARTIN. On a new Genus of the Madreporaria (Glyphastrea Forbesi, Ed. and H. from the Tertiaries of Md., U. S., with Plates).

Quart. Jour. Geol. Soc., London, vol. xliii, 1887, pp. 24-32.

Refers to writings by Milne-Edwards, Julius Haime, M. de Fromentel and others and gives a full description of Glyphastrea Forbesi.

HITCHCOCK, C. H. The Geological Map of the United States.

Proc. Amer. Inst. Min. Eng., vol. xv, 1887, pp. 465-488.

Gives an historical account of the geological maps previously published and shows one drawn in the colors adopted by the International Geological Congress.

McGEE, W J The Columbia Formation.

Proc. Amer. Assoc. Adv. Sci., vol. xxxvi, 1887, pp. 221-222.

Summary of information concerning the formation.

———Ovibos cavifrons from the Loess of Iowa.

Amer. Jour. Sci., 3rd ser., vol. xxxiv, 1887, pp. 217-220.

A brief discussion of the conditions aloug the Middle Atlantic slope during Quaternary time. All notes ou the size of the boulders deposited in the Susquehanna, Patapsco and Potomac deltas in Quaternary time.

STEVENSON, JOHN J. Notes on the Lower Carboniferous groups along the easterly side of the Appalachian area in Pennsylvania and the Virginias.

Amer. Jour. Sci., 3rd ser., vol. xxxiv, 1887, pp. 37-44.

General discussion of the "Umbral" and "Vespertine," containing notes ou the "Umbral" of Maryland, pp. 42-44.

SWANK, JAS. M. The American Iron Trade in 1886.

Mineral Resources U. S., 1886, Washington, 1887.

Gives statistics on production of iron for the year 1886, p. 18.

——— The American Iron Industry from its Beginning in 1619 to 1886.

Idem, pp. 23-38.

Gives a few interesting historical details concerning the iron industry of Maryland in early times.

WHITE, I. C. Rounded Boulders at High Altitudes along some Appalachian Rivers.

Amer. Jour. Sci., 3rd ser., vol. xxxiv, 1887, pp. 374-381.

Especially pp. 279 and 80 which deal with the bowlders on the eastern side of the Alleghanies. Considers these deposits to be due to different causes; submergence about Washington—even to Cumberland—ice dams (Wright) on western slopes, and snow slides which dammed the mountain streams.

WILLIAMS, G. H. On a Plan Proposed for Future Work upon the Geological Map of the Baltimore region.

Johns Hopkins Univ. Cir. No. 59, 1887, pp. 122-123.

——— Notes on the minerals occurring in the neighborhood of Baltimore. 18 pp. Baltimore, 1887.

The minerals are described "in preliminary way" and are euumerated according to their paragenesis in seven classes.

1888.

ANON. Provisions for establishing meridian lines in the State of Maryland and for observing the magnetic variation. Maryland Code, vol. i, pp. 424-426. 1888.

ASHBURNER, CHAS. A. Coal.

Mineral Resources U. S., 1887, Washington, 1888, pp. 169, 171, 177, 263-270, 337.

Statistics of coal trade, wages and shipment.

BODFISH, D. H. On the new Topographical Map of Baltimore and vicinity.

Johns Hopkins Univ. Cir. No. 65, vol. vii, 1888, p. 72.

Letter describing map.

CLARK, WM. B. On three Geological Excursions made during the months of October and November, 1887, into the southern counties of Maryland.

Johns Hopkins Univ. Cir. No. 63, vol. vii, 1888, pp. 65-67.

Stratigraphic description and lists of fossils.

——— Geology of Eastern Maryland.

Johns Hopkins Univ. Cir. No. 65, vol. vii, 1888, p. 73.

Abstract of lecture showing that there is no proof of the deposition of sediment prior to Middle Mesozoic time, to the east of the Archean belt.

DAY, D. T. (Editor). Infusorial Earth.

Mineral Resources U. S., 1887, Washington, 1888, p. 554.

Analysis of infusorial earth from Pope's Creek made by P. de P. Ricketts of New York.

——— Useful Minerals of the United States.

Idem, pp. 739-742.

Gives list of economic minerals and their occurrence and workings.

DAY, WM. C. Structural Materials.

Idem.

Statistics of the granite industry for 1887, p. 515; marble, p. 518; slate, p. 524; lime, p. 533; brick, pp. 536-538. Quarry opened at Guilford by Messrs. Smith & Johnson. p. 515.

GILBERT, G. K. Administrative Reports. Geologic and Paleontologic Investigations.

7th Ann. Rept. U. S. Geol. Surv., 1885-86, Washington, 1886, p. 67.

HALL, JAMES, and CLARKE, J. M. Paleontology, vol. vii. Text and Plates containing descriptions of the Trilobites and other Crustacea of the Oriskany, Upper Helderberg, Hamilton, Portage, Chemung and Catskill Groups. Geological Survey New York. Albany, 1888.

Description and figures of numerous forms from Cumberland and vicinity.

HOBBS, WILLIAM H. On the rocks occurring in the neighborhood of Ilchester, Howard county, Maryland; Being a detailed study of the area comprised in sheet No. 16 of the Johns Hopkins University map.

Johns Hopkins Univ. Cir. No. 65, vol. vii, 1888, pp. 69-70.

(Abst.) Amer. Nat., vol. xxii, 1888, p. 527.

Describes hypesthene gabbros, gabbro-diorite, and hornblende gneiss as a series due to progressive metamorphism; pyroxenites changing to talc and serpentine; granite porphyry carrying allanite-epidote.

HUNTINGTON, OLIVER WHIPPLE. Catalogue of all recorded Meteorites with a Description of the specimens in the Harvard College collection, including the cabinet of the late J. Lawrence Smith (presented June 15, 1887).

Proc. Amer. Acad. Arts and Sci., n. s. vol. xv, whole ser. xxiii, Boston, 1888, pp. 37-110.

Mentions meteorites which fell at Nanjemoy, Charles county, Feb. 10, 12 A. M., 1825, No. 98 in Harvard College; and at Emmitsburg, 1854 (?), No. 211.

KNOWLTON, F. H. The Fossil Lignites of the Potomac Formation.

Proc. Amer. Assoc. Adv. Sci., vol. xxxvii, 1888, pp. 206-208.

Abstract of the original paper, which itself is an abstract of Bull. U. S. Geol. Surv. No. 56.

MARSH, O. C. Notice of a New Genus of Sauropoda and other new Dinosaurs from the Potomac Formation.

Amer. Jour. Sci., 3rd ser., vol. xxxv, 1888, pp. 89-94, Figs. 1-9.

Description of remains collected largely from the vicinity of Muirkirk, Prince George County, by J. B. Hatcher under the auspices of the U. S. Geol. Surv., including Pleurocoelus nanus (gen. et sp. nov.), Pleurocoelus altus (sp. nov.), Allosaurus medians (sp. nov.) and Coelurus gracilis (sp. nov.).

McGEE, W J The Geology of the Head of Chesapeake Bay.

7th Ann. Rept. U. S. Geol. Surv., 1885-86, Washington, 1888, pp. 537-646, plates 56-71.

(Abst.) Amer. Geol., vol. i, 1887, pp. 113-115.

The author discusses the hydrography, topography, exposures and geological formations; and concludes with a summary of the Quaternary history as recorded in the Columbian formation, in its local and more general application.

——— Administrative Reports. Geologic and Paleontologic Investigations.

7th Ann. Rept. U. S. Geol. Surv., 1885-86, Washington, 1888, p. 110.

——— The Columbia Formation.

Proc. Amer. Assoc. Adv. Sci., vol. xxxvi, 1888, pp. 221-222.

Brief paper on general relations and summary.

——— Three Formations of the Middle Atlantic Slope.

Amer. Jour. Sci., 3rd ser., vol. xxxv, 1888, pp. 120-143, 328-331, 367-388, 448-466, plate ii.

(Absts.) Nature, vol. xxxviii, 1888, pp. 91, 190.
Amer. Geol., vol. ii, 1888, pp. 129-131.

Introduction (pp. 120-143), and Potomac (pp. 328-331), Appomattox (pp. 367-388), Columbia (pp. 448-466), Conclusion.

——— Paleolithic man in America; his Antiquity and Environment.

Pop. Sci. Mo., vol. xxxiv, 1888-89, pp. 20-36.

Discusses the geology at the head of the Chesapeake Bay.

MEYER, OTTO. Some remarks on the present state of our Knowledge of the North American Eastern Tertiary.

Amer. Geol., vol. ii, 1888, pp. 88-94.

Objects to Heilprin's correlations.

SWANK, JAS. M. The Iron and Steel Industries of the United States in 1887 and 1888.

Mineral Resources U. S., 1887, Washington, 1888.

Statistics, p. 11. First coke furnaces in the South established near Frostburg in 1839, p. 22.

UHLER, P. R. Sketch of the History of the Maryland Academy of Science.

Trans. Maryland Acad. Sci., vol. i, 1888, pp. 1-10.

——— The Albirupean Formation and its nearest relatives in Maryland.

Proc. Amer. Phil. Soc., vol. xxv, 1888, pp. 42-53.

Reply by H. Carvilie Lewis, pp. 53-54. A. Heilprin, p. 54.

(Uhler) introduces Albirupean and Baltimorean, giving vertical sections and a map showing distribution of his formations.

(Lewis) objects to terms as unnecessary and says that "Albirupean" as used includes Mesozoic. Heilprin agrees with Lewis.

——— Observations on the Eocene Tertiary and its Cretaceous Associates in the State of Maryland.

Trans. Md. Acad. Sci., vol. i, 1888, pp. 11-32.

Description of distribution, characteristics, paleontology, etc., of the Cretaceous and Eocene; and discussions of the relations and correlations of some portions of the latter.

WARD, LESTER F. Administrative Reports. Geologic and Paleontologic Investigations.

7th Ann. Rept. U. S. Geol. Surv., 1885-86, Washington, 1888, p. 125.

——— Evidence of Fossil Plants as to the Age of the Potomac Formation.

Amer. Jour. Sci., 3rd ser., vol. xxxvi, 1888, pp. 119-131.

Concludes that the fossil plants of the Potomac present no serious obstacle to its reference to the Jurassic.

WHITNEY, J. D. Physical Geography and Statistics. Part II. of article on United States.

Encyclopedia Britannica, vol. xxiii, New York, 1888, pp. 791-817.

Gives summary of information on topography, geology, climate, vegetation and mineral resources.

WILLIAMS, GEORGE H. Geology of the Baltimore Region.

Johns Hopkins Univ. Cir. No. 65, vol. vii, 1888, p. 73.

Report of a lecture in which the author refers to the sequence of the eruptions in the Plutonic rocks of the area.

——— Progress of Work on the Archean Geology of Maryland.
Johns Hopkins Univ. Cir. No. 65, vol. vii, 1888, pp. 61-63.

Sketch of Maryland geology and of the relations of the gneisses and eruptives about Baltimore and thence northward.

1889.

ANON. Mining Notes.
Eng. and Min. Jour., vol. xlviii, 1889.

Reference to Gold Mining at Great Falls (pp. 56, 235).

BRYAN, O. N. The Cretaceous Formation of Southwestern Maryland.
Amer. Nat., vol. xxiii, 1889, pp. 713-714.

Deposits of Cretaceous age found to outcrop from beneath a covering of Eocene strata. Certain beds at Fort Washington assigned to the Jurassic.

CLARK, WM. B. Discovery of fossil-bearing Cretaceous strata in Anne Arundel and Prince George Counties, Maryland.
Johns Hopkins Univ. Cir. No. 69, vol. viii, 1889, pp. 20-21.

Description of type localities, enumeration of fauna and correlation with Lower Marls of New Jersey.

CLARKE, F. W. Report of work done in the Division of Chemistry and Physics, 1886-87.
Bull. U. S. Geol. Surv. No. 55, 1889.
Also House Misc. Doc., 51st Cong., 1st sess., vol. xxxii, No. 244.

Two analyses of "Triassic Sandstone" from the Jaittelle quarry near Hancock (this is not a Triassic sandstone) (p. 80), and one of lepidomelane from Baltimore (p. 14).

DUTTON, C. E. The Charlestown Earthquake of August 31, 1886.
9th Ann. Rept. U. S. Geol. Surv., 1889, pp. 363, 366, 369, 453.

Report of earthquake observations in Maryland, August 31, 1886.

FONTAINE, W. M. Potomac or Younger Mesozoic Flora.
Mono. U. S. Geol. Surv., No. 15, 1889, 377 pp., 180 plates.
House Misc. Doc., 50th Cong., 2nd sess., vol. xvii, No. 147.
(Rev.) Amer. Jour. Sci., 3rd ser., vol. xxxix, 1890, p. 520 (L. F. W.).

Introduction, p. 4. A description of some fossil plants from the neighborhood of Baltimore, chiefly from Federal Hill and Ft. Washington, is given including twenty-five new species.

GANNETT, HENRY. Administrative Reports. Topographic Work in Maryland.
9th Ann. Rept. U. S. Geol. Surv., 1887-88, Washington, 1889, pp. 52-55.

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(See figs. 3 and 4 on pp. 650-561 for Cretaceous peneplain in Maryland, also neighboring text). A general study of the peneplains and the Piedmont Plateau of the Atlantic slope, in which it is maintained that the Permian and Jurassic constructional topography of the Atlantic slope was practically obliterated over the greater part of the area, resulting in a Cretaceous peneplain.

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——— Petrography and Structure of the Piedmont Plateau in Maryland.

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Covers in a general way the physiography, petrography and structure. The paper is accompanied by geological map and sections. In the discussion following the author mentions Triassic fossils from near Frederick and Utica Mills.

——— [On Transition of Crystalline and semi-crystalline rocks in Maryland.]

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——— The geological excursions by University students across the Appalachians in May, 1891.

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Johns Hopkins Univ. Cir. No. 87, vol. x, 1891, pp. 73-75.

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Bull. U. S. Geol. Surv. No. 80, 1891.

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WOOLMAN, LEWIS. Artesian wells and water-bearing horizons of Southern New Jersey (with a "note on the extension southward of diatomaceous clays and the occurrence there of flowing artesian wells").

New Jersey Geol. Surv., Rept. State Geologist for 1890, 1891, pp. 269-276.

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DALL, W. H., and HARRIS, G. D. Correlation Papers—Neocene.

Bull. U. S. Geol. Surv. No. 84, 1892.

House Misc. Doc., 52nd Cong., 1st sess., vol. xliii, No. 337.

Gives a descriptive account with several columnar sections of the Miocene, also a map showing distribution throughout the U. S., pp. 49-54.

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Idem.

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DAY, WM. C. Stone.

Idem.

Statistics of the limestone industry for 1888-89, p. 373; granite, p. 374; marble, p. 375; slate, p. 376. Details on stone industry, pp. 378-400, including analysis of Harford county serpentine, by Dr. F. A. Genth (p. 400). See also p. 424.[1]

[1] The statistics for the year are also given in the Eleventh Census.

FOOTE, A. E. A New Meteoric Iron from Garrett county, Maryland.

Amer. Jour. Sci., 3rd ser., vol. xliii, 1892, p. 64, plate i.

Proc. Acad. Nat. Sci., Phila., 1892, vol. xliii, p. 455.

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Amer. Jour. Sci., 3rd ser., vol. xliii, 1892, pp. 389-402.

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Eleventh Census, Report on Mineral Industries, 1892, pp. 345-422.

Maryland statistics, pp. 384-386.

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Amer. Geol., vol. x, 1892, pp. 362-368.

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KENT, WM. Gold and Silver.

Mineral Resources U. S., 1889-90, Washington, 1892.

Production of gold (from Eleventh Census), p. 49.

LESLEY, J. P. A Summary description of the Geology of Pennsylvania. 3 vol. Harrisburg, 1892.

Numerous references to formations passing southwards into Maryland.

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Mineral Resources U. S., 1889-90, Washington, 1892.

Statistics on hydraulic cement from Maryland, p. 461.

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Idem.

Coal statistics, pp. 146, 148, 170, 221-225. See also p. 155.

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Idem.

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Eleventh Census, Report on Mineral Industries, 1892, pp. 33-152.

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Bull. U. S. Geol. Surv. No. 85, 1892.
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Bibliography and areal distribution for Maryland, pp. 20-85.

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This paper contains general information presented in a popular style.

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Johns Hopkins Univ. Cir. No. 121, vol. xv, 1895, p. 16.

Enumerates fossils found at various localities which establish the identity of the Cretaceous on the Eastern Shore.

SWANK, JAMES M. Steel and Iron Industries.

16th Ann. Rept. U. S. Geol. Surv., 1894-95, part iii, Washington, 1895, pp. 219-250.

Maryland statistics, p. 221.

WARD, LESTER F. The Potomac Formation.

15th Ann. Rept. U. S. Geol. Surv., 1893-94, Washington, 1895, pp. 307-397, plates.

A paper dealing with the stratigraphical relations and especially with the description and correlation of the vegetable remains. Accompanied by numerous sections and illustrations.

WEEKS, JOSEPH D. Manganese.

16th Ann. Rept. U. S. Geol. Surv., 1894-95, part iii, Washington, 1895.

Maryland Manganese Products, p. 416.

WHITNEY, MILTON. Soil Moisture, A Record of the Amount of Water Contained in the Soils during the Month of July, 1895.

Bull. 3 U. S. Dept. Agri. Div. of Agri. Soils, Washington, 1895, 23 pp. and diagrams.

Contains diagrams of soil moisture of the early truck lands of Mardella Springs, Md.

——— Truck Lands of the Atlantic Seaboard.

Year-book, Dept. Agri., 1894, Washington, 1895, 129 pp., 143 illustrations.

Discussion of the truck soils of Maryland, with many chemical and mechanical analyses of sub-soils, pp. 139-143.

WILLIAMS, G. H. The general relations of the Granitic Rocks in the Middle Atlantic Piedmont Plateau (Introduction to Keyes' "Origin of Central Maryland Granites").

15th Ann. Rept. U. S. Geol. Surv., 1893-94, Washington, 1895, pp. 657-684, with plates.

A study of highly metamorphosed ancient plutonic rocks and of the origin of the Maryland pegmatites, which are believed to be both segregative and intrusive.

1896.

ANON. Directory to the Iron and Steel Works of the United States, compiled and published by the American Iron and Steel Association. 13th edit. corrected to Jan. 1896.

Maryland blast furnaces (27 and 70), rolling mills (144), bessemer (199), crucible steel (210), plate and sheet (215), tin plate (229), bloomeries (240), shipbuilders (257), light locomotives (260), malleable iron (263), cast iron pipe (270), car wheels (282), car building (290).

CLARK, WM. B. The Eocene Deposits of the Middle Atlantic Slope in Delaware, Maryland and Virginia.

Bull. U. S. Geol. Surv. No. 141, 1896, 167 pp. 40 plates.

House Misc. Doc., 54th Cong., 2nd sess., vol. —, No. 31.

A general discussion of the geological features, distribution, character and correlation of the deposits, with a description of the contained fossils.

——— The Potomac River Section of the Middle Atlantic Coast Eocene.

Amer. Jour. Sci., 4th ser., vol. i, 1896, pp. 365-374.

The middle Atlantic coast phase of the Eocene constitutes a single geologic unit of very homogeneous character, representing the major part of the "Lignitic," "Buhrstone," and "Claiborne" of Smith. Two well-defined faunas are described: the "Aquia Creek" and the "Woodstock."

DARTON, N. H. Artesian Well Prospects in the Atlantic Coastal Plain Region.

Bull. U. S. Geol. Surv. No. 138, 1896, 228 pp., 19 plates.

House Misc. Doc., 54th Cong., 2nd sess., vol. —, No. 28.

Considerable detailed local information. Md. ref. 22, 124-155.

——— Nomini Folio, Explanatory sheets.

U. S. Geol. Surv., Geol. Atlas, folio 23, Washington, 1896.

Brief epitomized account of the geology of the "quadrangle" studied.

DARTON, N. H., and TAFF, JOSEPH. Piedmont Folio, Explanatory sheets.

U. S. Geol. Surv., Geol. Atlas, folio 28, Washington, 1896.

Epitomized account of the geology, structure and economic resources of the "quadrangle" studied.

DAY, D. T. Minor Minerals of the United States.

Eng. Mag., vol. xi, 1896, pp. 299 and 504.

DORSEY, CLARENCE W. The Soils of the Hagerstown Valley.

Md. Agr. Exp. Sta. Bull. No. 44, College Park, 1896.

A study of the soils resulting from the disintegration of the Cambrian sandstone, Hudson River shales and Trenton limestones. Distinguishes five types.

FONTAINE, WM. M. The Potomac Formation in Virginia.

Bull. U. S. Geol. Surv. No. 145, 1896, 149 pp., plates.

House Misc. Doc., 54th Cong., 2nd sess., vol. —, No. 35.

GILBERT, G. K. Age of the Potomac Formation.

Science, n. s. vol. iv, 1896, pp. 875-877.

Reviews Professor Marsh's article on the Jurassic formations of the Atlantic Coast and points out certain discrepancies.

HILL, R. T. A Question of Classification.

Science, n. s., vol. iv, 1896, pp. 918-922.

Regards the Potomac group as Cretaceous.

KEYES, C. R. Central Maryland Granites.

Stone, vol. xiii, 1896, pp. 421-428 seq.

This is the paper published in the 15th Ann. Rept. U. S. Geol. Surv. in somewhat condensed form.

KLITTKE, M. Entwicklung, Organisation und Leitstungen der geologische Landesaufnahmen in den Vereinigten Staaten von Nord Amerika.

Zeit. f. prak. Geol., 1896, pp. 209-213, 289-352.

The history of Maryland surveys is given on pp. 312-313.

KNOWLTON, F. H. American Amber-producing Tree.

Science, n. s., vol. iii, 1896, pp. 582-584.

A description of material found by Mr. Arthur Bibbius at Cape Sable, Md.

MARCOU, JULES. The Jura in the United States.

Science, n. s., vol. iv, 1896, pp. 945-947.

Regards the Potomac formation as Jurassic and refers to Tyson's and Marsh's work.

MARSH, O. C. The Dinosaurs of North America.

16th Ann. Rept. U. S. Geol. Surv., 1894-95, part i, Washington, 1896, pp. 195-244, plates ii-lxxxv.

Many of the forms described were found in Maryland, especially in the Potomac formation.

——— The Jurassic Formation on the Atlantic Coast.

Science, n. s., vol. iv, 1896, pp. 805-816.

Amer. Jour. Sci., 4th ser., vol. ii, 1896, pp. 433-447.

The author claims that the vertebrates indicate the Jurassic age of the Potomac formation.

MARYLAND STATE WEATHER SERVICE. The Climatology and Physical Features of Maryland.

Second Biennial Report of the Maryland State Weather Service for the years 1894 and 1895. Baltimore, 1896.

PHILLIPS, J. A., and LOUIS, HENRY. A Treatise on Ore Deposits. 8vo. 943 pp. Macmillan, 1896.

References to Maryland gold (785), iron (826), chrome (828).

PHILLIPS, P. LEE. Virginia Cartography—a Bibliographical Description.

Smithsonian Misc. Coll. No. 1039, vol. xxxviii, Washington, 1896, 8vo, 85 pp.

Contains historical remarks on many of the old maps covering the area of Maryland.

SCHOTT, C. A. The Secular Variation in Direction and Intensity, of the Earth's Magnetic Force in the United States and in some adjacent foreign countries.

Rept. Supt. U. S. Coast and Geodetic Survey for 1895, Washington, 1896, pt. ii, appendix 1, pp. 167-320.

This is the latest of a series of papers on magnetism which have appeared almost annually in the publications of the Survey. As the subject is somewhat removed from

the aim of the bibliography, the more important papers are only appended. They appeared in Report for 1854, Appendix 43, pp. 143-145; Report for 1856, Appendix 28-30, 32-33, pp. 209-249; Report for 1858, Appendix 24, pp. 191-192; Report for 1859, Appendix 24, pp. 296-305; Report for 1861, Appendix 22, pp. 242-251; Report for 1862, Appendix 19, pp. 212-220; Report for 1874, Appendix 8, pp. 72-108; Report for 1885, Appendix 6, pp. 129-274; Report for 1886, Appendix 12, pp. 291-407; Report for 1888, Appendix 7, pp. 177-312; Report for 1890, pp. 274-275.

Van Der Hoogt, Cornelius, Bureau of Immigration. State of Maryland. 1896.

Brief popular summary of the natural resources of Maryland.

Van Hise, C. R. Principles of North American Pre-Cambrian Geology.

16th Ann. Rept. U. S. Geol. Surv., 1894-95, part i, Washington, 1896, pp. 581-843, 2 maps and illustrations.

Gives a few incidental references to the Maryland pre-cambrian.

Walcott, C. D. The Cambrian Rocks of Pennsylvania.

Bull. U. S. Geol. Surv. No. 134, 1896.

House Misc. Doc., 54th Cong., 2nd sess., vol. —, No. 24.

Contains incidental reference to his work with Keith in Frederick county and also to the southern continuation of Pennsylvania formations.

Ward, L. F. Some Analogies in the Lower Cretaceous of Europe and North America.

16th Ann. Rept. U. S. Geol. Surv., 1894-95, part i, Washington, 1896, pp. 463-542, plates xcvii-cvii.

A general discussion of the character and limits of the Potomac, especially of the Middle Atlantic Slope in comparison with the Wealden.

——— Fossil Plants of the Wealden.

Science, n. s., vol. iii, 1896, pp. 869-876.

Refers briefly to the cycads from the Potomac of Maryland.

——— Age of the Island Series.

Science, n. s., vol. iv, 1896, pp. 757-760.

Refers briefly to the Potomac group of Maryland.

Whitney, Milton. Texture of Some Important Soil Formations.

U. S. Dept. Agri., Div. Agri. Soils, Bull. No. 5, Washington, 1896. Illustrated, 23 pp., plates 35.

Six types taken from various portions of Maryland.

Willis, Bailey. The Northern Appalachians.

The Physiography of the United States.

Geographic Monographs I, American Book Co., 169 pp., 1896.

A study of the present topography and its origin.

CARTOGRAPHY.

1526.

ANON. Mappe monde Peinte sur Parchemin par ordre de Henri II Roi de France.

Monuments de la Geographie Publies par M. Jomard, Paris. (Peabody.)

AYLLON'S, LUCAS VASQUEZ.

See Kohl, Die Beiden altesten General-Karten von Amerika, Weimar 1860. (Peabody.)

1529 (?).

RIBERO.

See Kohl, Die Beiden altesten General-Karten, coast line reproduced in Mag. Amer. Hist. ii, 1878, pp. 257, 1. (Peabody.)

DE VERRAZANO,

Coast line reproduced in Mag. Amer. Hist. ii, pp. 257, 1, 1878.

1554.

ANGESE, BAPTISTA. No. 4 North America, South of the Penobscot and the Gulf of California, and the west coast of South America to 15° South; etc.

See Winsor, A Bibliography of Ptolemy's Geography. Bull. 18 of Harvard Library, p. 30.

——— No. 5 East coast of North America from Labrador South; (etc.).

See preceding.

1560.

HOMIN.

See Kohl, Discovery of Maine, 297.

1569.

MERCATOR. Map of the World. Duisbourg.

Copied in Monuments de la Geographie par M. Jomard, Paris. (Peabody.)

1590 (?).

HONDIUS, IODOCUS. America.

Queer map with many figures. No mention of Maryland. (U. S. G. S.)

1593.

JUDACIS, CORNELIO. Americae pars Boreales, Florida, Baccalaos, Canada Cortircalis; a Cornelio de Judaeis in lucem edita 1593.

Author's Speculum Orbis terrareum.

"Chesepooc sinus," "Virginia" and "Apalchen" on the map, but with no evidence of the use of White. (Winsor iv, p. 97.)

1596.

MERCATOR, MICHAEL. America sine India Nova, ad magnae Gerardi Mercatoris aui Vniversalis imitationem in compendium redacta, Per Michaelem Mercatorem, Duysburgensem.

(U. S. G. S.)

1597.

WYTFLIET, CORNELY. Norvmbega et Virginia 1597.

Wytfliet's Descriptionis Ptolemaicae augmentum. fol. Lovanii, 1597.

"The map differs only in delineation from With's map, but extends farther north, taking in the coast as far as Cape Breton." (Phillips.)

1599.

HAKLUYT, RICHARD. The Principal Navigations.

Nordenskiold's Facsimile Atlas, Stockholm, 1889. (Peabody.)

1608.

SMITH, JOHN. Chart of Virginia.

Published in 1812 (?). Quoted in 1813 by Purchas.

"Not drawn on exact scale; it seems to have been drawn on the basis of about five miles, or say one and a half leagues to an inch." (Phillips.)

1612.

SMITH, JOHN. A Mappe of Virginia. Oxford 1812.

With explanatory text. See 1624 and 1884.

1622.

DE WITT, FREDERICUM. Novissima et Accuratissima Descriptio, multis Locis recentibus, acta et correcté divisa in Runneo Partes Hodiemas per Fredericum de Witt, Amstelodami, Cum Privilegio D. D. Ordinum. Holl. Westfrisiae.

19x22¾, colored, figures. (Peabody.)

DE WIT, F. Novissima et Accuratissima Totius Americae Descriptio per F. de Wit, Amstelodami.

19x22¾, colored. (U. S. G. S.)

1624.

SMITH, JOHN. Virginia.

A Generall Historie of Virginia, New England and the Summer Isles.

1630.

HONDIJ, HENRICI. Virginiae Item et Floridae Americae Provinciarum, nova Descriptio.

Mercator's Atlas, edit. x, by Henrici Hondij.

19x13⅝, figures. Scale, "medius Meridianus est 300, reliqui ad hunc inclinantur pro ratione 30 & 70 parallelorem." "Apalatcy Montes Auriferi" Cheseploock Sinus." (Peabody.)

——— Septentrio America.

Atlas sive Cosmographicae (etc.), edit. x, Girardi Mercatoris pub., by Henry Hondy. Amsterodami, An. D. 1630.

19½x14¾, symbols and curious distortion. (Peabody.)

1632.

CHAMPLAIN. Carte de la nouvelle france.

16x6 (Winsor fascimile), scale irregular, about 200 miles to an inch along Chesapeake Bay. (Winsor iv, p. 387.)

1635.

BLEAU, J. & W. Nova Virginia tabula.

Tweede Del van't Tvourneel des Aerdrucx, Ofte Nievwe atlas uytgegeven Door Wilhelm: en Iohannem Bleau. Amsterdam, 1635.

14½x18½, hand-colored, symbols. Scale about 12 miles to an inch. (Amer. Geog. Soc., Harvard.)

HERMANN, AUGUST. Noua Terrae Marie tabula.

A Relation of Maryland; Together with a Map of the Country. The Conditions of Plantations, etc. London, 1635.

See 1865, 1873. For full title see bibliography.

1638.

KLING, MONS. (Map of Delaware.) (Winsor.)

1639.

VINGBOONS, JOAN. Pascaert van Nieuw Nederlandt, Virginia, ende Nieuw Engelandt, verthonende alles wat van die Landen by see oft by land is ondect oft bekent. (Routier de la Nouv. Néerlande, Virginie et Nouv. Angleterre etc.)

Carte manuscrite. (Phillips.)

——— (?) Pas Caerte van Nieu Nederlandt en de Englische Virginies van Cabo Cod tot Cabo Canvick.

20⅝x16¾, outline, drainage. Scale 25 miles to an inch. (Lenox.)

——— Carte manuscrite du Potomac de la baie jusqu'à Beremotho Citic. (Phillips).

1642.

DOUCKER, H. Pas Caert van Nieu Nederland, Virginia en Nieu Engelant, nieulyex uytgegeven y' Amsterdam, By Hendrich Doncker.

17⅝x21¼. Outline, drainage. Scale imperfect. (Same map seen under title Virginia, Nieu Nederlant.) (Amer. Geog. Soc.)

1650 (?).

VISSCHER, NICOLAS. Nova Tabula Geographica complectus Borealiorem Americae Partem, [etc.] [Title also in French].

35x21¾, boundaries colored, symbols. Bay carefully drawn. Potomac heads in lake in Pa. Scale 18 miles to an inch. (Lenox.)

1651.

FARRER, VIRGINIA. A mapp of Virginia discouered to ye Hills, and in it's Latt: From 35 deg: & ½ neer Florida, to 41 deg: bounds of New Englands. John Goddard sculp. Domina Virginia Farrer Collegit. Are sold by I. Stephenson at ye Sunn below Ludgate: 1651.

(Repub. in Winsor iii, p. 465.)

1654 (?).

MOLL, H. A New Map of the World According to Wright's alias Mercator's Projection, &c. Improved by Richard Monit and Tho. Page., H. Moll facit.

37x23, outline, drainage. Scale 10 miles to an inch. (Peabody.)

1656.

SANSON, N. Le Canada, ou Nouvelle France &c., (etc.), Par N. Sanson d'Abbeville. Geographe ordinaire du Roi. A Paris. 1656.

21⅝x15¾, colored boundaries. "Virginie" includes Maryland territory. (Lenox.)

1657.

JANSON, JOHN. Belgii Nove, Angliae novae et Partis Virginiae novissima Delineatio.

Atlantis Pars quarta in qua Asia, Africa, America et Orbis anlequies. Amstelodami, apud Ioannem Ianssonium, 1657. Amsterdami, ex-officina Henrici Hondii.

20x17½, symbols. Scale 8½ German miles to an inch. (Amer. Geog. Soc.)

——— America Septentrionalis. Amstelodami, excudet Ioannes Ianssonius.

Idem.

21½x18½, symbols. Scale about 200 miles to an inch. (Amer. Geog. Soc.)

——— Nova Virginiae tabula.

Idem.

19x15, copied from Smith. (Amer. Geog. Soc.)

1660.

CREXIUS, PERE DU.

Historiae Canadensis, sev Novae Franciae, libri decem, Paris, 1664, pp. xxvi, 810, 4to map and thirteen plates.

See Winsor iv, p. 388.

1661.

VISSCHER, NICH. JOHN. Novi Belge, Novae Angliae, nec non partes Virginiae Tabula. Van Nich., John Visscher. Amsterdam, 1659.

(Winsor.)

1663.

COLOM, JACOB. (Virginia Nieu-Nederlant).

Atlas of Wekelts-water-deel En desselfs Zee-Custen. Amsterdam, 1663.

21x14¾, coast outlined. Scale about 9 miles to an inch. Maryland included under Virginia. (Amer. Geog. Soc.)

1666.

ALSOP, GEORGE. A Land-skip of the Province of Mary-land or the Lord Baltmors Plantation neere Virginia, By Geo: Alsop Gent:.

Outline of bay, figures, symbols. 6⅝x5 in Gowan.

Octavo edit. (Peabody.)

1669.

GOOS, PETER. Pascaerte Van Westindien de Vaste Kusten En de Eylanden.

De Zee Atlas ofte Water Wereld (etc.), by Pieter Goos, 1669.

Looks like With's old map. (Amer. Geog. Soc.)

1669 (?).

SANSON, NICOLAS. Atlantis insula.

(Winsor.)

1671.

Blome, Richard. A Draught of the Sea Coast and Rivers, of Virginia, Maryland, and New England. Taken from the latest surveys. London. Printed for Ric Blome.

7x9, outline, with a few mountains. Same map without Calvert arms and dedication to Lord Baltimore in French edition, which bears a French title. (Boston Public Library.)

Ogilby, John. *Terrae Mariae* Noua *et* Virginiae Tabula (after Smith, but different figures).

America, by John Ogilby, p. 182.

15¾x11¼, outline, mountain figures. Scale 6½ sea leagues to an inch. Words italicized were in ink in Peabody copy. (Peabody.)

——— Novissima et Accuratissima Totius Americae Descriptio per Johanem Ogiluium.

In America, by John Ogilby.

17x21, figures and mountains hachured. (Peabody.)

——— Novi Belgii Quod nunc Novi Jorck vocatur, Novae Angliae & Partis Virginiae. Accuratissima et Novissima Delineatio.

America, by John Ogilby. London, 1671, p. 168.

14¼x11¼, outline, drainage, figures, mountain hachured. Scale about 65 miles to an inch. (⅞ in. Ger. mile.) (Peabody.)

——— Virginiae, partis australis et Floridae, partis orientalis, ... nova descriptio. Amsterdam Montanus.

America, by John Ogilby. London, 1671, p. 212. (Lenox.)

1673.

Herman, August. Virginia and Maryland As it is Planted and Inhabited this present Year 1670.

Outline, drainage, symbols. Scale 12 Eng. miles to an inch.

This contains the names of eight counties and many rivers quaintly spelled. (Md. Hist. Soc. Photolith.; also reprod. by Boundary Com., 1873.)

1675.

Roggeveen, Arent. "Pascaert vande Virginies Van Baija de la Magdelena tot de Zuijdt Revier" (Delaware river).

Het eerste deel von het Brandende Veen, verlichtende geheel West-Indien (etc.). fol. A'Amsterdam, 1675. (Phillips.)

Sellar, John. A chart of the sea coasts of New England, New Jarsey, Virginia, Maryland and Carolina, C. Cod to C. Hatteras.

His Atlas maritinius. London, 1675. (Phillips.)

1676.

SPEED, JOHN. A map of Virginia and Maryland.

The Theatre of the Empire of Great Britain, presenting an exact geography of the Kingdom of England (etc., etc.), together with a Prospect of the most famous Parts of the World, viz. Asia, Africa, Europe, America. London: printed for Thos. Bassett, 1676. Fol.

14¾x19½, symbols. (Lenox and Amer. Geog. Soc.)

1679.

DANIEL, R. A new map of the English Empire in America, viz: New England, New York, New Jersey, Maryland, Virginia, with an accurate description of those Countries. London (?) 1679 (Phillips).

1687.

MORDEN, ROBT. A New Map of Virginia, Maryland. Pensilvania. New Yarsey.

The Present State of His Majesties Isles and Territories in America. London, 1687, p. 182.

4x5, black and white. Scale about 70 miles to an inch. (Boston Public Library.)

1690 (?).

ANON. 't Noorder Gedeelte van Virginie door Bartholomeus Gosnol en Martin Pringe, ugt Engeland bevaaren.

8½x11¼, colored. Scale 110 German miles to an inch. Virginia extends to New Hampshire, no Md. (U. S. G. S.)

1690.

CORONELLI, VINCENZO. America settentrionale colle Neune Seoperte fin all 'Anno 1688 dal P Mrô Coronelli M. C.

Corso Geographico Universale, Vincenzo Coronelli M. C. Parte Seconda No. 51. In Venetia MDCXC.

34x23, symbols. Scale about 170 miles to an inch. (Amer. Geog. Soc.)

VAN NOORT, OLIVIER. Dry-Jaarige Scheep-togt der Niederlanders ouder Olivier van Noort door de Straat Magellaan om dem Gantsen.

Andkloot gedaan-public por pierre Vander Aa à Leide.

9x6. colored. Scale approximately 7 miles to an inch. Chesapeake reaches almost to the St. Lawrence. Little or no Eastern Shore. (U. S. G. S.)

1695 (?).

BINNEMAN, W. A map of ye Continent of America; viz: Virginia, Maryland, Carolina, New York, (etc). W. Binneman sculpsit. Sold by R. Morden. London. (Phillips).

THORNTON, JOHN, and FISHER, WILL. A map of Virginia, Maryland, Pennsylvania, and East and West New Jersey, by John Thornton, at the Plott in the Minories, and by Will Fisher, at ye Postern Gate, on Tower Hill, London. Same French edition, Amsterdam.

Scale one inch to 9.18 miles. (Jones, Williams, Md. Hist. Soc.)

1698.

THOMAS, GABRIEL. Pennsylvania and West Jersey.

Historical description of the Province and Country of West New Jersey in America (etc.), with maps.

See Winsor, 1884.

1700 (?).

SANSON, N. Carte nouvelle de l'Amérique Angloise, contenant la Virginie, Maryland, Caroline, Pensylvanie, Nouvelle Iorck, N: Iarsey, N: France, et les terres nouvellement decouverte dressée sur les relatione les plus nouvelles. Par le sieur S. Amsterdam. P. Mortier.

(Phillips.)

——— Carte particuliere de Virginie, Maryland, Pennsilvanie, la Nouvelle Jarsey Orient et Occidentale. P. Mortier, Amsterdam.

(Phillips.)

" An ancient map of the Province of Maryland on Vellum colored."

Mentioned in Maryland charts in the Public Record Office, Nation, vol. lv, 1892, p. 471.

1702.

CAMPANIUS, JOHAN. Virginia N. Angliae, N. Hollandiae nec non Novae Svcciae Delineatio.

Campanius Nya Swerige.

See Winsor, Nar. Crit. Hist., vol. iv, p. 485.

1705.

HARRIS, JOHN. America (north and south).

Navigautium atque Itinerantium Bibliotheca, or A Compleat Collection of Voyages and Travels. London MDCCV.

16½x14, outline, drainage, mountains hachured. (Peabody.)

1708.

MOLL, H. A new map of Virginia and Maryland.

Oldmixon, (John). The british empire in America, 12°, London for J. Nicholson, 1708, vi, p. 209.

7x10, outlines, drainage. Scale, 22 miles to an inch. (Peabody.)

——— Map of North America according to ye Newest and most Exact observations (etc) dedicated to John Lord Sommers. Printed for I. Bowles (et als). B. Lens. delin. G. Vertue, Sculp.

37x22¼, boundaries colored. Scale about 200 miles to an inch. Maryland extends to Lake Frontinac (Erie). Possibly published 1715. (U. S. G. S., Lenox.)

After 1711.

ANON. Carte Nouvelle de la Mer du Sud, dressée par ordre des Directeures, (etc). Donné au Public par And; and Henry de Leth. à Amsterdam.

36½x27½. colored, illustrated, imperfect scale. Pennsylvania, Maryland and Virginia grouped together. (Lenox.)

1714.

HOMANN, IOH. BAPT. Virginia, Marylandia et Carolina in America Septentrionali Britannorum industria excultae repraesentatie a Ioh. Bapt. Homann S. C. M. Geog. Norembergae.

Atlas Noves Terrarum Orbis Novibergae No. 27.

22½x19¼,. states colored. Scale 8 German miles to an inch. Md. extends to Hancock. (Amer. Geog. Soc.)

1715.

MOLL, HERMAN. A new and exact map of the dominions of the King of Great Britain on ye Continent of North America. Containing Newfoundland, New Scotland, New England, New York, New Jersey, Pensilvania, Maryland, Virginia and Carolina According to the Newest and most Exact observations by Herman Moll, Geographer, Dedicated to Walter Dowglass. 1715. Printed and sold by Tho. Bowles—London.

40x23¾, colored boundaries, illustrated. Scale about 50 miles to an inch. Side maps. Maryland extends to Frontignac Lake (Lake Erie). Little except along the Bay. (Lenox.)

1717.

MOLL, H. A new map of Virginia and Maryland.

Atlas Geographers; or a compleat System of Geography, 4°, in the Savoy —E. Nutt for J. Nicholson, 1717, vol. v, p. 700.

Reduced copy of Herman's map as originally published in 1708. (Phillips.)

1719.

SENIX, J. A new map of Virginia (and) Maryland and Improved parts of Pennsylvana & New Jersey, revised by I. Senix 1719 most humbly Inscribed to the Right Honble the Earl of Orkney &ct.

19¼x22, colored, symbols. Scale 13½ miles to an inch. (Peabody.)

——— A new map of the english empire in America, viz: Virginia, Maryland, Pennsylvania, New York, (etc) Revis'd by I'no Senix 1719. I. Harris sculpt.

A new general atlas (anon.) fol. London, for D. Browne, 1721, facing p. 236. (Phillips.)

1720.

Gosnal, Barth. 'T noorder gedeelte van Virginie door Bartholomeus Gosnal en Martin Pringe uyt Engeland bevaaren.

Uytgevoerd te Leyden door Pieter van der Aa (1720). (Phillips.)

Iaillot, H. America Septentrionale Divesée en Ses Principales Parties Presente a Monseigneur le Duc de Bourgogne par H. Iaillot.

22⅝x18½, symbols. Scale 200 miles to an inch. Maryland not mentioned. Virginia adjoins N. Suede. (U. S. G. S.)

Moll, H. A New Map of the North Parts of America claimed by France under y[e] Names of Louisiana, Mississippi, Canada and New France with y[e] adjoining Territories of England and Spain. The Projection of this Map is called Mercator's, And it is laid Down according to the Newest and Most Exact Observation By H. Moll. Geographer 1720. (Dedicated to Thomas Bromsall.)

24x40½, boundaries colored, illustrated. Scale about 85 miles to an inch. Maryland goes only part way to Lake Erie. (Lenox.)

Nolan, I. B. L'Amérique ou le Nouveau Continent.

22x20. Scale about 200 miles to an inch. "Miralana" is not sharply defined. (Lenox.)

1720 (?).

Seale, R. W. A map of North America With the European Settlements & whatever else is remarkable in ye West Indies from the latest observations.

R. W. Seale delin. et sculpt. (n. d.).

14½x18¼, symbols. Small scale. Maryland boundary on the south branch of the Potomac. (U. S. G. S.)

1721.

Senix, John. A New Map of the English Empire in America viz Virginia, Maryland, Carolina, New York, New Iarsey, New England, Pennsylvania, Newfoundland, New France &c. Revised by I'on Senix 1719. Most humbly inscribed to Hewer Edgly Hewer of Clapham Esq.

A new general Atlas. London, for Daniel Brown (etc.), MDCCXXI.

23x19¾, outline, colored, drainage, mountains hachured. Scale 90 miles to an inch. (Peabody.)

1722.

DELISLE, GUILLAUME. Cartes d'Amérique Dressée pour l'Usage du Roy par Guillaume Delisle . . . à Amsterdam chez Jean Cóvens et Corneille Mortier.

Also titled Amerique accuraté in Imperia Regna Status & Populas Divisa, ad Usum Ludovici XV Gaillarum Regis.

19¼x23¼, outline colored. Scale about 375 miles to an inch. Maryland represented as extending indefinitely westward and embracing present Delaware. (U. S. G. S.)

——— L'Amérique Septentrionale Dressée sur les Observations de Mrs. de l'Academie Royale des Sciences &c. à Amsterdam chez Pierre Mortier. avec privilege.

In Atlas Novum ad Usum serenissimi Burguveliae Duiss.

22½x17¾, colored. Scale about 100 French leagues to an inch. Maryland bounded on west by Pays des Illinois. (Amer. Geog. Soc.)

——— Carte de la Louisiane et du Cours du Mississippi Dressée sur un grand nombre de Memoires entr'autres sur ceux de Mr le Maire, Par Guill.me de l'Isle. à Amsterdam chez Jean Cóvens et Corneille Mortier.

23⅝x17, colored, symbols. Scale 3½ inches to 100 French leagues. Maryland bounded on south by Acconachena River, on west by summit of the mountains, on the north by Iroquois, and east by PensilVanie and Delaware Bay. (U. S. G. S.)

——— Carte du Mexique et de la Floride des Terres Angloises et des Isles Antilles (etc). à Amsterdam chez Cóvens et Mortier, 1722.
23x18½. (Lenox.) (U. S. G. S.)

DE LA POLERIE. Carte generalle de la Nouvelle France.

Histoire de L'Amérique Septentrionale.

5x6⅝, outline, drainage, mountains hachured. Scale about 500 miles to an inch. (Peabody.)

SANSON, N. Atlantis Insula a Nicolao Sanson, Amstelodami. I. Cóvens et C. Mortier.
21½x15¼. (U. S. G. S.)

About 1725.

ZÜNERI, A. F. Americae tam Septentrionalis quam Meridionalis in Mappa Geographica Delineatio (etc).

Opera A. F. Züneri, ex officina Petri Schenkii.

22¾x19⅝, colored. Scale about 200 miles to an inch. "mirlland" is not definitely bounded. (Lenox.)

1728.

ANON (?). Atlas Maritemis et Commercialis, London 1728.

Contains maps of the Chesapeake and Delaware.

1730.

Delisle. America Accurate in Imperia Regna Status & Populus-Divisa ad Usum Ludovici xv Galliarium Regis. or Carte D'Amérique Dressée pour l'Usage du Roy Par Guillaume Delisle.

23½x18¾. Maryland bounded on north. (Lenox.) Possibly another edition in 1822.

Moll, H. Virginia and Maryland.

10½x9⅞, outline colored. Scale about 18 miles to an inch. Baltimore town at Bush Creek. Small area for Delaware. (U. S. G. S.)

——— New England, New York, New Jersey and Pennsylvania. An account of ye Post of ye Continent of Nth America as they were regulated by ye Postmasters Gen. of ye Post House. No. 49.

10¾x8, colored, symbols. Scale 50 miles to an inch.

Curious winding of the Md. Del. boundary giving the southern limits of "Dellawar" near Cape Henlopen. (U. S. G. S.)

1731.

Homann, Ioh. Bapt. Virginia, Marylandia et Carolina in America Septentrionali Britainorum industria (etc). a Ioh. Bapt. Homann S. C. M. Geog. Noremborga. "Cum privilegio Sae Cas. Magist."

Bound up with something else. Grosser Atlas Nurmburg MDCXXXI. (Amer. Geog. Soc.)

Luillier, J. l'Amérique Meridionale et Septentrionale Dressée sur les Nouv^{les} Descouv.^{tes} (etc) published by Sr. Guill e Danet. Paris 1731.

Roughly drawn. (Lenox.)

Sillverling, Jonas (sculpt). Delineatio Pennsilvaniae et Caesareae Nov-Occident SeuWest N. Iersey in America.

7x10⅛ symbols. Scale 22 miles to an inch (reprod.?). (Lenox.)

1732.

Popple, Henry. Map of the British Empire in America, with the French and Spanish Settlements adjacent thereto.

Twenty sheets 19 x 27. Colored. (Winsor.) See 1733.

Anon. Lord Baltimore's Map.

Printed by B. Franklin, Phila., 1732 (?). (Williams.)

1733.

Haxton, Walter. A Merchants chart of the Chesapeake.

"To the merchants of London trading to Virginia and Maryland this mapp of the Chesapeake with the rivers Potomoch, Patapsco and part of Chester is dedicated." (Md. Hist. Soc.)

POPPLE, HENRY. A Map of the British Empire in America with the French and Spanish Settlements adjacent thereto (London 1733).

(An index map to the twenty sheet map.)

19⅛x19⅝, colored or uncolored. Scale about 200 miles to an inch. (Peabody.)

——— A Map of the British Empire in America with the French and Spanish settlements adjacent thereto by Henry Popple.

20 sheets 19x27. Scale not given.

Same base, colored or uncolored. One edition was sold by S. Hardig, etc. (Peabody.)

1735.

HAXTON, WALTER. To the Merchants of London Trading to Virginia and Maryland This mapp of the Bay of Chesapeack with the Rivers Potomack, Patapsco North East and part of Chester, Is humbly dedicated & Presented by Walter Haxton 1735.

56x36, outline. (Peabody.)

SENEX, JOHN. A map of Virginia, according to Capt. Iohn Smith's map published anno 1606 Also Of the Adjacent country called by the Dutch Niew Nederlant, anno 1630, by Iohn Senex, 1735.

(Winsor.)

——— Maryland according to the bounds mentioned in the charter and also of the adjacent country, anno 1630, London 1735.

(Probably same as preceding.) (Winsor.)

1736.

MOLL, H. Virginia and Maryland.

Atlas minor obl. fol. London for T. Bowles and J. Bowles, 1736, No. 50.

A reduced copy of Herman's Map. See 1708 and 1717. (Phillips.)

1737.

[BYRD, WM., ET ALS.] A Survey of the Northern Neck of Virginia, etc. with the Courses of the Rivers Rappahannock and Potowmack in Virginia as surveyed according to Order in the Years 1736 & 1737.

11⅝x13⅞, outlines. Scale 14 miles to an inch. Course of Potomac, St. Mary's to head. See Lewis, 1745. (Lenox.)

——— The courses of the Rivers Rappahannock and Potowmack in Virginia, as surveyed according to order in the years 1736-1737.

12x14 inches. See Wm. Byrd, History of the dividing line. Gives S. shore of Maryland. Same as preceding, but different title. (Peabody.)

1738.

ANON. A new map of Virginia, humbly dedicated to Thomas Lord Fairfax 1738.

13x8½, facsimile Winsor Narrative and Crit. Hist., iv, p. 275.

1740.

ANON. A map of Parts of the Provinces of Pennsylvania and Maryland, with the counties of New Castle, Kent, and Sussex in Delaware according to the most exact surveys yet made, drawn in the year 1740. London. (Chancery Proc.)

Pub. sep. (Winsor.)

BAKEWELL, THO. America, a new and most exact Map laid down according to the observations communicated to the English Royal Society, the French Royal Academy of Sciences, (etc.) Printed and sold by Tho. Bakewell.

23⅜x19⅜, boundaries colored. Poor drawing of Chesapeake. (U. S. G. S.)

1741.

ECHARD, LAWRENCE. Gazetteer, or Newmans Interpreter, being a geographical Index of all the Empires, Kingdoms, Islands etc, in Africa, Asia and America. London. 1741.

"New York is made to join Maryland." (Winsor Nar. and Crit. Hist., vol. iv, p. 235.)

1745.

LEWIS, THOS. A survey of the Northern Neck of Virginia, being the lands belonging to the Rt. Honourable Thomas Lord Fairfax, Baron Cameron, bounded by and within the Bay of Chesapoyocke, and between the Rivers Rappahannock and Potowmack.

Facsimile in Winsor's Nar. and Crit. Hist., vol. iv, p. 277, probably a corrected copy of Byrd's 1737, as they were both of the same commission.

Pt. Tobacco to Pt. Lookout is equal to 3 inches. See 1737. (Amer. Geog. Soc.)

1746.

D'ANVILLE. Amérique Septentrionale Publiée sous les auspices de Monseigneur le Duc d'Orleans—Prémier Prince du Sang. Par le Sr. d'Anville. MDCCXLVI, avec privilege.

Theatre du Monde a Paris chez le Sr. Julien.

32⅝x34, hachured, drainage. Scale 100 miles to an inch. (Peabody.)

1747.

Bowen, Eman. A new and accurate map of Virginia & Maryland. Laid down from surveys and regulated by astron'l Observat'ns.

A complete system of geography. fol. London, for W. Inns, 1747, vol. ii, p. 647. (Phillips.)

1750.

Garvin. A map of Virginia and Maryland.

London, 1750. (Phillips.)

Vaugondy, Robert de. Amérique Septentrionale dressée sur les Relations les plus modernes des Voyageurs et Navigateurs, et divisée suivant les differentes possessions des Européens. Par le Sr. Robert de Vaugondy, fils de Mr. Robert, Géographe ordin. du Roy. avec Privilege: 1750.

23x18¾, colored. Scale 240 miles to an inch.

Maryland embraces Delaware. (U. S. G. S.) (Lenox.)

1751.

Fry, Joshua, and Jefferson, Peter. Map of the " most " (written in on Lenox copy) Inhabited Part of Virginia, containing the whole Province of Maryland, with Parts of Pensilvania, New Jersey and North Carolina. Drawn by Joshua Fry and Peter Jefferson in 1751. Engraved by Th. Jeffrys. London 1751. 4 sheets.

30x48, boundaries colored, mountains hachured, symbol. Scale 10½ miles to an inch. (Lenox.)

French edition, 1755.

1752.

Bowen, Eman. A new and accurate map of Virginia & Maryland. Laid down from Surveys and regulated by Astron'l Observat'ns.

A Complete atlas. fol. London, for W. Innys, 1752, No. 59.

(Same as Bowen, 1747). (Phillips.)

Buache. Carte des Terres nouvellement connues au Nord de la Mer du Sud tant du Côte de l'Asie du Côte de l'Amérique.

(Winsor.)

Guittard, (Jean Etienne). Carte Minéralogique où l'on voit la nature des terrains du Canada et de la Louisiane. (made by Buache).

Accompanying " Mémoire dans lequel on compare la Canada à la Suisse par rapport à ses mineraux." Histoire de l'Académie Royale des Science. 4°. Paris, 1752, p. 189, plate vii. * (Marcou.)

1754.

Cresap, Thos. (?) Original MS. map of the course of the Potomac.

(Reprod.) Md. Hist. Soc. Fund Pub. No. 29, appendix D.

1755.

D'ANVILLE, SR. Canada, Louisiane et Terres Angloises par le Sr. d'Anville Novembre MDCCLV sous le privilege de l'Académie.

Theatre du Monde, Paris, chez St. Julien.

44½x34¼, outline, drainage, mountains hachured. Scale about 45 miles to an inch. (Peabody.)

———Canada, Louisiane et Terres Angloises Novembre MDCCLV 2 sheets In Atlas du Sr D'Anville.

25x15¾, for the sheet containing Maryland, mountains hachured. Scale 50 miles to an inch. (Amer. Geog. Soc.)

——— North America From the French of Mr. D'Anville Improved with the Back Settlements of Virginia and Course of Ohio illustrated with Geographical and Historical remarks.

Pub. by Thos. Jefferys, London, 1755.

20x18. Scale about 105 miles to an inch. Maryland as at present outlined. (Lenox.)

BALDWIN, R. A map of Virginia, north and south Carolina, Georgia, Maryland, with a part of New Jersey (etc.). London 1755. (Phillips.)

DALRYMPLE, J. A map of Northern Virginia, Delaware, New Jersey, Southern Pennsylvania and Maryland. London Jan. 1, 1755.

"From information collected on the spot and entered in his journal." 2 folio sheets, colored. (Md. Hist. Soc.)

EVANS, LEWIS. A general map of the middle british colonies in America viz: Virginia, Mariland, Delaware, Pensilvania (etc).

Evans' geographical, historical, political, philosophical and mechanical essays. 4°. Phila.: B. Franklin & D. Hall, 1755.

27½x20½, sometimes colored, reprinted in London, 1756 and 1771. (Peabody?)

FRY, JOSUE et JEFFERSON, PIERRE. Carte de la Virginie et du Maryland, Dressée sur la grande carte Angloise de Mrs. Josue Fry et Pierre Jefferson. Par le Sr. Robert de Vangondy. Géographe ordinaire du Roi. 1755.

Atlas Universal (Grand Vangondy). fol. Paris, 1757.

19x25, colored, coast and bay creeks. Scale 12 miles to an inch. Baltimore on Bush river. Six counties named. (Lenox.)

HUSKE, JOHN. A new and accurate map of North America (wherein the errors of all preceding British, French, and Dutch maps respecting the rights of Great Britain, France and Spain and the limits of each of His Majesty's Provinces are corrected) by Huske, London. 1755.

Present state of North America, 2nd edit., London, 1755.

This is small in scale, but shows Maryland bounded as at present with Virginia, Pennsylvania, North Carolina, Georgia and South Carolina, extending indefinitely westward. (Winsor.)

Mitchell, John. A map of the British Colonies in North America, with the roads, distances, limits and extent of the settlements. Six sheets. London 1755.

(Winsor, Nar. and Crit. Hist., iv, p. 83.)

Mitchill, Jno. A Map of the British and French Dominions in North America with the Roads, Distances, Limits, and Extent of the Settlements. [etc.] London 1755.

Six sheets, was originally drawn in 1750 and then revised. (Reprod. 1873.) (Boston Public Library.)

Society of Anti-Gallicans. A new and accurate map of the English Empire in North America, representing their Rightful claim, as confirmed by charters and the formal Surrender of their Indian Friends, likewise the Encroachments of the French. London 1755.

See Winsor, Nar. and Crit. Hist., iv, p. 235.

De Vaugondy, Robert. Partie de l'Amérique Septentrionale qui comprend le Cours de l'Ohio, la N'lle Angleterre, la N'lle York, le New Jersey, la Pensylvania, le Maryland, la Virginie, la Caroline.

23½x18¾. Scale about 35 miles to an inch.

Maryland extends about to Cumberland. (Lenox.) (U. S. G. S.)

1756.

Anon. An exact Platt of Baltimore Town in Baltimore County, Md.

(Md. Hist. Soc.)

Evans, Lewis. A general map (etc.), see 1755.

1757.

Anon. Carte de la Virginie de la baye de Chesapeack et pays voisins, pour servir à l'historie générale des voyages. (Phillips.)

Anon. L'Amérique Septentrionale Dressée sur les Mémoires le plus récens des meilleurs Geographes & publiée par Cóvens & Mortier à Amsterdam.

23½x18, symbols. (U. S. G. S.)

D'Anville. L'Amérique Septentrionale, Dressée sur les Mémoires le plus récens des meilleurs Geographes & publiée par Cóvens & Mortier à Amsterdam MDCCLVII, atlas Homannianus.

Amsterdam MDCCLVII, atlas Homannianus.

23½x18. (Amer. Geog. Soc.)

Popple, Henry. A Map of the British Empire in America with the French, Spanish and the Dutch Settlements adjacent thereto by Henry Popple. Printed at Amsterdam for I. Cóvens and C. Mortier. (Certified to by Edm. Halleij.)

18½x19⅝, drainage, mountains hachured. Illustrated. Maryland not separated from Pennsylvania. (U. S. G. S.)

1758.

Anon. Carte de la Louisiane, Maryland, Virginie Caroline, Georgie, avec Partie de la Floride a Amsterdam chez Cóvens & Mortier 1758. (C. Lepp scult).

23⅛x15½, boundary colored, mountains hachured. Scale about 33 miles to an inch. (Lenox.)

Anon. Carte de la Louisiane, Maryland, Virginie, Caroline, Jarsey. Sold by William Mount & Thos. Page. Tower Hill.

The English Pilot, fourth book fol. London, 1758, facing p. 23.

"Hermann's map, with some alterations," 20x31. (Amer. Geog. Soc.)

Anon. Karte von der bay Chesapeack und den benach barten landen.

Allgemeine historie der reisen zu wasser und lande. 4°. Leipsig: Arkstie & Merkus, 1758, vol. xvi, p. 538.

Same map in the French edition "Histoire générale des voyages," 7½x11. (Phillips.,

Evans, Lewis (and I. Gibson). A general map of the middle british colonies in America, viz Virginia, Maryland, Delaware (etc) Carefully copied from the original published at Philadelphia by Mr. Lewis Evans 1755 with some improvements by I. Gibson. (London 1758) (Phillips).

Evans, Lewis (and Thos. Jeffrys). A general map of the middle british colonies in America viz. Virginia, Maryland, Delaware (etc) By Lewis Evans. Corrected and improved by Thos. Jeffreys. London. R. Sayer & T. Jeffrys 1758.

A general topography of North America and the West Indies, 1768, No. 32. (Phillips.)

1759.

Homann, Ioh. Bapt. Virginia, Marylandia et Carolina in America Septentrionali Britannorum industria excultae repraesentatae a Ioh. Bapt. Homann S. CM. Geog. Norumbergae.

Atlas geographicus maior fol. Norumbergae curantibus Homannianis heredibus, 1759.

1760.

ANON. Indenture of Agreement, 4th. July, 1760, Between Lord Baltimore and Thomas and Richard Penn Esquires, settling the limits and boundaries of Maryland, Pennsylvania, and the Three Lower Counties of New Castle, Kent, and Sussex. Phila. 1851 (?) folio 31 pp. and maps. Printed privately for Edward D. Ingraham.
Winsor Nar. and Crit. Hist. iii, p. 514.

ANON. A new and accurate Map of the Province of Virginia in North America. (after Fry?)
13x11, outline, drainage, mountains hachured. Scale about 20 miles to an inch. Curious boundary of Maryland. (U. S. G. S.)

ANON. A new map of the Province of Maryland in North America.
Gives Maryland boundary on south branch of Potomac (same source as one of Virginia). 13x11¾.

D'ANVILLE (and THOMAS JEFFRYS). North America, from the french of Mr. D'Anville, Improved with the back settlements of Virginia and course of Ohio. Illustrated with geographical and historical remarks.
The natural and civil history of the French dominion in North and South America, by Thos. Jefferys, fol. London, 1760, facing p. 134. (Phillips.)

1760.

BOWEN, E. A new and accurate Chart of the West Indies with the Adjacent Coasts of North and South America by Eman. Bowen.
14x17½, outline, drainage, etc. 1740 on the map. (U. S. G. S.)

——— A map of the British American Plantations, extending from Boston in New England to Georgia, including all the back settlements in the respective Provinces as far as the Mississipi.
11x9¾. Scale 100 miles to an inch. Maryland embraces Delaware and extends to Lake Erie. (U. S. G. S.)

1760 (?).

KITCHIN, T. North America, Drawn from the Best Authorities by T. Kitchin.
8¾x7½. (U. S. G. S.)

1762 (?).

ANON. Mar del Nort.
21x16¾. A curious distribution of provinces, Maryland and Pennsylvania not mentioned. (U. S. G. S.)

1762.

ANON. Carte de la Virginia, Maryland, etc., tirées des meilleures cartes angloises (Bellin, Paris 1762) (Phillips).

1763.

ANON. A new & Accurate Map of North America Including the British Acquisitions gained By the late War. 1763.

9x7½, outlines. Scale about 200 miles to an inch, Maryland not bounded. (Lenox.)

ANON. An Accurate Map of the British Empire in Nth-America as settled by the Preliminaries in 1762. J. Gibson Sculp.

Gent. Mag., 1763 (?).

9½x8¼, political area shaded. Scale 250 miles to an inch. (U. S. G. S.)

BOWEN, E. Accurate map of N. America after the Treaty of Paris.

(Williams.)

1767 (?).

MASON and DIXON.

(Williams, Md. Hist. Soc.)

1767.

(HERMANN, A.) Virginia, Maryland, Pennsylvania East and West New Jarsey. Dublin. Sold by Geo. Grierson at the Two Bibles in Essex Street.

The English Pilot. The fourth book fol. Dublin: B. Grierson, 1767, after p. 24.

Same map in London ed., 1758, Hermann's map. (Phillips.)

1768.

FRY, JOSHUA & JEFFERSON, PETER. A map of the most inhabited part of Virginia containing the whole province of Maryland etc.

A general topography of North America and the West Indies. fol. London, for R. Sayer and T. Jeffery, 1768, Nos. 54-57. (Williams) (Winsor) (Phillips).

1770.

ANON. Accompanying (Report on Canals and Roads).

Trans. Amer. Phil. Soc., Phila., n. s. vol. i, 1770.

Outline of river courses and surveyed distances. Scale about 7 miles to an inch.

1772.

(D'ANVILLE.) A map of the whole continent of America divided into North and South and West Indies with a Copious Table (etc). Compiled from Mr. D'Anvilles maps of that continent 1772. London pub. by Robt. Sayer. Apr. 1772.

41x46, mountains hachured, symbols. Maryland stops at Hancock. (Lenox.)

1774.

DUNN, SAM'L. North America as Divided amongst the European Powers By Samuel Dunn, Mathematician. London Robt. Sayer. 1774.

17½x12. Shows Maryland extending west to present limits. (Lenox.)

1775.

FRY, JOSHUA & JEFFERSON, PETER. A Map of the most Inhabited part of Virginia containing the whole Province of Maryland with Parts of Pensilvania, New Jersey and North Carolina. Drawn by Joshua Fry & Peter Jefferson in 1775.

Dedicated to the Earl of Halifax, (et als.)

The American Atlas. London, 1778, Sayer & Bennett.

50x31 hachured. Scale nearly 10 miles to an inch. Maryland practically all of Delaware and north of Lancaster, Pa. No western boundary drawn to state, but "Lord Fairfax his boundary line" is given. (Amer. Geog. Soc.)

EVANS, LEWIS (and JEFFRYS, THOS.). A general Map of the Middle British Colonies in America, viz., Virginia, Maryland, Delaware, Pensilvania, New Jersey, New York, Connecticut and Rhode Island (etc.)

Published by Lewis Evans, Phila., corrected and improved with additions by Thos. Jefferys. In American Atlas, by Thos. Jefferys, No. 18, London, 1755. Sold by R. Sayer in Fleet Street, and T. Jefferys, Charing Cross.

26¼x19, colored, symbols. Scale 36 miles to an inch.

Baltimore in present location, western boundary uncertain. (Peabody.)

LODGE, JNO. A map of the American indian nations, adjoining Mississippi, West and East Florida, Georgia, S. & N. Carolina, Virginia &c. Jno. Lodge sculp.

The history of the American Indians, by James Adair. 4°. London, for Edward and Chas. Dilley, 1775.

12¾x9½, outline, drainage, mountains hachured. Scale about 52 miles to an inch. (Peabody.)

1776.

ANON. The Theatre of War in North America with the Roads, and Tables, of the Superficial Contents, Distances, &ca. By an American. London. 1776.

15¾x19½, hachured. Scale about 100 miles to an inch. (Boston Public Library.)

POWNALL, I. Topographical description of such parts of North America as are contained in the (annexed) map of the British middle colonies, (etc.), in North America. London, 1776. (J. Almon).

Based on Evans' map (1775).

(See other reference.) (Williams.)

——— General map of Middle British Colonies in America containing Virginia, Maryland, the Delaware counties, Pennsylvania and New Jersey. (etc) corrected from Gov. Pownall's late map 1776. London for R. Sayer & J. Bennett 15 Oct. 1776.

The American military pocket atlas. 8°.

25x19, boundaries, colored. Scale 35 miles to an inch. Western boundary a little different from that at present. (Lenox.)

SMITH, ANTHONY. A New and Accurate Chart of the Bay of Chesapeake with all the Shoals, Channels, Islands, Entrances, Soundings and Sailors marks, as far as the Navigable Part of the Rivers Potowmack, Patapsco and North East. Drawn from several Draughts made by the most experienced navigators, chiefly from those of Anthony Smith, Pilot of St. Mary's.

38x54, colored, symbols. Scale 3½ miles to an inch. Baltimore on Bush river. (Lenox.)

1777.

FADEN, WM. The British Colonies in North America. Engraved by William Faden, MDCCLXXVII.

The North American Atlas. London. Printed for William Faden, 1777. (Lenox.)

1777.

KITCHIN, SEN. THOS. Seat of War in the Environs of Philadelphia. London Magazine 1777.

10x7½, outlines. Scale 10 miles to an inch. Map includes Cecil county. (Lenox or Amer. Geog. Soc.)

1778.

CHURCHMAN, J. "To the American Philosophical Society This Map of the Peninsula Between Delaware & Chesapeake Bay with the said Bays and Shores adjacent drawn from the most accurate Surveys is inscribed by John Churchman." Published without place or date. (Phillips.)

HUTCHINS, THOS. A New map of the western parts of Virginia, Pennsylvania, Maryland and North Carolina; (etc) by Thos. Hutchins.

44½x35½, symbols. Scale 20 miles to an inch. Gives Maryland west of Williams Ferry. (Amer. Geog. Soc.)

LE ROUGE, GEO. L. Virginie, Maryland en 2 feuilles par Fry et Jefferson. Traduit, corregé, augmenté.

Atlas Amériquain Septentrional. fol. Paris, Le Rouge 1778-(1792?), No. 16. (Phillips.)

RUSSELL, WM. An Exact Map of New Jersey, Pensylvania, New York, Maryland & Virginia from the latest Surveys.

The History of America, by Wm. Russell. 4°. London, 1778, vol. ii, p. 267.
9¾x7⅞, outlines, mountains hachured. Scale about 38 miles to an inch.
(Possible modified reproduction of Fry & Jefferson.) (Lenox.)

SARTINE (?). Carte reduite des côtes orientales de l'Amérique Septentrionale, contenant partie due Nouveau Jersey, la Pensylvanie, le Mary-land, la Virginia, la Caroline Septentrionale, la Caroline Méridionale et la Georgie, (etc). Dressée au dépôt général des cartes, plans et journax de la marine. Par ordre de M. de Sartine 1778.

Hydrographie françoise, par Jacques Nicolas Bellin. fol. Paris, 1737-1778, vol. ii. (Phillips.)

SMITH, A. Carte de la baie de Chesapeake et de la partie navigable des rivières James, York, Patowmack, Patuxent, Patapsco, North-East, Choptant et Pokomack. Redigée pour le service des vaissance du roi, par ordre de M. de Sartine d'apres des plans anglois et particulierement ceux d'Antoine Smith, 1778.

(See also Smith, 1776, 1794, etc.) (Phillips.)

1775-1780.

ANON. Part of North America comprehending The course of the Ohio, New England, New York, New Jersey, Pennsylvania, Maryland, Virginia, Carolina & Georgia.

11⅝x8½, outlines (reproduction with reduction (?) of an earlier map. Lenox).

1780 (?).

CONDER, THOS. North America agreeable to the Most approved maps and Charts by Thos. Conder.

13x14¾, outlines. Small scale. (Lenox.)

1780.

LODGE, JNO. A new and accurate map of Virginia and part of Maryland and Pennsylvania.

The Political Magazine. 8°. London, for J. Bew, 31 Dec., 1780, p. 787. (Phillips.)

PRESBURY, G. G. Plan of Baltimore (MS).

25x17, outline of small area about Baltimore and Calvert streets. "Scale of twelve miles in one inch." (Md. Hist. Soc.)

1781.

Hutchins, Thos. Partie occidentale de la Virginie, Pensylvania, Maryland, et Carolin Sept'le la rivière d'Ohio (etc). Par Hutchins capitaine anglais Paris, le Rouge, 1781. (Eng. edit. 1778.)

19x23. (Phillips.)

1782.

Hilliard. Carte de la Virginia, du Maryland et de l'état de Delaware.

Essais historiques et politique sur les Anglo-Americans, par Michel René Hilliard d'Aubertenil. Gravures et cartes. 4°. Bruxelles, 1782, pl. v. (Phillips.)

1783.

Pownall. A new map of North America, with the West India Islands, divided according to the Preliminary Articles of Peace, signed at Versailles 20 Jan. 1783. Laid down according to the Latest Surveys and corrected from the Original Materials of Governor Pownall. Memb^{r} of Parlia^{mt} 1783.

46x40, on two sheets, colored. Scale 75 miles to an inch. Maryland distorted too short east and west. Published 1786.

1784.

Faden, Wm. The United States of North America: with the British Territories, and those of Spain, according to the Treaty of 1784. Engraved by Wm. Faden, 1793.

27x28, hachured. Scale about 100 miles to an inch. (Boston Public Library.)

Lattré. Carte des Etats-Unis de l'Amerique suivant le Traité de Paix de 1783 Dédiée et Presentée a S Excellence M^{r} Benjamin Franklin. . . . 1784.

29⅝x20¾. hachured. Scale 75 miles to an inch. (Boston Public Library.)

After 1784.

D'Anville. America Septentrionalis a Domino d'Anville in Gallius edita nunc in Anglia Coloniis in Interiorem Virginiam deductis etc. Norinbergae A° 1777.

Atlas Homannianus, vol. iv.

19½x18, lines colored. Scale about 100 miles to an inch. (Amer. Geog. Soc.)

1785.

Anon. Carte génerale des Treize États Unis de l'Amérique Septentrionale à Amsterdam chez C. Mortier & J. Cóvens et Fils.

Scale 113 miles to an inch. (U. S. G. S.)

BAILEY, FRANCIS. A map of the United States of N. America. Philadelphia 1785.

Outlines, 6½x5. Shows state divisions and poor map of the Chesapeake. Republished in McCulloh, Introduction to the History of Amer., 1787.

1786.

ANON. Nouvelle Carte de l'Amérique avec tous ses Royaumes, États, Iles, (etc) published by Pierre Vander, Aa, Marchand, Libraire à Leide. (U. S. G. S.)

SAYER, ROBT. A new map of the whole continent of America, divided into North and South and West Indies, wherein are exactly described The United States of North America as well as the several European Possessions according to the Preliminaries of Peace signed at Versailles, Jan. 20, 1783. Compiled from Mr. D'Anville's maps of that continent with the addition of the Spanish Discoveries in 1775 to the north of California and corrected in the several Parts belonging to Great Britain from the original materials of Governor Pownall M.P. London. Printed for Robt. Sayer 1786.

40x36, outline, symbols. Scale 4⅜ inches to 1000 miles. No streams except the Patomak and no western boundary. Annapolis only town given. (U. S. G. S.)

1787.

ANON. Carte génerale des états de Virginie, Maryland, Delaware, Pensilvanie, (etc) d'après la carte amériquaine de Louis Evans et la carte anglaise de Thomas Jefferys. Gravé par P. F. Tardieu.

Letters d'un cultivateur américain, par J. Hector saint John de Crèvecoeur. 8°. Paris, 1787, vol. ii, front. (Phillips.)

ANON. A map of the country between Albemarle sound and lake Erie, comprehending the whole of Virginia, Maryland, Delaware and Pensylvania, with parts of several others of the United States of America.

Notes on the state of Virginia, by Thos. Jefferson. 8°. London, for J. Stockdale, 1787. Based on Fry and Jefferson. (Phillips.)

The Peabody copy contains "The State of Virginia from the best authorities, by Samuel Lewis, 1794," from Cary's American edition of Guthrie's Geography.

FADEN, WM. The Marches of Lord Cornwallis in the Southern Provinces, now States of North America; Comprehending the Two Carolinas with Virginia and Maryland, and the Delaware counties, By William Faden. London 1787.

A History of the Campaign of 1780 and 1781 in the Southern Provinces of North America, by Banastre Tarleton. 4°. London, for T. Cadell, 1787.

Also published separately? (Phillips.)

1790.

Lotter, Matthieu Albert. Carte Nouvelle de l'Amérique Anglois, contenant de l'Amerique septentrionale savoir le Canada la Nouvelle Ecosse ou Acadie les treize Provinces Unies qui font: les quartres Colonies, (etc). Gravée exactement d'apres les determinations géographique dernierement faites par Matthieu Albert Lotter à Augsbourg.

19¼x23⅜, colored, symbols, few towns. Scale 10 leagues to an inch. Maryland ends at Hancock and includes Delaware; shore line but little indented. (U. S. G. S.)

Lotter, Tob. Cour. Pensylvania Nova Jersey et Nova York cum Regionibus ad Fluvium Delaware in America Sitis, nova Delineatione ob oculas posita per Tob. Cour. Lotter, Geographium. Aug. Vind.

22½x19½, states, colored, symbol. Scale 16 miles to an inch. Curious distribution of state lines. Maryland extends to Hancock. (Amer. Geog. Soc.)

1791.

Evans, Lewis. New Pocket Map of the following Independent States of North America. Virginia, Maryland, Delaware, Pennsylvania, New Jersey, New York, Connecticut, Rhode Island.

Bowles's Universal Atlas. London, 1791 (?). fol. (Amer. Geog. Soc.?)

1792.

Folie, A. P. Plan of the Town of Baltimore and Environs. Dedicated to the Citizens of Baltimore. Taken upon the spot by their most humble Servant A. P. Folie, French Geographer. James Poapard sculpsit, Phila.

25x28, outline. Scale 40 perches to an inch.

1793.

Miñoz, J. B. Mapa del Nuevo-Mundo.

Historia del Neuvo-Mundo eseribiala D. Juan Bant Miñoz Tome I, Madrid, MDCCXCIII.

12½x14¾, outline, maps of both continents. (Peabody.)

1794.

Holland, N. A New chart of the Coast of North America from New York to Cape Hattaras including the Bays of Delaware and Chesapeak with the coasts of New Jersey, Maryland, Virginia, and

Parts of the coast of North Carolina, By Captain N. Holland. London Laurie & Whittle 1794.

North American Pilot, second part. London, Laurie & Whittle, 1807 and 1800.

41x28, outline. Scale about 15 miles to an inch.

LEWIS, SAMUEL. The State of Virginia from the Best Authorities By Samuel Lewis 1794.

Notes on the State of Virginia, by Thos. Jefferson. 8°. London, for J. Stockdale, 1787. Boston, Lilly & Wait, 1832.

Map is from Carey's Amer. edit. of Gunthries' Geography. (Peabody.)

POWNALL. A new map of North America with the West Indian Islands Divided according to the Preliminary articles of Peace, Signed at Versailles, 20 Jan. 1783. . . . Laid down according to the Latest surveys and Corrected from the Original materials of Gov. Pownall. Memb^r^ of Parlia^mt^. London. Published by Laurie & Whittle 53 Fleet St. 12 May 1794.

A new Universal Atlas, 3rd edit., by Thomas Kitchin. London, 1799.

2 sheets each 20x45½, boundaries colored. Scale 87 miles to an inch. (Peabody.)

RUSSELL, J. An Accurate Map of the United States of America according to the Treaty of Peace of 1783. London, H. D. Symonds 1794.

18¾x14⅝, colored states. Scale about 100 miles to an inch. (Lenox.)

SMITH, ANTHONY. A New and Accurate Chart of the Bay of Chesapeake (etc).

North American Pilot, second part. London, 1794. Robt. Sayer and John Bennett.

38x54, colored, symbols. Scale 3½ miles to an inch. Baltimore on Bush river.

1795.

ANON. Map of the Northern & Middle States Comprehending the Western Territory & the British Dominions in North America. From the best Authorities.

14¾x11¾, outline, drainage, mountains. Scale about 100 miles to an inch. (U. S. G. S.)

GRIFFITH, DENNIS. Map of the State of Maryland, laid down from an actual survey of all the principal waters, public roads and divisions of the Counties therein; etc. by Dennis Griffith June 20 1794—. Phila. pub. June 6, 1795 by J. Vallance, Engraver.

52x30, outline, road map, mountains hachured. Scale 4¼ miles to an inch. (Md. Hist. Soc.)

——— Map of the state of Maryland and of the Federal Territory as also of the State of Delaware. Philadelphia. (J. Vallanee). 3 large sheets. (Williams).

LEWIS, SAMUEL. Maryland.

Carey's General Atlas improved and enlarged No. 16. Phila., 1795.

16½x11⅝, counties colored, hachured. Scale 12 miles to an inch. New map unlike other editions, does not include Delaware. See 1794.

PURCELL, JOSEPH. A map of the States of Virginia, North Carolina, South Carolina and Georgia. Comprehending the Spanish Provinces of East and West Florida (etc).

14x11½, outline, drainage and boundaries. Scale 100 miles to an inch. (U. S. G. S.)

RUSSELL, J. Map of the southern states, comprehending Maryland, Virginia, Kentucky territory s'th of the Ohio, (etc) By J. Russell.

An American Atlas, by J. Russell. fol. London, H. D. Symond, 1795, No. 7. (Phillips.)

SCOTT, JOSEPH. Maryland.

The United States Gazetteer. 16°. Phila., 1795. (Phillips.)

VALLANCE. (Map of Maryland with plan of Washington). Phila. 1795.

53x30. (Winsor.) Probably Griffith's map.

1797.

SOTZMANN, D. F. Maryland and Delaware von D. F. Sotzmann. (Williams.)

1798.

SMITH, ANTHONY. A new and accurate Chart of the Bay of Chesapeak including Delaware Bay (etc).

North Amer. Pilot. fol. Boston, 1798.

(See Smith, 1776.) (Phillips.)

1799.

ANON. Plan of Baltimore. (Md. Hist. Soc.)

HANDUCOEUR, C. P. Map of the Head of Chesapeake Bay and the Susquehanna River, with a plan of the town of Havre de Grace. (Phillips.)

1800.

HOLLAND, N. A new chart of the Coast of North America (etc).

North American Pilot, 2nd part, new edit. fol. London, R. Laurie & J. Whittle, 1800, No. 9. (Phillips.)

Klockhoff, H. A chronographical map of the Country round Philadelphia. H. Klockhoff, sculps. Amsterdam, Cóvens et Mortier et Cóvens, Jr.

12½x11⅛. Scale 12½ miles to an inch. (Lenox.)

About 1800 (?).

Delisle. America Septentrionalis (Lenox).

Evans and Jeffrys. Carte générale des États de Virginie, Maryland, Delaware, Pennsylvanie, Nouveau Jersey, New York etc. d'après la carte de L. Evans et Th. Jefferys.

(Williams.) See 1787.

Lea, Philip. A new map of New England, New York, New Iarsey, Pensilvania, Maryland and Virginia. Sold by Geo. Willdey (?), London.

21x17¾ outline. Scale 10 miles to an inch. Somewhat distorted. No mts. south of the bay. (Amer. Geog. Soc. ?)

Neale, S. J. Map of the Country between Albemarle Sound—Lake Erie, including the whole of Maryland, Virginia etc. London. engraved by S. J. Neale.

Jefferson's Notes on Virginia [different editions].

Ottens, R. J. Carte des Possessions Angloises Francoises du continent de l'Amérique Septentrionale à Amsterdam chez Ret J. Ottens.

22⅛x16⅛, colored. Scale about 110 miles to an inch. Maryland as at present. (Lenox.)

Russell, J. Plan of the City of Washington in the Territory of Columbia ceded by the States of Virginia and Maryland to the United States of America and by them established as the Seat of Government after the year 1800. Russell, sculp.

Scale 100 poles to an inch. (Lenox, Amer. Geog. Soc.)

Smith, Anthony. A new and accurate chart of the bay of Chesapeake, with shoals (etc).

North American Pilot, 2nd edit. fol. London, R. Laurie & J. Whittle, 1800, No. 11-12. (Phillips.)

Trebout, C. New Map of Georgia, Carolina, Virginia, and Maryland. C. Trebout sculp. New York. (Williams.)

1801.

Warner & Hanna's Plan of the City and Environs of Baltimore, Respectfully dedicated to the Mayor, City Council & Citizens thereof by the Proprietors. Republished by Lucas Bros. 1870.

19x28½, drainage, figures. Scale 40 perch to an inch. (Peabody.) (Md. Hist. Soc.)

1803.

ANDERSON and GILPIN. "Two maps of the survey between the Chesapeake and Delaware."

Mentioned in Minutes of Proc. Amer. Phil. Soc., Phila., 1744-1838, Proc. Amer. Phil. Soc., xxii (2), p. 345.

1804.

LEWIS, SAMUEL. The State of Maryland, from the best authorities.

Carey's General Atlas No. 35. Phila., 1804 (not in English edit.).

16¼x11¼, outline, symbols. Scale 11 miles to an inch. (Amer. Geog. Soc.)

1806.

ANON. Carte de la Virginie, du Maryland et de l'état de Delaware (1806).

(Phillips.)

1807.

MENTELLE (E.) et CHAULAIRE (P. G.). Carte Générale des États Unis de l'Amérique Septentrionale renfermant aussi quelques Provinces Angloises adjacentes.

Atlas Universal par Mentelle et Chaulaire No. 133. Paris, 1807.

16¾x12⅝, outline and drainage. Scale about 120 miles to an inch. Curious boundaries of Maryland, Hancock south to Rappahaunock. (See next map.) (Peabody.)

——— Carte de la Caroline Meridionale et Septentrionale et de la Virginie.

Atlas Universal de Geographie, physique et politique, anciene et modern No. 135, par Mentelle et Chaulaire. Paris, 1807.

17x12⅝, mountains hachured. Scale 47 miles to an inch.

Maryland includes S. shore of Rappahannock (Peabody) (next map preceding has western limit from Hancock S. to Rappahanuock.)

SCOTT, JOSEPH. Maryland.

A geographical description of the State of Maryland and Delaware. 12mo. Phila., Kimber, Conrad & Co., 1807.

Small map showing the location of twenty-one towns. (Boston Public Lib.)

1808.

CARY, JOHN. A new map of Part of the United States of North America containing those of New York, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island, Pennsylvania, New Jersey, Delaware, Maryland and Virginia from the latest Authorities.

Cary's New Universal Atlas, London, 1808.

20⅝x18, states colored. Scale about 48 miles to an inch. Maryland bounded on west by "Yohogany River." (Amer. Geog. Soc.)

1809.

Maclure, Wm. Map of the United States of Ameriea, (ete).

Accompanying "Observations," etc., in Trans. Amer. Phil. Soc., vol. vi, Phila., 1809, p. 411. (Marcou.)

1811.

Maclure, Wm. Cartes des États-Unis de l'Amérique-Nord pour servir aux observations géologiques.

Jour. de Phys., de Chim. et d'Hist. Nat., vol. lxxii. Paris, 1811. (Marcou.)

Howell, Reading. A map of the State of Pennsylvania. Kimber & Conrad, Phila. 1811.

34½x31½, counties and hachures. Scale 10 miles to an inch. Includes Maryland north of Baltimore. (Amer. Geog. Soc.)

1813.

Griffith, Dennis. Map of the state of Maryland and of the Federal Territory as also of the state of Delaware. 2nd. Edition J. Melish. Phila. 1813.

(See 1795.) (Williams.)

1817.

Maclure, Wm. Map of the United States of Ameriea, designed to illustrate the Geological Memoir of Wm. Maclure, Esq.

Observations on the Geology of the United States. Phila., 1817.

Trans. Amer. Phil. Soc., n. s. vol. i, 1818. Phila.

15½x18¾, hand-colored in seven colors. Scale 120 miles to an inch. (Peabody.)

1818.

[Carey, M.] Maryland.

Carey's General Atlas, improved and enlarged, 3rd edit. Phila., 1818. [1st edit. 1814.]

12 miles to one inch. (Boston Public Library.)

Poppleton, I. H. Plan of Baltimore by I. H. Poppleton, under Commission of General Assembly February 1818.

50x44. (Md. Hist. Soc.)

1820.

Tanner, H. S. Virginia, Maryland and Delaware. By H. S. Tanner. Engraved and published by H. S. Tanner.

A new American Atlas. fol. Phila., 1823, No. 15. Copyrighted Dec. 20, 1820. (Phillips.)

1822.

LUCAS, FIELDING, JR. Map of Baltimore.

Scale 100 perches to one and one-half inches. (Williams.)

MACLURE, WM. (Geological map) The United States.

An Elementary treatise on Mineralogy and Geology, by Parker Cleaveland, 2nd edit. Boston, 1822.

Reduced copy of Maclure's map of 1817. (J. H. U.)

1823.

SMALL, W. F. A map shewing the extent of the Susquehanna Country and its Practical Canal routes as designated by the Susquehanna Commissioners 1823.

Report by the Maryland Commission on a Proposed Canal from Baltimore to Conowago. Baltimore, 1823.

10⅝x12, drainage, mountains hachured. Scale about 35 miles to an inch. (J. H. U.)

LUCAS, F., JR. A topographical Map of the route of a Proposed Canal and the country between Conewago and Baltimore.

Report by the Maryland Commission on a Proposed Canal from Baltimore to Conowago. Baltimore, 1823.

15½x18½, colored, roughly hachured. Scale 4¾ miles to an inch. (J. H. U.)

——— Maryland (with plan of Baltimore). Copyrighted Nov. 1, 1819.

A General Atlas containing distinct Maps of all the known countries in the world. Baltimore, by Fielding Lucas, Jr., 1823.

19⅝x11¼, hachured. Scale 12 miles to an inch. (Peabody.)

1824.

SHRIVER, JAS. Map of the Country through which a Canal to connect the waters of the Chesapeake and Ohio is proposed to pass and of the National Road between Cumberland and Wheeling with adjacent country from Actual Survey by Jas. Shriver.

Shriver's account of surveys relative to the projected Chesapeake and Ohio and Lake Erie Canals. Baltimore, 1824. (J. H. U.)

VANCE, D. H. Map of Virginia and Maryland. Constructed from the latest authorities, 1824. Drawn by D. H. Vance. Engraved by J. H. Young. Published by A. Finley, Phila. 1824.

A new American Atlas fol. Philadelphia. A. Finley, 1826, No. 7.

1826.

MEASE, JAMES.

See Minutes of Proc. Amer. Phil. Soc., Phila., 1743-1838.

Proc. Amer. Phil. Soc., xxii (2), 1884, p. 554.

1827.

Bernard, S., and Poussin, W. T. Map of a Reconnaissance between Baltimore and Philadelphia exhibiting the several routes of the mail-road contemplated by the resolution of Congress approved on the 4th of May 1826.

Accompanying report of Gen. Bernard on surveys of routes for a post road from Baltimore to Philadelphia. Washington, 1827.

30x9, outline, drainage, towns, roads. Scale 9 miles to an inch.

Vandermaelen, Ph. Atlas Universel der Geographie, Physique, Politique, Statistique et Mineralogique. 1/1641836 Bruxelles 1827.

4me parte Amer. sept. No. 50 et 51 represent Maryland and adjacent states. Population, towns, counties and minerals by signs from Pr. Frederick to Newmarket. This map represents Maryland extending to Cape Charles and is lacking in Garrett, Carroll and Howard counties, and includes Accomack and Northampton. Mountains in hachure.

1828.

Lucas, F., Jr. [No title.]

Second Ann. Rept. of the President and Directors to the stockholders of the B. & O. R. R. Co. Baltimore, 1828.

13⅜x7¾, outline map of railroad location. Scale about one mile to an inch. (Peabody.)

1829.

Barney, J. Map of the Country Embracing the various Routes Surveyed for the Baltimore & Ohio Railroad by order of the Board of Engineers Drawn by Lt. J. Barney, U. S. Army.

Accompanying Third Annual Report of the President and Directors of the B. & O. R. R. Baltimore, 1829; also in 4th Ann. Rept., 1830.

23½x9¾, drainage, hachured, 3⅛ miles to an inch. (Peabody.)

Barney, C. R. Profiles of Two of the Principal Routes surveyed for the Baltimore and Ohio Rail Road from Baltimore to Williamsport.

Accompanying Ann. Rept. Pres. and Direct. B. & O. R. R. Baltimore, 1829.

37½x8¾. Horizontal scale 3.1 miles to an inch; vertical, 400 feet to an inch. (Peabody.)

1832 (?).

Hinton, J. A New and Accurate Map of North America, Laid down according to the latest and most approved Observations and Discoveries.

Univ. Mag., J. Hinton, Newgate Street.

13½x10¼, colored. Small scale.

(Reduction of Moll?). Maryland extends to Lake Erie. (Lenox, U. S. G. S.)

1832.

Lucas, Fielding, Jr. Chart of the Chesapeake and Delaware Bays compiled and published by Fielding Lucas, Jr. Baltimore. 1832.

40x28½, colored outline of coast. Scale about 6 miles to an inch. (Peabody.) See 1859.

1833.

Anon. North America, Sheet VII. Pennsylvania, New Jersey, Maryland, Delaware, Columbia and Part of Virginia.

Published July 15th, 1833, in a series of maps, modern and ancient, published under the superintendence of the Society for the Diffusion of Useful Knowledge. London (etc.).

12¼x14¾, general, hachured. Scale about 28 miles to an inch. (Peabody.)

Tanner, H. S. Virginia, Maryland and Delaware. Exhibiting the route of the James river & Kanaiwha improvement. Engraved & Published by H. S. Tanner, Phila. 1833, (Phillips).

——— A new map of Maryland and Delaware with their Canals, roads and Distances.

Tanner's Universal Atlas No. 12. Phila., 1833.

13½x10½, counties colored. Scale about 19 miles to an inch. (Peabody.)

Hayden, H. H. A Sketch of the Bare Hills near Baltimore.

Amer. Jour. Sci., vol. xxiv, 1833, facing p. 360.

5x3⅝, outline, with mineral localities indicated. Scale 4 inches to the mile.

Latrobe, B. H. Map & Profile of the Projected Lateral Railroad to the City of Washington in connection with the first Nine miles of the Balt. & Ohio Rail Road shewing the entire route from Balto. to Washington.

Accompanying Seventh Annual Report Pres. and Dir. B. & O. R. R. Baltimore, 1833.

36x8¼ (two sheets), roads, drainage. Vertical 400 feet to an inch. Scale 1 mile to an inch. (Peabody.)

1834.

Anon. A Map & Profile of the Sixth Division of the Balto. & Ohio Railroad, Extending from the Point of Rocks to Harpers Ferry Bridge.

Accompanying Eighth Ann. Rept. Pres. and Dir. B. & O. R. R., appendix 5th Ann. Rept. Chief Engineer.

26¾x10½, hachured. Horizontal scale 2 miles to an inch; vertical scale of profile 100 feet to an inch. (Peabody.)

ANON. Sketch of the Bituminous Coal Region adjacent to the Atlantic Coast.

Jour. of Int. Imp. Convention, [etc]. [1834.]

13¼x11, outline. Scale 20 miles to an inch.

DUCATEL and ALEXANDER. Maryland.

Report on the Projected Survey of the State of Maryland. Annapolis, 1834.

14x8, outline, drainage. Scale 20 miles to an inch. Location of mineral deposits given.

1835.

KNIGHT, JONATHAN. Map of the Country between Cumberland and the Ohio representing the Routes reconnoitred with a view to the extension of the Baltimore & Ohio Rail Road to that River, Drawn by H. R. Hazelhurst.

Ninth Ann. Rept. Pres. and Dir. B. & O. R. R. Appendix A, Sixth Ann. Rept. Chief Engineer.

22¾x17¾ railroads, canals, boundaries colored. Scale 5 miles to an inch. (Peabody.)

1836.

ALEXANDER, J. H. Map of the proposed Canal between the Choptank and Blackwater Rivers. (With profile.)

Report on the new map of Maryland, 1835. Annapolis, 1836, p. 4.*

17x9, four foot contours. Scale 1254 ft. to an inch. (J. H. U., Peabody.)

——— Reconnaissance of Piscatawa Creek.

Report on the new map of Maryland, 1835, p. 9.

15x11⅝, hachured. Scale 1/10680. (J. H. U.)

——— Map and Profile of the Survey of Allens Fresh.

Report on the new map of Maryland, 1835, p. 16.

17½x6¾, hachured. Scale about 11 inches to a mile. (J. H. U., Peabody.)

——— Map A (Topographical map of Southeastern Maryland.)

Report on the new map of Maryland, 1835, after p. 42.

23x14½. four foot contours, 1:211200 geology printed on. Scale 3 3/16 to an inch. (J. H. U., Peabody.)

DUCATEL, J. T., and ALEXANDER, J. H. Map B. (Geol. map western shore).

Report on the new map of Maryland, 1835, after p. 34.

16x18¾, ten foot contours, 1:200000 geology printed on. Scale 3 3/16 to an inch. (J. H. U., Peabody.)

* The pagination for these maps varies widely in the different editions.

1837.

ALEXANDER, J. H. Map of the Proposed Rail Road from Fredericktown to the Pennsylvania Line. (With two profiles.)

Report on the new map of Maryland, 1836, opp. p. 92 or 104.

22½x11¼, hachured. Scale 1:95040. (J. H. U.) (Peabody.)

——— Reconnoissance for the Atlantic Rail Road and Profile.

Report on the new map of Maryland, 1836, facing p. 84 or 95.

18¾x5½, legend horizontal scale 1:126720; vertical scale 1:12672. (J. H. U., Peabody.)

——— Reconnaissance of the Choptank and Transquaking Canal.

Report on the new map of Maryland, 1836, after p. 60 or 66.

18½x7, hachured. Horizontal scale 1:13000; vertical scale 1:860. (J. H. U., Peabody.)

——— Maryland.

Accompanying Outline of the Physical Geography of Maryland (etc.), by J. T. Ducatel in Trans. Md. Acad. Sci. and Lit., vol. i, Baltimore, 1837, p. 54.

4¼x8, hachured, towns indicated by numbers. Scale 30 miles to an inch. (J. H. U., Peabody.)

ALEXANDER, J. H., and DUCATEL, J. T. Map A (Geological map along the Patuxent).

Report on the new map of Maryland, 1836, after p. 60 or 66.

23¼x11, hachured, geological remarks.

Scale 1:150000. (Peabody copy says "read Feb. 1837.")

——— Map B (Topographic map of Georges Creek.)

Report on the new map of Maryland, 1836, after p. 60 or 66.

19x6¼, hachured. Scale 1:84480 = 1¼ miles to an inch, location of coal veins. (J. H. U., Peabody.)

LUCAS, FIELDING, JR. Small map of Maryland and Virginia. (Phillips).

TRIMBLE, ISAAC. Map of the Country between Baltimore and the Potomac embracing the several Routes, surveyed for the Maryland Canal by F. Harrison under the direction of Isaac Trimble.

Report of the engineer on the subject of the Maryland Canal. Baltimore, Lucas & Deaver, 1837.

24x29, outline, drainage, roughly hachured. Scale 1/125000, or 2 miles to an inch. (J. H. U.)

1838.

ALEXANDER, J. H., and DUCATEL, J. T. Map A (Topographical map of Cecil and Kent counties).

Ann. Rept. of the Geologist of Maryland, 1837.

21x13⅝, hachured, geological remarks. Scale 1:150000, about 3⅛ miles to an inch. (Peabody.)

——— Map B (Topographical map of Montgomery county.)

Ann. Rept. of the Geologist of Maryland, 1837.

19x12, hachured, geological remarks. Scale 1:120000, or 1.9 miles to an inch. (Peabody.)

DOUGLAS, D. B.

Report on the coal and iron formation of Frostburg (etc.). Brooklyn (?), 1838.

LOOMIS, E. Magnetic Chart of the United States.

Amer. Jour. Sci., vol. xxxiv, 1838, opposite p. 290. Gives lines of equal declination and dip.

1840.

ALEXANDER, J. H. (Topographic map of Maryland) manuscript.

79x41 contoured 50 east and 100 feet west of the Monocacy. Scale 1:2000000. (Williams.)

ALEXANDER, J. H., and DUCATEL, J. T. Map A (Topographic map of Frederick County).

Accompanying Ann. Rept. of the Geologist of Maryland, 1839.

13½x10⅝, hachure, geological remarks. Scale 1:20000. (Peabody.)

——— Map B (Topographic map of Harford, Baltimore and part of Carroll counties).

Accompanying Ann. Rept. of the Geologist of Maryland, 1839.

18⅝x12⅛, hachures, geological remarks. Scale 1:200000. (Peabody.)

1841.

ALEXANDER, J. H. Map illustrative of Allegany & Washington Counties (with geological profile).

Ann. Rept. of the Geologist of Maryland, 1840.

16½x6⅞, hachures. Scale 1:400000. (J. H. U., Peabody.)

1843.

HALL, JAS. Geological map of the Middle and Western States.

Accompanying "Geology of New York," part iv, 4to. Albany, 1843.

Also issued separately. (Marcou.)

MOXON, CHAS. Sketch of the Geology of the United States.

Accompanying "On the geology of the United States" in Geologist, edited by C. Moxon. Frontispiece. London, 1843.

"A rough reproduction and reprint of Maclure." (Marcou.)

1845.

LYELL, CHAS. Geological Map of the United States, Canada, &c.

Accompanying Travels in North America (etc.), vol. ii. New York and London, 1845.

19½x15¼, hachured, 20 colors. Scale about 27 miles to an inch. Map of Maryland better than Maclure, but the Cretaceous is lacking on the western shore.

1846.

——— Geognostische Karte der Vereinigten Staaten, Canada &c.

Accompanying Reisen in Nord Amerika von Charles Lyell. Deutsch von Dr. Emil J. L. Wolff. Halle, 1846. (Marcou.)

1848.

TAYLOR, R. C. Map illustrative of the Statistics of the Coal Trade in Pennsylvania (etc).

Statistics of Coal. Phila., 1848.

14¾x10⅛, boundaries colored, coal areas outlined. Scale 19 miles to an inch. (Peabody.) See 1854.

1849.

SMITH, JOHN. Virginia Discovered and Described by Captain John Smith, Graven by William Hole.

The Historie of Travaile into Virginia Brittania (etc.), by William Strachey Gent., edit. by R. H. Major, published by Hakluyt Society, London, 1849.

16x12¾, outline, symbols. Scale 6¾ leagues to an inch. (Peabody.)

U. S. COAST & GEODETIC SURVEY. Mouth of Chester River. No. 383.

14x17 (class F). Scale 1/40000, or 1.58 inches to a mile.

1850.

GRAHAM, J. D. The Boundary Lines between the Provinces of Maryland and Pennsylvania; including the three lower counties of New Castle, Kent, & Sussex, forming now the State of Delaware.

Message from the Governor of Maryland transmitting the Reports of the Joint Commissioners, and of Lt. Col. Graham, U. S. Engineers, in relation to the intersection of the boundary lines of the States of Maryland, Pennsylvania, and Delaware. Washington, 1850.

7¾x10¾. Scale about 10½ miles to an inch.

LATROBE, BENJ. H. Map & Profile of the location of the Baltimore and Ohio Rail Road from Cumberland to Wheeling (etc.) (with profile). Drawn by Albert Finch 1850.

64½x46, hachured. Horizontal scale 2 miles to an inch; vertical feet 500 to an inch. Also (as) wall map. (Peabody.)

About 1850.

Map of the Cumberland Coal Region in Allegany County, Maryland showing the lands of the Cumberland Coal and Iron Co. etc. New York. Ackerman lith.

Report upon surveys for the extension of the B. & O. R. R. (Harper's Ferry to Ohio).

24½x15⅝, hachure. Scale one inch to the mile. (After Alexander?) (Peabody, Patent.)

1851.

Poppleton, I. H. Plan of Baltimore by I. H. Poppleton corrected to date (Hoen Lith.) 1851.

See 1818. (Williams.)

Sidney, J. C., and Brown, J. P. Map of City and County of Baltimore from original surveys by J. C. Sidney and J. P. Brown.

Scale 1 mile to an inch. (Williams.)

Simmons. Poppleton's Map of Baltimore City corrected to 1851.

44x57, wall map. Scale 500 feet to an inch.

1852.

Anon. Map of Baltimore City and part of Baltimore county, including the Valley of the Great Gunpowder River, from Warren Factory to tide, from surveys made in accordance with the Resolutions of Mayor and City Council of Baltimore, May 11, 1852. Lith. by Hoen.

42½x19¼, hachured. Horizontal scale 200 feet to an inch; vertical 250 feet to an inch. (Peabody.)

Lucas, Fielding, Jr. Map of Maryland, constructed from the best authorities by Fielding Lucas, Jr. 1852.

Scale nearly 6 miles to an inch. (Williams.)

1853.

Slade, James. Plan of Baltimore and Vicinity, showing proposed routes for bringing water from Jones', Gwynn's Falls, and Patapsco River, directed by Jas. Slade, 1853.

42½x27, roughly hachured. Scale 2⅝ inch to a mile. (Peabody.)

Buch, Leopold von. Geognostische Karte von Nord America.

Ueber die Jura formation auf der Erdflache Monatsber. d. k. Akad. Wiss. Berlin, 1853. (Marcou.)

HITCHCOCK, E. A geological map of the United States and Canada 1853.

Published separately.

24x16¼, fifteen colors. Scale 113 miles to an inch. See 1854 and 1856. (Peabody.)

MARCOU, JULES. Geological Map of the United States and the British Provinces of North America.

A geological map . . . with explanatory text (etc.). Boston, 1853.

1854.

HITCHCOCK, E. A geological map of the United States and Canada 1853.

Outlines of the Geology of the globe, etc. Boston, 1854.

24x16¼, fifteen colors. 113 miles to an inch. No Cretaceous and little Eocene in Maryland. Base very poor for Maryland. (Peabody, Phila. Acad.)

SIDES, WM. Plan of Curtis Creek wharf and Railroad Company's improvements 1854.

22x28 outline figures. Scale 1/30000. (Peabody.)

TAYLOR, R. C., and HALDEMAN, S. S. Map illustrative of the Statistics of the Coal Trade of Pennsylvania (etc).

Statistics of Coal, 2nd edit. Phila., 1854.

14¾x10⅛, boundaries colored. Coal area outlined. Scale 19 miles to an inch. See 1848. (Peabody.)

1855.

LOGAN, W. E. Carte géologique du Canada. Scale: lieues de 25 au degrè dont une = 4445m.

Esquisse géologique du Canada pour servir l'intelligence de la carte géologique envoyá à l'Exposition universelle de Paris en 1855, par W. E. Logan et T. Sterry Hunt in 12°, Paris, 1855.

Bull. Geol. Soc., France, 2 serie, tome xii, Paris, 1855, p. 1316. (Marcou.)

LYELL, CHAS. Geological map of the United States, Canada etc. London 1855. See Lyell 1845.

MARCOU, JULES. Carte géologique des États Unis et des provinces anglaise de l'Amérique du Nord.

Bull. Soc. Geol. France, tome xii, 1855, p. 813.

Ann. des Mines, 5 serie, tome vii, 1855, p. 320, pl. ix. (Marcou.)

——— Carte du terrain Carbonifère dans un partie de l'Amérique du Nord.

La Bibliotheque universelle de Genève, Juin, 1855.

Black etching. (Marcou.)

——— Geologische karte der Vereingten Staaten und britischen Provincen von Nord Amerika.

Petermann's Mittheilungen, 1855, No. 15.

15½x9⅝, 12 colors. Scale 1/14000000, or 18½ miles to an inch. No Cretaceous west of Chesapeake Bay. (J. H. U.)

——— Carte géologique des États-Unis et des provinces Britaniques de l'Amérique du Nord.

Voyage dans l'Amérique du Nord en 1853 et 1854, par Guillaume Lambert. Bruxelles, 1855.

See 1853. (Marcou).

U. S. Coast and Geodetic Survey. Delaware & Chesapeake Bays. No. 376.

26x34 (class F). Scale 1/400000, or 0.16 inch to a mile.

1856.

Anon. Plat of South Baltimore.

Prospectus of the South Baltimore Company. Baltimore, 1856.

30x25½, outline of streets, etc. Scale 12 inches to a mile. (J. H. U.)

Hitchcock, E. Geological map of the United States and Canada 1853.

Outline of the Geology of the Globe, 3rd edit., 8vo. Boston, 1856.

24x16¼, fifteen colors. 113 miles to an inch. See 1853 and '54. (Peabody.)

Rogers, H. D. Geological Map of the United States and British North America by H. D. Rogers. 1855.

Physical Atlas of Natural Phenomena, by Alexander Keith Johnston. New and enlarged edition. Folio. Plate viii, Edinburgh, 1856.

24¼x20, outline, drainage, 17 colors. Scale about 160 miles to an inch. (Peabody.)

Scott, Jos. (?) Scott's Map of the City of Baltimore, from Surveys by Martenet.

36x50, wall map. Scale 500 feet to an inch. (Williams.)

1857.

Abert, J. J., and Kearney, J. Map of the Patuxent & St. Mary's Rivers, Maryland, from surveys by Major J. J. Abert, Top'l Eng'rs, and Major J. Kearney, Top'l Eng'rs. Compiled in the Bureau of Top'l Eng'rs. By order of the Sec. of War. . . . 1857.

38x27, outline, hachure. Scale 1/63360. Series of soundings in the river. (Amer. Geog. Soc.)

JOHNSTON, A. KEITH. United States of North America (Eastern States) by A. Keith Johnston.

The Royal Atlas of Modern Geography, by Alexander Keith Johnston. Edinburgh, 1857.

17⅝x22½, outline, drainage, mountains hachured, tinted. Scale 75 miles to an inch.

OWEN, RICHARD. 1. Map of Geological Formations and of the Forces Supposed to have Acted in Bringing these Strata to Their Present Position on the Surface of the Globe.

2. Map of North America exhibiting the localities most abounding in Coal, Metals etc. also the Parallelism of Structure in the Two Continents.

Key to the Geology of the Globe. 8°, pp. 256. Boston, 1857.

These maps represent Maryland with only Tertiary and Cretaceous and noted for copper. (Peabody.)

TAYLOR, ROBERT. Map of the City and County of Baltimore, Maryland, from actual surveys by Robert Taylor. Lith. Hinckel & Son, Baltimore, 1857.

50x60, roads, drainage. Wall map 1½ inches to a mile. (Peabody.)

1858.

BOND, ISAAC. Map of Frederick County.

34x44, wall map. Scale 1 mile to an inch. (Martenet.)

MACLURE, WM. Carte de États-Unis de l'Amérique du Nord, pour servir aux observations géologiques.

Geology of North America, by Jules Marcou. 4°. Zurich, 1858.

"Copy, on somewhat smaller scale, of the Paris edition of 1811." (J. H. U.)

MARCOU, JULES. Carte géologique États-Unis et des provinces anglaises de l'Amérique du Nord.

Geology of North America (etc.), 4°, Zurich, 1858.

Reduced copies published in Geologie und Physikalische Karten. Artaria & Co., Vienna, 1872.

La Vie souterraine, ou les mines et les mineurs, par Louis Sernonian. 4°, Carte x, p. 112. Paris, 1867. (J. H. U.)

MARTENET, SIMON. Map of Cecil County.

41x41, outline, road, wall map. Scale 1½ inches to a mile.

1859.

LUCAS, FIELDING, JR. A Chart of the Chesapeake and Delaware Bays compiled and published by Fielding Lucas, Jr. Baltimore. Corrected 1859. (Copyrighted 1832).

40x28½, outline of coast. Scale about 6 miles to an inch. (Amer. Geog. Soc.)

MORRIS, WM. E. Map of Pennsylvania, constructed from the County Surveys authorized by the State and other original documents under the supervision of Wm. E. Morris, C. E. Published by R. C. Barnes, Phila. 1859.

25x25, 6 sheets, outline. Scale 5 miles to an inch. Includes outline map of most of Maryland. (Amer. Geog. Soc.)

SHANAHAN, CHAS. E. Talbot County, Maryland.

20½x17½, outlines. Scale about 2 miles to an inch. (Martenet.)

TYSON, P. T. Geological Illustrations Accompanying the first report of Philip T. Tyson, Agricultural Chemist of the State of Maryland 1859. (Published with report 1860.)

25½x13⅜, 24 colors, 9¾ miles to an inch. (J. H. U.) (Peabody.)

U. S. COAST AND GEODETIC SURVEY. Patuxent River (lower part). No. 386. First edition (last edition 1880).

19x22 (class F). Scale 1/60000, or 1.06 inches to a mile.

DILWORTH, W. H. Talbot County.

(Martenet.)

TAGGART, THOS. Washington County.

51x68, outline, road, wall map. Scale 2 inches to a mile. (Martenet.)

1860.

CAMP, JOHN DE LA. Southern Boundary of Maryland between Smith's Point and the Atlantic.

Southern Boundary of Maryland, by Thos. J. Lee. Baltimore (?), 1860.

30½x10¾, based on coast survey chart. Scale 1/128000. (J. H. U., Peabody.)

FAUL, AUG. (Manuscript map of Druid Hill Park.)

(Williams, Peabody.)

MARTENET, SIMON. Map of Howard County.

53x32, outline, roads, wall map. Scale 1½ miles to an inch. (Martenet.)

——— Map of Kent County.

Surveyed by Baker, County Surveyor, published by Martenet.

35x32, outline wall map. Scale 1 mile to an inch.

——— Map of Anne Arundel County.

(Williams.)

SANDOZ, ERNEST. Physikalische Karte des Alleghany-Systems, nach allen vorhandenen Messungen und Untersuchungen gezeichnet von Ernest Sandoz.

Petermann's Mittheilungen, 1860, No. 12.

16x9⅝, hachured. Scale 1:6000000. (J. H. U.)

TYSON, P. T. Preliminary geological map of Maryland.

First report of Philip T. Tyson, State Agri. Chemist [etc.]. Annapolis, 1860 (see 1859).

U. S. COAST AND GEODETIC SURVEY. Patuxent River—Pt. Judith to Nottingham. No. 387. First edition (last edition, 1881).

19x22 (class F). Scale 1/30000, or 2.11 inches to a mile.

1861.

ANON. Map showing the war operations in Virginia and Maryland. J. H. Bufford, Boston, (1861).

25x36, colored. (Phillips.)

ANON. Eastern Virginia and part of Maryland. New York. Schönberg & Co.

20x25, colored. (Phillips.)

ANON. A New County Map of Pennsylvania and adjoining states showing the route of the railroads [etc]. Barnes. Phila. 1861.

37x26, roughly hachured. Scale 10 miles to an inch. Maryland as far south as Washington and Annapolis. (Amer. Geog. Soc.)

BASCHKE, A. Topographical Map of the District of Columbia Surveyed in the years 1856, 57, 58 & 59. D. McClelland, Blanchard & Mohun. Washington, 1861.

41x41, symbols, contour (10 ft.). Scale 4 miles to an inch. Steel or copper plate. (Amer. Geog. Soc.)

BLUNT, E. & G. W. Corrected map of Washington and the seat of War on the Potomac.

19¼x13½, colored, roughly drawn. Scale about 3½ miles to an inch. (Amer. Geog. Soc.)

HEYNE, CHAS. Map of Part of Virginia, Maryland and Delaware, from the best Authorities compiled by Chas. Heyne, New York. E. & G. W. Blunt.

26¼x37¾, outline. (Amer. Geog. Soc.)

LLOYD, J. T. Official Map of the State of Virginia From Actual Surveys by order of the Executive. 1828 & 1859. Corrected and revised by J. T. Lloyd to 1861. New York, J. T. Lloyd. Published in 4 forms.

2 sheets, total 30x46, counties colored, hachured. Scale 10 miles to an inch. Eastern Shore shows all of Maryland. (Amer. Geog. Soc.)

SCHEDLER, J. The Seat of War (or) Birds Eye View of Virginia, Maryland, Delaware & District of Columbia. Published by W. Schaus, New York 1861 (?).

30x22¾, hachured, colored. Scale 13 miles to an inch. (Peabody—Patent.)

1862.

ANON. "Surveys for military defences." Map of northeastern Virginia and vicinity of Washington. Compiled.
U. S. War Dept., Corps of Engineers, 1862.
49x66, fold. 8°. (Phillips.)

ANON. "Surveys for military defences." Map of N. Eastern Virginia and Vicinity of Washington compiled (etc).
25x26 (4), hachure, symbols. Scale 1 mile to an inch. (J. H. U.)

ANON. War telegram marking map of Eastern Virginia, Part of Maryland and Pennsylvania. L. Prang & Co. Boston, 1862. (Peabody.)

ANON. Colton's new topographical map of the states of Virginia, Maryland and Delaware (etc). Compiled from the latest and most authentic sources on a scale of 12 miles to the inch. New York, J. H. Colton. 1862.
31x44, colored, fold. Scale 12 miles to an inch. (Phillips.)

BACHE, A. Map of Eastern Virginia. Compiled from the best authorities and printed at the Coast Survey Office.
18½x22, hachured. Scale 7 miles to an inch. Railroads in red. Philadelphia to North Carolina. (Amer. Geog. Soc.)

MARTENET, SIMON. Map of Carroll County.
44x52, outline, road, wall map. Scale 1 mile to 1½ inches.

U. S. COAST AND GEODETIC SURVEY. Lower Cedar Point to Indian Head. No. 390. First edition (last edition 1882).
23x29 (class F). Scale 1/60000, or 1.06 inches to a mile.

1863.

BRUFF, J. G. New Map of the seat of war in Virginia and Maryland. Drawn by J. G. Bruff. New York. J. Distumell 1863.
26x28, colored, fold. 8°. (Phillips.)

SMITH, J. CALVIN. Map of the Southern States, Maryland, Delaware, Virginia, Kentucky, Tennessee, Missouri, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, Louisiana and Texas. New York 1863.
55x37. Scale 25 miles to an inch. (Peabody.)

U. S. COAST AND GEODETIC SURVEY. Chesapeake Bay, Pokomoke Sound to Potomac River. No. 133. First edition. (last edition 1877).
25x38 (class F). Scale 1/80000, or 0.79 inches to a mile.

——— Chesapeake Bay. Potomac River to Choptank River. No. 134. First edition. (last edition 1896).
29x38 (class F). Scale 1/80000, or 0.79 inch to a mile.

——— Chesapeake Bay. Choptank River to Magothy River. No. 135. First edition. (last edition 1895).
29x38 (class F). Scale 1/80000, or 0.79 inch to a mile.

——— Chesapeake Bay. Magothy River to Head of Bay. No. 136. First edition. (last edition 1877).
29x38 (class F). Scale 1/80000, or 0.79 inch to a mile.

Weyss, John E. Military Map showing the topographical features of the country adjacent to Harper's Ferry, Va. etc. Surveyed from August 3rd to Sept. 30th 1863 under the direction of Capt. N. Michler, Corps of Eng. U. S. Army, by Major John E. Weyss, Principal Assistant, Engineer Department, Army of the Potomac.
29x24½, contours and hachures. Scale 4 inches to one mile, 20 foot contour. (Peabody.)

1864.

Bache, A. Map of the State of Virginia Compiled from the best authorities and printed at the Coast Survey office.
22x34¾, colored, hachured. Same as 1862 and 1865. (Amer. Geog. Soc.)

Green, W., Jr. Map showing the relation of the anthracite coal region to the great Appalachian coal-field according to Leslie.
Trans. North of England, Inst. Mining Eng., vol. xiii, p. 25. Newcastle-upon-Tyne, 1864. (Marcou.)

Johnson. Johnson's Virginia, Delaware, Maryland and West Virginia. New York. Johnson & Ward 1864.
17x23. (Phillips.)

Logan (Wm. E.). Geological map of Canada and the Adjacent region, including parts of the British provinces and of the United States.
Accompanying Geol. Survey of Canada (etc.). Montreal, 1865.
19⅝x8½, 30 colors. Scale 125 miles to an inch. (J. H. U.)

Martenet, S. Map of Allegany and Garrett Counties.
MS. never published. Scale 1 mile to 1¼ inches. (Williams.)

1865.

Andriveau, Goujon E. Carte Générale des Etats-Unis et du Mexique comprenant l'Amérique centrale et les Antilles. Paris 1865.
Atlas Classique et Universel de Geographie.
18⅛x24¼. (Peabody.)

BACHE, A. Map of the State of Virginia Compiled from the best authorities and printed at the Coast Survey office.

22x34¾, colored, hachures. Reprint. (Amer. Geog. Soc.)

MARTENET, SIMON J. Martenet's Map of Maryland, including the District of Columbia, a sketch of Delaware and a portion of Northern and Eastern Virginia (etc).

4 sheets, 36½x21¾, colored. Hachured roughly. Scale 1/221760, or 3½ miles to an inch. (J. H. U.)

——— Map of Maryland.

Atlas and wall editions. Scale 15 miles to an inch or 1/950400. (Peabody.)

——— Map of Montgomery County.

35x30 wall map. Scale 1 mile to an inch. (Martenet.)

1866.

DADDOW, S. H., and BANNON, BENJ. Map of Cumberland coal field.

Coal, Iron and Oil; or the Practical American Miner. Pottsville, Pa., 1866.

7x4⅝, outline, roughly hachured. Scale 4 miles to an inch. (Peabody.)

SMITH, JOHN. Virginia.

A True Relation of Virginia by Captain John Smith with an Introduction and Notes by Charles Deane (Virginia Series 1). Boston, 1866.

16x12¾, outline of bay, figures and symbols.

LOGAN, WM. Geological Map of Canada (etc.) While that of the United States is compiled under the authority of Professor Jas. Hall.

42x49 (2), 30 colors. Scale 1/1584000. (Peabody) fine map.

U. S. WAR DEPARTMENT. Central Virginia showing Lt. Gen. U. S. Grant's Campaign and Marches (etc). Engineer Bureau War Dept.

32x31, outline, drainage, hachured. Scale 1/350000. (Peabody.)

U. S. COAST AND GEODETIC SURVEY. Isle of Wight to Chincoteague Inlet. No. 128. First Edition (last edition 1890).

30x33 (class F). Scale 1/80000, 0.79 inches to a mile.

1867.

KITTLEWELL, S. H. Map of the Baltimore and Ohio Rail Road with its Branches and Connections, also Profiles.

50x46, wall map, hachured. Scale 6 miles to an inch. Vertical scale 2000 feet to an inch.

MICHLER, N. Harper's Ferry—prepared by Bvt. Brig. Gen. N. Michler. . . . By order of Brig. Gen. & Bvt. Maj. Gen. A. A. Humphreys, Chief of Engineers.

27½x22¾, hachured, fortifications. Scale 3 inches to a mile. (J. H. U.)

STAMP, H. M. F. P. Topographical map of the Great Gunpowder Aqueducts, (etc.)

Report to His Honor John Lee Chapman, Mayor of Baltimore, October, 1867.

7¼x12¼, contoured. Scale about 2 miles to an inch. (Peabody.)

U. S. COAST AND GEODETIC SURVEY. Chesapeake Bay. Magothy River to Head of Bay. No. 136. First edition (last edition, 1877).

29x38 (class F). Scale 1/80000, or 0.79 inch to a mile.

1868.

BEERS, D. G. Broughman, Thomas & Co's map of the peninsula, embracing Delaware and the Eastern Shores of Maryland and Virginia. Compiled from the U. S. Coast Surveys and other actual Surveys. Broughman, Thomas & Co. Wilmington. 1868.

40x26, colored. (Phillips.)

U. S. COAST AND GEODETIC SURVEY. Potomac River. Entrance to Piney Pt. No. 388. First edition (last edition, 1877).

23x30 (class F). Scale 1/60000, or 1.06 inches to a mile.

U. S. COAST AND GEODETIC SURVEY. Potomac River. Piney Pt. to Lower Cedar Pt. No. 389. First edition (last edition, 1877).

23x29 (class F). Scale 1/60000, or 1.06 inches to a mile.

1869.

FOSTER, J. W. Geological sketch of the United States.

Resources of the Mississippi Valley, p. 272. Chicago, 1869.

7x32½, black sketching, 10 shadings. Roughly drawn in Maryland. (Peabody.)

1871.

CREDNER, HERMANN. Geognostische Karte des Alleghany-Systems nach den vorhandenen arbeiten sowie eignen Untersuchungen zusammengestellt von Hermann Credner. Die Physikalische Grundlage von A. Petermann und E. Sandoz.

Petermann's Mittheilungen, 1871, No. 3.

16x9⅝, hachured, eleven colors. Scale 1:6000000. Phyllites considered Huronian. Quaternary not separated from Tertiary. (J. H. U.)

1872.

HITCHCOCK and BLAKE. Geological Map of the United States. Compiled for 9th Census.

21½x23½, 9 colors. Scale 90 miles to an inch. (Peabody.)

1873.

ASHER and ADAMS. Delaware, Maryland, Virginia, West Virginia and District of Columbia.

Asher & Adams, Atlas and Gazetteer of the United States. New York, 1873.

15¾x22⅝, roughly hachured. Scale 20 miles to an inch (roughly drawn map). (Peabody.)

BLODGET, L. Climatological Map of Maryland.

New Topographic Atlas of Maryland, by Martenet, Walling and Gray. Baltimore, 1873.

Scale 10 miles to an inch. (Peabody.)

GRAY, F. A. A New railroad map of the states of Maryland, Delaware and the District of Columbia compiled and drawn by Frank Arnold Gray 1873.

24x14½, counties colored. Scale 10 miles to an inch. (Peabody.)

HITCHCOCK, C. H., and BLAKE, W. P. Geological map of the United States.

Statistics of mines and mining in the States and Territories west of the Rocky Mountains (Raymond), p. 480. Washington, 1873.

33x21, nine colors. Scale about 90 miles to an inch.

LUKE, J. D. Atlas of Frederick County. 4°. Phila. C. A. Titus & Co. 1873.

(Williams.)

MACFARLANE, JAMES. Map showing the coal fields of the United States.

The coal regions of America. New York, 1873.

13¾x23½, "black etching," roughly hand-colored, about 58 miles to an inch. (Peabody.)

——— A Topographical map of the Cumberland or Piedmont coal regions.

The coal regions of America. New York, 1873.

4¼x7¾, hachured. Scale 3 miles to an inch. (Peabody.)

——— Map of the Cumberland Coal Basin.

The coal regions of America. New York, 1873.

4¼x7¾, hachured. Scale 3 miles to an inch. (Peabody.)

MARTENET, S. J., WALLING, H. F., GRAY, F. A. New Topographic Atlas of Maryland, with historical, scientific and statistical descriptions, and map of the United States, by Martenet, Walling & Gray. Baltimore, 1873.

Contains: 1. Map of Maryland and the District of Columbia, colored to illustrate the geological formations, by Philip Tyson, which see.

2. Climatological Map of Maryland, by Louis Blodget.

3. New Railroad Map of Maryland, by Frank A. Gray.

Scales: counties Allegany, 1/221760; Washington, 1/221760; Carroll and Frederick, Baltimore and Harford, Cecil and Kent, Howard and Montgomery, and District of Columbia, Anne Arundel and Prince George, Calvert, Charles, St. Mary's, Caroline, Queen Anne and Talbot, Dorchester, Wicomico, Somerset and Worcester, same scale. (Peabody.)

PETERMANN, A. Nord Amerika.

Adolf Stieler's Hand Atlas No. 77. Gotha, 1873.

10x13, colored, faintly hachured, bathymetric contours. Scale 1:25000000. (J. H. U.)

——— West-Indien in 4 Blättern. Bl. 2.

Adolf Stieler's Hand Atlas No. 80. Gotha, 1873.

16x13, outline and few towns, colored, faintly hachured. Scale 1:7500000. Nebenkarte:—Die Atlantischen Staaten zwischen Washington und Boston. Scale 1/2000000. (J. H. U.)

PETERMANN, A. Vereinigten Staaten von Amerika in 6 Blättern. Bl. 3.

Adolf Stieler's Hand Atlas No. 85.

16x13, colored, faintly hachured. Scale 1/3700000. (J. H. U.)

TYSON, P. T. Map of Maryland and the District of Columbia colored to illustrate the Geological Formations by Philip T. Tyson.

Atlas of Maryland, by Martenet, Walling and Gray, No. 15.

24x14½, 24 colors. Scale 10 miles to an inch. (Peabody.)

1874.

ABERT, J. J. Map of the Country Embraced in the Surveys made in 1838 under the direction of Col. J. J. Abert for routes for the proposed Maryland Canal. Annapolis 1838. Reprinted Washington Eng. Dept. 1874.

28x22, outline, hachured. Scale 1 mile to an inch approximately. Includes country between Patuxent and Monocacy rivers.

HITCHCOCK, C. H. Map of the Coal fields of the United States compiled from State reports.

Statistical Atlas of the United States based on the results of the Ninth Census, 1870 (etc.), plates xi and xii, folio. Washington, 1874.

HITCHCOCK (C. H.) and BLAKE (W. P.). Geological map of the United States, compiled from the sources mentioned in the text.

Statistical Atlas (etc.), plates xiii, xiv, folio. Washington, 1874, also published 1872, '76 and '79.

(Tyson for Md.)

LAND OFFICE. Map of the United States and Territories showing the extent of Public Surveys etc. General Land Office 1874.

Scale 40 miles to an inch. (Peabody.)

1875.

HALL, JAMES. Map illustrating the Paper on the Relations of the Niagara and Lower Helderberg Formations and their Geographical Distribution. (1874).

28th Rept. N. Y. State Museum. Albany, 1875.

22x22, colored to represent Niagara, Onondago and L. Helderberg. Scale about 55 miles to an inch. (J. H. U.)

HITCHCOCK & BLAKE. Die Steinkohlen felder der Vereinigten Staaten von N. A., nach der Karte von Hitchcock und Blake. Maastab. 1: 13,500,000.

Petermann's Mitth. 4°, vol. xxi, 1875, pl. xvi.

7⅝x9⅞, coal areas colored. Scale 1/13500000. (J. H. U.)

ISLER, JOHN B. Map of Caroline County, Maryland. Phila. (?) 1875. Copyright 1873.

61x36¾, outline, drainage districts. Scale 1⅝ inches to mile. (Peabody.)

1876.

BOYD, E. F. Geological Map of the United States.

Trans. North of Eng. Inst. Mining Eng., vol. xxv, plate xliii, p. 188. Newcastle-upon-Tyne, 1876.

Rough map based on Hitchcock and Blake, 1874. (Marcou.)

——— Map of the Coal fields of the United States.

Idem., plate xliv. (Marcou.)

BRADLEY, F. H. Geological chart of the United States East of the Rocky Mountains and of Canada. New Haven 1875.

Black etching. (Marcou.)

GRAY, FRANK A. Maryland, Delaware and the District of Columbia.

The National Atlas. Phila., 1885.

64x40 cm., colored, counties, hachures, towns. Scale 10 miles to an inch. (J. H. U.)

HITCHCOCK, C. H., and BLAKE, W. P. Geological map of the United States.

Accompanying special report of the Smithsonian Institution for the Centennial. Washington, 1876.

See authors, 1874. (Marcou.)

1877.

HITCHCOCK, C. H., and BLAKE, W. P. Geological map of the United States.

Atlas of the United States and the World, by Gray, folio. Phila., 1877. See authors, 1874. (Marcou.)

HOPKINS, G. M. Map of Maryland, Delaware and the District of Columbia by G. M. Hopkins.

Hopkins Atlases.

24x15¾, counties colored. Scale 1/506886, or 8 miles to an inch. (Peabody.)

GRAY, F. A. New Railroad map of the states of Maryland, Delaware and the District of Columbia. Copyrighted by O. W. Gray & Son.

All of Lake, Griffing & Stevenson's county atlases.

24x14¾, counties colored. Scale 10 miles to an inch. (Peabody.)

HOPKINS, G. M. Atlas of Baltimore County. 4°. Phila. 1877. (Williams.)

——— Atlas of Baltimore and its Environs. 2 vols. 4°. Phila. (?) 1876-7.

Scale 800 feet to 1 inch. (Williams.)

LAKE, GRIFFING and STEVENSON. An Illustrated Atlas of Kent and Queen Anne Counties. 4°. Phila. Lake, Griffing & Stevenson, Phila. 1877.

Contents: Outline plan of Kent and Queen Anne counties, 2½ miles to an inch.
1st District, Millington. Scale 1½ inches to a mile.
2nd District, Kennedysville. Scale 1½ inches to a mile.
3rd District, Worton. Scale 2 inches to a mile.
4th District, Chestertown. Scale 2 inches to a mile.
5th District, Edesville. Scale 1½ inches to a mile.
Dixon's Tavern District No. 1. Scale 1½ inches to a mile.
Church Hill No. 2. Scale 1½ inches to a mile.
Centreville No. 3. Scale 1½ inches to a mile.
Kent Island No. 4. Scale 1½ inches to a mile.
Queenstown No. 5. Scale 1½ inches to a mile.
Ruthsburg No. 6. Scale 1½ inches to a mile. (Peabody.)

——— Atlas of Cecil County. 4°. Lake, Griffing & Stevenson, Phila. 1877.

Contains outline map of Cecil county, 2 miles to an inch.
Cecilton, 1st Dist. Scale 1½ inches to a mile.
Chesapeake City, 2nd Dist. Scale 2 inches to a mile.
Elkton, 3rd Dist. Scale 2 inches to a mile.
Fair Hill, 4th Dist. Scale 2 inches to a mile.
North East, 5th Dist. Scale 1½ inches to a mile.
Brick Meeting House, 9th Dist. Scale 2 inches to a mile.

Port Deposit, 7th Dist. Scale 2 inches to a mile.
Rising Sun, 6th Dist. Scale 2 inches to a mile.
Mt. Pleasant's, 8th Dist. Scale 2 inches to a mile.
Plats of towns. (Peabody.)

——— An Illustrated Atlas of Talbot and Dorchester Counties. 4°. Lake, Griffing & Stevenson, Phila. 1877.

Conteuts:
Outline plan of Talbot county. Scale 2 miles to an inch.
Easton. Scale 1½ inches to a mile.
St. Michaels. Scale 1½ inches to a mile.
Trappe. Scale 1½ inches to a mile.
Chapel. Scale 1½ inches to a mile.
Bay Hundred. Scale 1½ inches to a mile.
Fork. Scale 1⅛ inches to a mile.
East New Market. Scale 1¼ inches to a mile.
Vienna. Scale 1⅓ inches to a mile.
Parson's creek. Scale 1⅓ inches to a mile.
Lake. Scale 1¼ inches to a mile.
Hooper's Islaud. Scale 1½ inches to a mile.
Cambridge. Scale 200 rods to an inch.
Neck. Scale 200 rods to an inch.
Church creek. Scale 1½ inches to the mile.
Strait. Scale 1 inch to the mile.
Drawbridge. Scale 1 inch to the mile.
Williamsburg. Scale 2 inches to the mile.
Bucktown. Scale 1 inch to the mile.
Besides plans of towns and map of state. (Peabody.)

——— Atlas of Washington County. 4°. Phila. Lake, Griffing & Stevenson. 1877.
(Williams.)

——— Atlas of Carroll County. 4°. Phila. Lake, Griffing & Stevenson 1877.
(Williams.)

Martenet, Simon J. Outline Plan of Wicomico, Somerset and Worcester Counties, Md.

12½x14½. Scale 3 miles to an inch.
Wicomico, 12½x14½. Scale ½ inch to a mile.
1. Barren creek. Scale 1½ inches to a mile.
2. Quantico. Scale 1⅓ inches to a mile.
3. Tyaskin. Scale 1⅓ inches to a mile.
4. Pittsburg. Scale 1½ inches to a mile.
5. Parsons. Scale 1½ inches to a mile.
6. Dennis. Scale 1⅜ inches to a mile.
7. Trappe. Scale 200 rods to an inch.
8. Nutters. Scale 1½ inches to a mile.
9. Salisbury. Scale 1½ inches to a mile.
Somerset, 23x14½. Scale ½ inch to a mile.
1. Princess Anne. Scale 1⅓ inches to a mile.
2. Dame's Quarter. Scale 2 inches to a mile.
3. Brinkley's. Scale 1⅛ inches to a mile.
4. Dublin. Scale 1⅓ inches to a mile.

5. Hungary Neck. Scale 2 inches to a mile.
6. Fairmount. Scale 200 rods to an inch.
7. Trappe. Scale 200 rods to an inch.
8. Lawsons. Scale 2 inches to a mile.
9. Tangier. Scale 3 inches to a mile.

Worcester. Scale ½ inch to a mile.

1. Newtown. Scale 1½ inches to a mile.
2. Snow Hill. Scale 1⅓ inches to a mile.
3. E. Berlin. Scale 1⅓ inches to a mile.
4. Newark. Scale 1½ inches to a mile.
5. St. Martin's. Scale 1 inch to a mile.
6. Colbourne. Scale 1½ inches to a mile.
7. Atkinson. Scale 1¼ inches to a mile.
8. Stockton. Scale 1⅓ inches to a mile.
9. West Berlin. Scale 1⅓ inches to a mile.

Plats of towns, etc. (Peabody.)

U. S. Coast and Geodetic Survey. Chesapeake Bay—Pocomoke Sd. to Potomac River. No. 133.

Last edition (first edition, 1863), 25x38 (class F). Scale 1/80000, or 0.79 inch to a mile.

——— Chesapeake Bay. Magothy River to Head of Bay. No. 136.

Last edition (first edition, 1863), 29x38 (class F). Scale 1/80000, or 0.79 inch to a mile.

——— Chesapeake Bay. Potomac River, Entrance to Piney Pt. No. 388.

Last edition (first edition, 1868), 23x30 (class F). Scale 1/60000, or 1.06 inches to a mile.

——— Potomac River—Piney Pt. to Lower Cedar Pt. No. 389.

Last edition (first edition, 1868), 23x29 (class F). Scale 1/60000, or 1.06 inches to a mile.

1878.

Hopkins, G. H. Atlas of fifteen miles around Washington including the county of Prince George. 4°. Phila. 1878.

Contains outline map of Montgomery county. Scale 2¼ miles to an inch.
Outline map of Prince George (Md.). Scale 2¼ miles to an inch.
Fairfax and Alexandria (Va.). Scale 2¼ miles to an inch.
Rockville Dist. 4th Montgomery. Scale 2 inches to a mile.
Berry Dist. 5th. Scale 2 inches to a mile.
Mechanicsville Dist. 8th. Scale 2 inches to a mile.
Cracklin Dist. 1st. Scale 2 inches to a mile.
Clarksburg Dist. 2nd. Scale 1¼ inches to a mile.
Bethesda Dist. 7th. Scale 2 inches to a mile.
Medley Dist. 3rd. Scale 1¼ inches to a mile.
Damestown Dist. 6th. Scale 1½ inches to a mile.
Vansville Dist. 1st Prince George. Scale 2 inches to a mile.
Bladensburg Dist. 2nd. Scale 2 inches to a mile.

Nottingham Dist. 4th. Scale 1½ inches to a mile.
Piscataway Dist. 5th. Scale 2 inches to a mile.
Upper Marlboro' Dist. 3rd. Scale 1½ inches to a mile.
Spalding Dist. 6th. Scale 2 inches to a mile.
Aquasco Dist. 8th. Scale 1½ inches to a mile.
Laurel Dist. 10th. Scale 2 inches to a mile.
Surrats Dist. 9th. Scale 2 inches to a mile.
Brandywine Dist. 11th. Scale 1½ inches to a mile.
Queen Anne Dist. 7th. Scale 2 inches to a mile.
Oxen Hill Dist. 12th. Scale 2 inches to a mile.
Kent Dist. 13th. Scale 1½ inches to a mile.
Fourteenth Dist. Scale 2 inches to a mile.
District of Columbia, 4 sheets, 4 inches to a mile.
Town plats and Virginia counties, etc. (Peabody.)

HOPKINS, G. M. Atlas of fifteen miles around Baltimore including Anne Arundel County. 4°. Phila. 1878.

Contains outline map of Anne Arundel county and 15 miles around Baltimore. Scale 2¼ miles to an inch.
1st Dist. Anne Arundel county. Scale 1½ inches to a mile.
2nd Dist. Anne Arundel county. Scale 1½ inches to a mile.
3rd Dist. Anne Arundel county. Scale 1⅓ inches to a mile.
4th Dist. Anne Arundel county. Scale 1½ inches to a mile.
5th Dist. Anne Arundel county. Scale 2 inches to a mile.
8th Dist. Anne Arundel county. Scale 1½ inches to a mile.
1st and 13th Dists. Baltimore county. Scale 2 inches to a mile.
2nd Dist. Baltimore county. Scale 2 inches to a mile.
3rd Dist. Baltimore county. Scale 2 inches to a mile.
4th Dist. Baltimore county. Scale 2 inches to a mile.
9th Dist. Baltimore county. Scale 2 inches to a mile.
8th and 10th Dists. Baltimore county. Scale 2 inches to a mile.
11th Dist. Baltimore county. Scale 2 inches to a mile.
12th Dist. Baltimore county. Scale 1¾ inches to a mile.
1st Dist. Howard county. Scale 3 inches to a mile.
2nd Dist. Howard county. Scale 2 inches to a mile.
Plats of towns, etc. (Peabody.)

HOPKINS, G. M. Atlas of fifteen miles around Baltimore including Howard County. 4°. Phila. 1878.

Contains outline map of county and fifteen miles around Baltimore. Scale 2¼ miles to an inch.
2nd Dist. Scale 2 inches to the mile.
1st Dist. Scale 3 inches to the mile.
3rd Dist. (Cross Dist.). Scale 1½ inches to the mile.
4th Dist. (Lisbon). Scale 1½ inches to the mile.
5th Dist. Clarksville. Scale 1⅞ inches to the mile.
6th Dist. Guilford. Scale 2¼ inches to the mile.
2nd Dist. Baltimore county. Scale 2 inches to the mile.
3rd Dist. Baltimore county. Scale 2 inches to the mile.
9th Dist. Baltimore county. Scale 2 inches to the mile.
8th and 10th Dist. Baltimore county. Scale 2 inches to the mile.
11th Dist. Baltimore county. Scale 1¾ inches to the mile.
12th Dist. Baltimore county. Scale 2 inches to the mile.
3rd Dist. (Anne Arundel). Scale 1⅓ inches to the mile.

4th Dist. (Anne Arundel). Scale 1½ inches to the mile.
5th Dist. (Anne Arundel). Scale 2 inches to the mile.
Map of state, etc. (Peabody.)

Martenet, Simon. Map of Harford County.
Scale 1 mile to 1½ inches. (Belair.)

Ratzel (Frieder). Geologische Karte der Vereinigten Staaten.
Die Vereinigten Staaten von Nord Amerika, vol. i, p. 28. München, 1878.
Perhaps reduced from 3rd issue of Hitchcock & Blake (?). (Marcou.)

Twinning, Wm. I. (?). Plat of award with certificates signed by Boundary Commissioners and Governors 9th Sept. 1878.
Platted on coast chart No. 33, Chesapeake Bay sheet No. 3, of U. S. Coast and Geodetic Survey. Scale 1/80000. (Peabody.)

1879.

Hopkins, G. M. Atlas of fifteen miles around Washington including the County of Montgomery, Md. 4°. Phila. 1879.
Same as Hopkins "Prince George," but with different title.

Macfarlane, J. Geological sketch of the United States.
An American geological railway guide, p. 216. New York, 1879.
Octavo, black etching and numbers. (J. H. U.)

1880.

Anon. Topographical Map of the District of Columbia showing the Projected Harbor Improvements (etc). corrected to 1880.
20x20, contour, symbols. Scale 3000 ft. to an inch. (J. H. U. Hist.)

U. S. Coast and Geodetic Survey. Patuxent River (lower part). No. 386. Last edition (first edition, 1859).
19x22 (class F). Scale 1/60000, or 1.06 inches to a mile.

About 1880.

Frederick County, Maryland (manuscript.)
19x20. Scale 2 miles to an inch. Drainage in blue, roads in red, railroad in black. (Looks like base of county map.) (Amer. Geog. Soc.)

(Map of Gunpowder River).
22½x11⅝, hachure. Scale 72 inches to a mile. (Peabody.)

Kettlewell, S. H. Plan and Profile of Proposed Diversion of Jones Falls from Belvidere Bridge to Head of Back Creek (etc).
34x16, hachured. Scale about 875 feet to an inch. (J. H. U. Hist.)

SMITH, J. C. & RAE. Smith's Topographical Map of Virginia and Maryland.

13x24¾, colored, with shading to represent hachures. Roughly drawn. Scale about 25 miles to an inch. (Amer. Geol. Soc.)

——— Enlarged map of the Coast from New York Harbor to Cape Fear (2 sheets).

12½x40, outline. Scale 12½ miles to an inch. (J. H. U. Hist.)

STRONG. Map of Queen Anne County. (Williams.)

WORCESTER. Map shewing the Several Surveys for the Western Maryland Railway.

Lith. Hoen. 16¼x32¾, hachured with profile. Scale 3 inches to a mile. (Peabody.)

1881.

ANDREE, RICHARD. Vereinigten Staaten von Nord Amerika.

Allgemeiner Hand Atlas in sechs- und achtzig Karten mit erlauternden text. Bielefeld u. Leipzig, 1881.

14¼x9½. drainage, colored, hachure. Scale 1:10000000. (J. H. U.)

——— Die Nordast Staaten der Union.

Allgemeiner Hand Atlas [etc.]. Bielefeld u. Leipzig, 1881.

14¼x9½, drainage and principal towns, hachured, colored. Scale 1:5000000. (J. H. U.)

COLTON. Colton's new topographical map of the States of Virginia, West Virginia, Maryland and Delaware and portions of adjoining States. New York, C. W. & C. B. Colton & Co. 1881.

30x43, colored. (Phillips.)

HITCHCOCK, C. H. Geological Map of the United States. Scale 20 miles to the inch. New York, 1881.

(Rev.) Amer. Jour. Sci., 3rd ser., vol. xxi, 1881.

13 ft. x 8 ft, colors. Scale 20 miles to an inch. Wall map.

REESE, GEORGE M. Map of the uppermost part of the Peninsula showing the location of Indian forts . . . boundary line etc.

Johnston's History of Cecil county.

12x12. Scale 5 miles to an inch.

U. S. COAST AND GEODETIC SURVEY. Patuxent River—Pt. Judith to Nottingham. No. 387. Last edition (first edition, 1860).

19x22 (class F). Scale 1/30000, or 2.11 inches to a mile.

1882.

ANON. (Maryland, Delaware.)

Rand, McNally & Co.'s Indexed Atlas of the World. Chicago, 1882.

Several editions of different dates.

19x12¾, countries colored, rough hachure, 11½ miles to an inch. (Peabody.)

Hitchcock, C. H. Gray's Geological Map of the United States.

The National Atlas. Stedman & Brown, Phila., 1885, p. 205.

24¾x15⅝, 9 colors. Scale 1/7466470, or 118 miles to an inch.

Little or no alluvium on Western Shore. Seven formations distinguished in Maryland. (J. H. U.)

Robinson, E. Map of Baltimore and Vicinity. E. Robinson (?). New York, 84 Nassau St. 1882. (Williams.)

U. S. Coast and Geodetic Survey. Baltimore Harbor and Approaches with sub-charts of the Basin and Sparrows Point on scale 1/10000. No. 384. First edition (last edition, 1895).

27x39 (class F). Scale 1/40000, or 1.58 inches to a mile.

——— Potomac River. Lower Cedar Point to Indian Head. No. 390.

First edition, 1862.

23x29 (class F). Scale 1/60000, or 1.06 inches to a mile.

1884.

Chester, F. D. Map showing Distribution of Delaware Gravels—Northern area.

Amer. Jour. Sci., 3rd ser., vol. xxvii, 1884, p. 192.

3¾x4¾. Scale about 9 miles to an inch.

Comprises in area the larger portion of New Castle and all of Cecil county, Md.

De Laet. Nova Anglia, Novum Belgium et Virginia (1630).

Winsor's Narrative and Critical History, vol. iii. Boston, 1884. p. 124.

Farrer, Virginia. A mapp of Virginia discovered to ye Hills [etc].

Winsor's Narrative and Critical History, vol. iii. Boston, 1884. p. 464.

See 1651.

Heilprin, A. Heilprin on Tertiary Geology of Eastern and Southern United States.

Contributions to the Tertiary Geology and Paleontology of the United States, by Angelo Heilprin. Phila., 1884.

11x15, colored. Scale about 120 miles to an inch.

Heilprin, A. On Tertiary Geology of Eastern and Southern United States.

Jour. Acad. Nat. Sci., Phila., 2nd ser., vol. ix, 1884.

10x15, outline with six colors. Scale about 120 miles to an inch.

HERMANN, A. (Map of Maryland) (1635).
Winsor's Narrative and Critical History, vol. iii. Boston, 1884. p. 523.
Reduced reproduction.

HEWES, F. W., and GANNETT, HENRY. Map of the United States showing the Principal Topographical features.
Scribner's Statistical Atlas of the United States, by Fletcher W. Hewes and Henry Gannett.
25½x17⅝, hachured, colored. Scale 44 miles to an inch. Drainage, topography, prominent towns. (J. H. U.)

HOTCHKISS, J. Geological Map of Virginia and West Virginia. The Geology by Prof. W. B. Rogers chiefly from the Virginia State Survey " with later observations in some parts."
Geology of the Virginias. Appleton, 1884.
17x10, eleven colors. Scale 1/1520, or 24 English statute miles to an inch.

SMITH, JOHN. Virginia.
Winsor's Narrative and Critical History, vol. iii. Boston, 1884. p. 167.
Reproduced reproduction.

——— [Virginia.]
The General Historie etc. Third Book 1624, A reprint, with variations of the Second Part of The Map of Virginia 1812.
Eng. Scholars' Library No. 16. Birmingham, 1884.
15¾x12¼. Scale 5¾ leagues to the inch.

THOMAS, GABRIEL. Pennsylvania and West Jersey.
Winsor's Narrative and Critical History, vol. iii. Boston, 1884. p. 501.
Reduced reproduction.

WEBSTER, ALBERT L. Baltimore and its Neighborhood. An Excursion Map compiled for the Johns Hopkins University, etc. Edited by Albert L. Webster. Drawn by Louis Neil. Baltimore, Johns Hopkins University, 1884.

1885.

BROMLEY, G. W. & W. S. Atlas of Baltimore, Md. (incomplete) 2 vols. 1885.
(See 1896.) (Peabody.)

LAING, JOHN. Topographical Map of Portions of Maryland and Pennsylvania showing the crossing of the Blue Ridge Mountains by the Western Maryland Railroad [etc]. 1895.
22x16½, hachured. Scale 2⅔ inches to a mile. (J. H. U.)

MARTENET, S. J. Map of Maryland, Atlas edition.
Scale 15 miles to an inch, or 1/950400. (Martenet.)

——— Martenet's map of Maryland and District of Columbia, 1885.

72x46. Districts tinted, ridges hachured. Scale 3½ miles to an inch, or 1/221760. (Peabody.)

1886.

BENTON, EDWARD R. Map of Eastern Maryland, showing location of iron orebands sampled.

10th Census, vol. xv, Mineral Industries of the United States. Washington, 1886.

6x6, outline. Scale approx. 10 miles to an inch.

PUMPELLY, RAPHAEL. Geological Distribution of the Iron Ores of the United States.

10th Census, vol. xv, Mineral Industries. Washington, 1886.

11x18, colored. Scale 83½ miles to an inch.

WILLIAMS, G. H. Geological map of the Baltimore Gabbro-area, colored upon a portion of the Johns Hopkins University Excursion map.

Bull. U. S. Geol. Survey No. 28. Washington, 1886.

11½x13 5/16, five colors. Scale 1/62500. Actual outcrops and generalized distribution represented. (J. H. U.)

1887.

HITCHCOCK, C. H. Geological map of the United States.

Trans. Amer. Inst. Min. Eng., vol. i, pp. 465.

WEBSTER, ALBERT L. Baltimore and its neighborhood. An Excursion Map compiled for the Johns Hopkins University, etc. Edited by Albert L. Webster. Drawn by Louis Neil. Second edition. Johns Hopkins University. 1887.

25x25, outline. Scale 1 mile to an inch.

WINSOR, JUSTIN (?). Map of Maryland (showing original charter Boundary and the present Boundary).

Winsor's Narrative and Critical History of America, vol. v. Boston, 1887. p. 272.

5x7½. Scale 33 miles to inch.

1888.

ANON. Sketch showing Progress of Triangulation in the Appalachian Region to June 30, 1886.

Seventh Ann. Rept. U. S. Geol. Survey, 1888, pocket.

23½x19, black, outline. Scale 30 miles to an inch. (J. H. U.)

ANON. [Maryland, Delaware].

Rand, McNally & Co.'s Improved Indexed Business Atlas and Shippers' Guide No. 173. Chicago, 1888. 17th edition.

19x12¾, same base as 1882, but uncolored. (Peabody.)

This map has been published several times in different editions.

McGEE, W J Drainage map of the Middle Atlantic Slope.

Seventh Ann. Rept. U. S. Geol. Surv., 1888, facing p. 548.

6⅝x9½, outline and drainage. Scale 1/2230000, or 35 miles to an inch. Shows fall line and divide. (J. H. U.)

——— Map of the Head of Chesapeake Bay. Showing the Distribution [and coarseness] of the Columbia Formation.

Seventh Ann. Rept. U. S. Geol. Surv., 1888, facing p. 552.

6⅝x7⅝, colored. Scale 1:320000, or 5 miles to an inch. (J. H. U.)

——— Stereogram of the Middle Atlantic Slope.

Seventh Ann. Rept. U. S. Geol. Surv., 1888, after p. 586.

9½x9½, colored, shaded, sections. Horizontal scale 1:2230000, or 35 miles to an inch; vertical scale 1:425000, or 35000 ft. to an inch. Shows form of the continental platform. (J. H. U.)

RIPPEY, Jos. Index Map of Baltimore. New York 1888.

Scale 500 feet to an inch. (Williams.)

UHLER, P. R. [The Distribution of the Albirupean Formation in Maryland.]

Proc. Amer. Phil. Soc., vol. xxv, 1888, p. 51.

4x4, outline, geological shading. Scale about 20 miles to an inch.

1889.

U. S. COAST AND GEODETIC SURVEY. Annapolis Harbor. No. 385.

Last edition (first edition, 1859).

30x32 (class L). Scale 1/10000, or 6.34 inches to a mile.

1890.

BARTHOLOMEW, J. New York, New Jersey, Pennsylvania, Maryland and Delaware with environs of New York and Philadelphia.

The Library Reference Atlas of the World, by John Bartholomew. London, Macmillan, 1890.

11⅝x16, outline, drainage, hachured, states colored. Scale 33 miles to an inch. (Peabody.)

CHESTER, F. D. Map of Gabbro Area in Delaware, by F. D. Chester.

Bull. U. S. Geol. Survey, No. 59, Washington, 1890, p. 7.

Includes northeast corner of Maryland as far east as Elkton.

Flaherty, W. T. Map of Canton with Adjoining Portion of Baltimore city. Drawn by W. T. Flaherty.

34¾x23¼, outline. Scale 1000 ft. to an inch.

Smith, John. Virginia. Discovered and Described by Captayn John Smith, graven by William Hole.

Facsimile [reduced] in "Genesis of the United States," by Alexander Brown, vol. ii, p. 596. Boston, 1890.

5¾x7¾.

Tyndall, Robt. or Pownall, Captain.

The Genesis of the United States, by Alexander Brown, vol. i, p. 456. Boston, Houghton, Mifflin & Co., 1890.

28¾x20¾. Scale 100 leagues to 5¾ inches. (Peabody.)

U. S. Coast and Geodetic Survey. Isle of Wight to Chincoteague Inlet. No. 128.

First edition, 1866. 30x33 (class F). Scale 1/80000, or 0.79 inches to a mile.

U. S. Geological Survey. Topographical Sheets. Baltimore.

First edition (last edition, 1896) 13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets, Mt. Vernon.

First edition (last edition 1897), 13⅝x17½, 50 feet contour. Scale 1/125000.

1891.

Bradley, [F. H.] Delaware, Maryland, Virginia and West Virginia.

Bradley's Atlas of the World. Phila., 1891. No. 61.

23¾x15. Counties colored, drainage, towns and railroads. Scale 20 miles to an inch. (J. H. U.)

Clark, W. B. Distribution of the Eocene in the United States.

Bull. U. S. Geol. Survey No. 83, 1891, p. 147.

12¼x8, outline, one color. Scale 250 miles to an inch. (J. H. U.)

Dall, W. H. Map of the Known Distribution of the Neocene Formations in the United States.

Bull. U. S. Geol. Survey No. 84. Washington, 1892. p. 178.

14¾x8¼. eight colors. Scale about 515 miles to an inch. (J. H. U.)

Darton, N. H. Preliminary Geologic Map of Eastern Virginia and Maryland.

Bull. Geol. Soc. Amer., vol. ii, 1891, p. 431.

4¾x7½, seven patterns. Scale 25 miles to an inch. (J. H. U.)

Geiger, H. R., and Keith, Arthur. Geologic Map of Harper's Ferry Region.

Bull. Geol. Soc. Amer., vol. ii, 1891, pl. 4.

4½x5¾, outline, geological shading. Scale 6 miles to an inch.

LINDENKOHL, A. Middle Atlantic Coast Region.
Amer. Jour. Sci., 3rd ser., vol. xli, 1891, p. 492.
7⅞x8, contours at 150,300 and 400 ft. Scale 1/2000000, also 20, 100, 500, 1000, and 1500 fathoms lines.

MCGEE, W J Physiography of the Coastal Plain of Southeastern United States by W J McGee.
Twelfth Ann. Rept. U. S. Geol. Survey, vol. i. Washington, 1891. Pocket.
21x16½, land and marine contours. Scale 1/5000000. On this same basis are also:—

——— Areal Distribution of the Columbia and Lafayette Formations of Southeastern United States.
2 colors.

——— Physiography of the Coastal Plain of Southeastern United States during the Lafayette Period.

——— Physiography of the Coastal Plain of Southeastern United States during the Post-Lafayette and Pre-Columbia Period.

——— Physiography of the Coastal Plain of Southeastern United States during the Columbia Period.

U. S. GEOLOGICAL SURVEY. Topographical Sheets. Relay.
First edition (last edition, 1896).
13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. West Washington.
13⅝x17½, 20 ft. contour. Scale 1/62500, or one mile to an inch.

WALCOTT, C. D. Distribution by Geological Provinces of the Cambrian Strata as shown by Surface Outcrops in North America by C. D. Walcott.
Bull. U. S. Geol. Survey No. 81. Washington, 1891, p. 358.
12x8, outline, one color. Scale about 315 miles to an inch. (J. H. U.)

WHITE, C. A. Map showing the Distributions of Cretaceous Formations of North America.
Bull. U. S. Geol. Surv. No. 82. Washington, 1891, p. 268.
8x10, two colors. Scale about 515 miles to an inch. (J. H. U.)

WHITE, I. C. Map Showing the general distribution of the Upper and Middle Carboniferous Formations in the Bituminous Coal Regions of Pennsylvania, West Virginia, and Ohio by I. C. White 1888.
Bull. U. S. Geol. Survey No. 65. Washington, 1891, p. 1.
22½x23, outline, six colors. Scale 16 miles to an inch, or 1/1584000. (J. H. U.)

WILLIAMS, G. H. Piedmont Plateau in Maryland.
Bull. Geol. Soc. Amer., vol. ii, 1891, p. 301.
4¾x7½, outline with four patterns. Scale about 14 miles to an inch. (J. H. U.)

1892.

ANON. Uebersicht von Nord Amerika nach den geologischen Vermessungen von Canada, der Vereinigten Staaten und anderen Quellen.
Berghau's Physikalischer Atlas, 3rd edit. Gotha, 1892.
16x13, six colors, scale 1:30000000. (J. H. U., Peabody.)

DARTON, N. H. Baltimore sheet (U. S. G. S. preliminary edition).
Guide to Baltimore.
See Williams.

MARYLAND STATE WEATHER SERVICE. Map of Maryland and Delaware showing the Precipitation and lines of mean temperature for —.
Monthly Report, 1892-3, vol. ii and vol. iii.
Maps given for May-December.

RUSSELL, I. C. New York, Virginia and other Newark areas.
Bull. U. S. Geol. Survey No. 85. Washington, 1892. p. 21.
7¾x9½, four colors. Scale 35 miles to an inch. (J. H. U.)

U. S. COAST AND GEODETIC SURVEY. Delaware and Chesapeake Bays. No. 376.
Last edition (first edition, 1855), 26x34 (class F). Scale 1/400000, or 0.16 inch to a mile.

U. S. GEOLOGICAL SURVEY. Topographical Sheets. Annapolis.
First edition (last edition, 1896), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Baltimore [Special].
13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Drum Point.
First edition (last edition, 1896), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Ellicott.
First edition (last edition, 1896), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Leonardtown.
First edition (last edition, 1895) 13⅝x17½, 20 feet coutour. Scale 1/62500.

——— Topographical Sheets. Montross.
First edition (last edition, 1895), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Piney Point.
First edition (last edition, 1895), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Point Lookout.
First edition (last edition, 1894), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Prince Frederick.
First edition (last edition, 1895), 13⅝x17½. 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Wicomico.

First edition (last edition, 1895), 13⅝x17½, 20 feet contour. Scale 1/62500.

VAN HISE, C. R. Geological Map of the Northeastern States, showing pre-Cambrian and Crystalline rocks. After McGee and Hitchcock.

Bull. U. S. Geol. Survey No. 86. Washington, 1892. p. 349.

5¾x5¼, three colors. Scale 1/7600000. (J. H. U.)

WILLIAMS, GEO. H. (Editor). Geological Map of Baltimore and Vicinity.

Published by the Johns Hopkins University on the topographic base of the U. S. Geological Survey.

23¼x24, contour 20 feet. 18 colors. Scale 1/62500. (J. H. U.)

——— Same, without geological formations.

——— (editor). Baltimore Sheet (U. S. G. S. preliminary edition).

Guide to Baltimore, 1892.

17 colors and patterns. Scale 1/62500. Crystalline rocks by G. H. Williams, Sedimentary rocks by N. H. Darton.

——— Baltimore.

Guide to Baltimore, Amer. Inst. Min. Eng., 1892. Lith. by Hoen.

16x13¾, plan of streets, certain places in red. Scale 2⅞ inches to a mile.

1893.

DARTON, N. H. Magothy and Associated Formations in Northeastern Maryland.

Amer. Jour. Sci., 3rd ser., vol. xlv, 1893, p. 409.

3x4½. Scale 16 miles to an inch.

HARRIS, G. D. Map & Stratigraphy of Calvert Cliffs, Md.

Amer. Jour. Sci., 3rd ser., vol. xlv, 1893, p. 23.

5⅝x6½. Scale about 5 miles to an inch.

MCGEE, W J Reconnoissance Map of the Distribution of the Geologic System so far as known.

14th Ann. Rept. U. S. Geol. Survey, part i. Washington, 1894. Pocket.

13 sheets, 28¼x17½. contoured, colored. Scale about 110 miles to an inch.

MARYLAND STATE WEATHER SERVICE. Map of Maryland and Delaware showing the Precipitation and lines of mean temperature for 1893.

Monthly Report, 1893-4, vol. iii and vol. iv.

Maps given for each month in the year.

MARYLAND STATE WEATHER SERVICE. Climatic Charts of Maryland, including Delaware and the District of Columbia, together with a Map showing the distribution of the Geological and Soil Formations.

TORBET, J. B. Map of Maryland, showing the present status of the new U. S. Topographical Survey. 1892.
Johns Hopkins University Circulars No. 103, vol. xii, p. 44.
7½x4⅝, outline. Scale 33⅓ miles to an inch. (J. H. U.)

U. S. GEOLOGICAL SURVEY. Topographical Sheets. Gunpowder.
First edition (last edition, 1896), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. North Point.
First edition (last edition, 1896), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Sharps Island.
First edition (last edition, 1896), 13⅝x17½, 20 feet contour. Scale 1/62500.

——— Topographical Sheets. Mt. Vernon.
(Last edition, 1896), 13⅝x17½, 20 feet contour. Scale 1/12500.

WILLIAMS, G. H. (Editor). A Preliminary Geological map of Maryland [etc].
Maryland, Its Resources, Industries, and Institutions.
30½x17⅞, drainage, 29 colors. Scale 1/5000000 or 8 miles to an inch.

WHITNEY, MILTON. Map showing the Area and Distribution of the Principal Soil Formations in Maryland.
Bull. No. 21, Md. Agri. Exper. Sta., College Park, 1893.
Monthly Rept. Md. State Weather Service, vol. iii, 1893, p. 17.
5x9. Scale 30 miles to an inch.

WILLIS, BAILEY. Map of the Structural Districts of the Appalachian Province.
13th Ann. Rept. U. S. Geol. Survey. Washington, 1893.
Drainage, five colors. Scale approximately 74 miles to an inch. (J. H. U.)

1894.

ANON. Supplement to the Baltimore American, June 26th, 1894.
11¼x25, outline, drainage. Scale 15 miles to an inch. (J. H. U.)

DARTON, N. H. Map of the Middle Atlantic region to illustrate the extent of the Pleistocene submergence.
Jour. Geol., vol. ii, 1894, p. 583.
4¾x5¾, shaded. Scale about 50 miles to an inch.

——— Map of the Middle Atlantic Slope indicating the conditions in the time of Post Columbia maximum uplift [etc].
Idem, p. 585.
Black and white. Scale about 50 miles to an inch.

——— Fredericksburg Folio.

Geologic Atlas of the United States, folio No. 13. Washington, 1894.
13⅞x17½, contours 50 ft., seven colors. Scale 1/125000. (J. H. U.)

Douglas, H. T. (Eng.). City of Baltimore Topographical Survey (in 42 sheets).

27½x27½, contour interval 5 ft. Scale 26.4 inches to a mile.

Grimsley, G. P. Geological map of the Northwestern Portion of Cecil County, Maryland.

Cincinnati Soc. Nat. Hist., vol. xvii, 1894.
5x6½, six patterns. Scale 2 miles to an inch. (J. H. U.)

Keith, A. Harpers Ferry Folio.

Geologic Atlas of the United States, folio No. 10. Washington, 1894.
13⅞x17½, contour 100 ft., 15 colors. Scale 1/125000.

——— Geologic map of the Catoctin Belt by Arthur Keith 1893.

14th Ann. Rept. U. S. Geological Survey. Washington, 1894. Part ii. p. 309.
10x13, contour 200 ft., 16 colors. Scale 1/375000. (J. H. U.)

——— Map of the Tertiary Base-level by Arthur Keith.

14th Ann. Rept. U. S. Geol. Survey, part ii. Washington, 1894. p. 377.
10x13, contour 100 ft., colored. Scale 1/375000. (J. H. U.)

Maryland State Weather Service. Map of Maryland and Delaware showing the Precipitation and lines of mean temperature for 1894.

Monthly Report, 1894-5, vol. iv and vol. v.
Maps given for each month in the year.

Weeks, T. D. Upper Potomac and Elk Garden Coal Basins.

14th Ann. Rept. U. S. Geol. Survey, part ii. Washington, 1894. p. 580.
12½x6½, contoured, with some geological lines. Scale 3¾ miles to an inch.

Williams, G. H. Map showing the known and probable occurrences of Ancient Volcanic Rocks in Eastern North America, by George Huntington Williams 1893.

Jour. Geol., vol. ii, p. 1, 1894.
6x7¾, outline, colored geologically in two colors. Scale about 200 miles to an inch. (J. H. U.)

1895.

Anon. Map of the Cumberland, Georges Creek Coal Region. 1895.

17½x25. Property and railroad lines, also line of outcrop of "Big Vein." Hachured. Scale 1 mile to an inch. (J. H. U.)

KEYES, C. R. Map of Central Maryland showing the Distribution of the Granites by ("G. H. Williams") C. R. Keyes.

15th Ann. Rept. U. S. Geol. Survey. Washington, 1895.

6x7⅝, outline, drainage, areas colored. Scale 11 miles to an inch.

MARYLAND STATE WEATHER SERVICE. Map of Maryland and Delaware showing the Precipitation and lines of mean temperature for 1895.

Monthly Report, 1895-6, vol. v and vol. vi.

Maps given for each month in the year.

U. S. COAST AND GEODETIC SURVEY. Chesapeake Bay. Choptank River to Magothy River. No. 135.

Last edition (first edition, 1863), 29x38 (class F). Scale 1/80000, or 0.79 inch to a mile.

——— Baltimore Harbor & Approaches with sub-charts of the Basin & Sparrows Point on scale 1/10000. No. 384.

Last edition (first edition, 1882), 27x39 (class F). Scale 1/40000, or 1.58 inches to a mile.

U. S. GEOLOGICAL SURVEY. Topographical Sheets. Brandywine.

13⅞x17½, 20 ft. contours. Scale 1/625000.

——— Topographical Sheets. Montross.

Last edition, 13⅞x17½, 20 ft. contours. Scale 1/62500.

——— Topographical Sheets. Nomini.

Last edition, 13⅞x17½, 20 ft. contours. Scale 1/125000.

——— Topographical Sheets. Owensville.

Last edition, 13⅞x17½, 20 ft. contours. Scale 1/62500.

——— Topographical Sheets. Piney Point.

Last edition, 13⅞x17½, 20 ft. contours. Scale 1/62500.

——— Topographical Sheets. Prince Frederick.

Last edition, 13⅞x17½, 20 ft. contours. Scale 1/62500.

——— Topographical Sheets. Washington.

29x19, contour interval 20 ft. Scale 1/62500. (J. H. U.)

1896.

BROMLEY, GEORGE W. & WALTER S. Atlas of the City of Baltimore, Maryland. 1 vol. fol. Phila. 1896.

33 sheets, 20¼x30¼. Scale 200 ft. to the inch. (Peabody.)

CLARK, W. B. Map showing Distribution of Eocene strata in Middle Atlantic Slope.

Bull. U. S. Geol. Survey No. 141, 1896, facing p. 13.

4⅝x7½, outline, drainage and geological shading. Scale 40 miles to an inch. (J. H. U.)

Darton, N. H. Map of Portions of Maryland, Virginia and District of Columbia showing distribution of the Potomac Formation in part overlain by Columbia and Lafayette formations from data furnished by N. H. Darton 1896.

Bull. U. S. Geol. Surv. No. 145, 1896, facing p. 14.

7⅝x19, four colors, geological outline, drainage. Scale 1/500000 or 8 miles to an inch. (J. H. U.)

——— Nomini Folio.

Geologic Atlas of the United States, folio No. 23. Washington, 1896.

13⅞x17½, contour 20 ft., four colors. Scale 1/125000.

——— The Coastal Plain region of Maryland and Delaware, showing relations of underground waters, by N. H. Darton.

Bull. U. S. Geol. Survey No. 138, 1896, pl. v.

8x9, colored, symbols. Scale 15 miles to an inch.

——— Map of Baltimore region, illustrating features of underground waters, by N. H. Darton.

Bull. U. S. Geol. Survey No. 138, 1896, pl. vii.

8x10, colored, symbols. Scale 1 mile to an inch.

Darton, N. H. & Taff, Jos. Piedmont Folio.

Geologic Atlas of the United States, folio No. 28. Washington, 1896.

13⅞x17½, contour 100 ft., colors. Scale 1/125000.

Maryland State Weather Service. Map of Maryland and Delaware showing the Precipitation and lines of mean temperature for 1896.

Monthly Report, 1896-7, vol. vi and vol. vii.

Maps given for each month, Jan.-April.

U. S. Coast and Geodetic Survey. Potomac River. From Indian Head to Georgetown. No. 391.

(First edition, 1862) 23x39 (class F). Scale 1/40000 or 1.58 inches to a mile.

U. S. Geological Survey. Topographical Sheets. Annapolis.

13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Baltimore.

13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Drum Point.

13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Ellicott.

13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Frederick.

13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Gunpowder.
13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Harpers Ferry.
13⅝x17½, 100 ft. contour. Scale 1/62500.

——— Topographical Sheets. Laurel.
13⅞x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Mt. Vernon.
13⅞x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. North Point.
13⅞x17½, 20 ft. contours. Scale 1/62500.

——— Topographical Sheets. Relay.
13⅝x17½, 20 ft. contour. Scale 1/62500.

——— Topographical Sheets. Sharps Island.
13⅞x17½, 20 ft. contour. Scale 1/62500.

Van Der Hoogt, C. W. (Sec). Map of Maryland, Delaware and District of Columbia prepared by the State Bureau of Immigration.
21x13¼, counties colored. Scale about 12 miles to an inch. (J. H. U.)

ADDENDA.

Baird, G. W. Experiment to Determine the Economic Vaporization of George's Creek Cumberland Coal, Under Conditions of Actual Practice on board the Dolphin in port.
Jour. Amer. Soc. Naval Eng., vol. vii, 1895, pp. 329-331.
The most careful determinations yet made are here recorded.

Hayden, H. H. Geological Sketch of Baltimore. (Baltimore Medical and Philosophical Journal, vol. I.)
Bruce's Amer. Min. Jour., vol. i, New York, 1814, pp. 243-248.
This is practically a reprint of the earlier publication written as an abstract by the author.

Mitchill, Saml. L. A Sketch of the Scenery in the region around Harper's ferry, where the ridge of Blue Mountains is penetrated by the joint waters of the Potomac and Shenandoah rivers. In a letter . . . . to the Editor; dated Harper's ferry, July 4th, 1812.
Bruce's Amer. Min. Jour., vol. i, New York, 1814, pp. 211-218.
The author discusses the geology and stratigraphy along the Potomac between Harper's Ferry and Washington and regards the slates as older than the limestones.

PART V

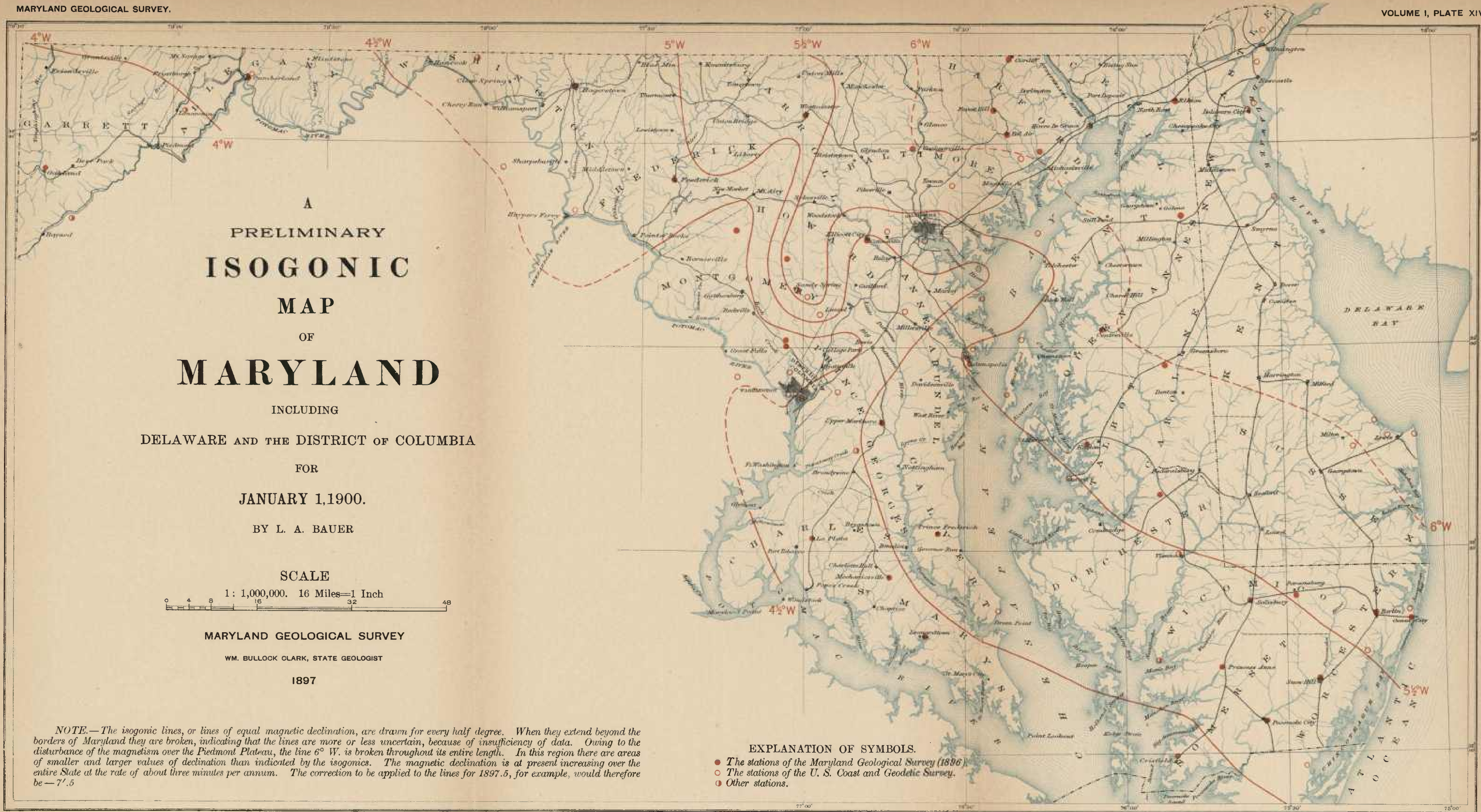
FIRST REPORT UPON MAGNETIC WORK IN MARYLAND

INCLUDING

THE HISTORY AND OBJECTS OF MAGNETIC SURVEYS

BY

L. A. BAUER



A PRELIMINARY ISOGONIC MAP OF MARYLAND

INCLUDING

DELAWARE AND THE DISTRICT OF COLUMBIA

FOR

JANUARY 1, 1900.

BY L. A. BAUER

SCALE

1 : 1,000,000. 16 Miles=1 Inch

MARYLAND GEOLOGICAL SURVEY

WM. BULLOCK CLARK, STATE GEOLOGIST

1897

NOTE.—The isogonic lines, or lines of equal magnetic declination, are drawn for every half degree. When they extend beyond the borders of Maryland they are broken, indicating that the lines are more or less uncertain, because of insufficiency of data. Owing to the disturbance of the magnetism over the Piedmont Plateau, the line 6° W. is broken throughout its entire length. In this region there are areas of smaller and larger values of declination than indicated by the isogonics. The magnetic declination is at present increasing over the entire State at the rate of about three minutes per annum. The correction to be applied to the lines for 1897.5, for example, would therefore be — 7′.5

EXPLANATION OF SYMBOLS.

- ● *The stations of the Maryland Geological Survey (1896).*
- ○ *The stations of the U. S. Coast and Geodetic Survey.*
- ◑ *Other stations.*

FIRST REPORT UPON MAGNETIC WORK IN MARYLAND.

INCLUDING

THE HISTORY AND OBJECTS OF MAGNETIC SURVEYS

INTRODUCTION.

A detailed magnetic survey of Maryland was conducted during 1896 by the writer under the auspices of the Maryland Geological Survey. The matter herewith presented forms the first part of a complete report on this work.

As it was made a special object to obtain the data that would be of direct benefit to the practical needs of the land surveyor of Maryland, this first report has been prepared with this object in view. The present communication must therefore treat primarily of the magnetic declination, its variation with time and locality. The requirements of a magnetic survey as regarded from the standpoint of the geologist and of the magnetician have, however, not been neglected. The presentation of the complete observations, their final reduction and discussion must be reserved, however, for future reports.

In addition to the funds provided by the Geological Survey, a small grant was made by the American Association for the Advancement of Science at the Buffalo meeting of 1896, for the purpose of "carrying on investigations on terrestrial magnetism in connection with the magnetic survey of Maryland." Additional data were also obtained in connection with the establishment of meridian lines at some of the county-seats, the cost of such lines being, according to the laws of Maryland, defrayed by the several counties themselves.

The entire instrumental outfit was courteously furnished by the

United States Coast and Geodetic Survey. Had it not been for this timely assistance and the hearty co-operation extended by the Coast and Geodetic Survey at all times during the progress of the magnetic survey, it could not have been carried out with such dispatch and success. The magnetic outfit—one of the best in the possession of the Coast and Geodetic Survey—will be described in detail in its proper place.

Assistance has also been rendered by the Magnetic Observatory of the Washington Naval Observatory. Unfortunately, however, owing primarily to the conditions under which the work at this observatory at present must be carried on, it was not possible to associate the work of the magnetic survey of Maryland as intimately with that of the Washington Magnetic Observatory, as the proximity of the latter to the base of operations of the survey would have made desirable and as would have been the custom abroad.

Requests for information with regard to magnetically disturbed days and for other data were promptly complied with by the Toronto Magnetic Observatory, Professor R. F. Stupart in charge.

Tho United States Geological Survey furnished such of its topographical sheets as were published at the time.

Again much valuable assistance was rendered by county commissioners, surveyors, school teachers and others in the selection of suitable sites for stations, and by telegraph operators, especially those of the Western Union Telegraph Company, in receiving or transmitting time signals. To all who have aided in carrying out the purposes of the Maryland magnetic survey, grateful acknowledgment is herewith made.

Personally, I desire to express my high appreciation of the encouragement given and the interest shown throughout the work by the State Geologist, Professor William Bullock Clark. Likewise do I wish to tender my thanks for the advice and suggestions which my former colleagues of the Coast and Geodetic Survey were ever ready to give me.

It should be added that in criticising this report the conditions under which the magnetic survey had to be prosecuted should be borne in mind.

THE DEVELOPMENT AND PURPOSES OF MAGNETIC SURVEYS.

THE MAGNETIC DECLINATION.

"True as the needle to the pole" is an old and familiar saying. How *untrue* it is even within the borders of our own country may be judged from the fact that in the extreme northeastern part of Maine the compass needle points twenty-one degrees to the *west* of north, while in the extreme northwestern part of the state of Washington it points twenty-three degrees to the *east* of north; hence a change of forty-four degrees from one end of our country to the other! And even over so comparatively small a territory as that of Maryland the pointing of the needle varies from six degrees west to three and one-half degrees west.

There are portions of the earth's surface where the needle points due *east* and *west* and still others where the north end actually points *south*. We are thus made acquainted with one element involved in a magnetic survey, viz., the *magnetic declination*, or "variation," as the mariner and the surveyor are accustomed to say. Scientifically defined, *the magnetic declination is the angle between the true north and south line and the magnetic north and south line as pointed out by a compass needle, i. e., a magnetized needle so mounted as to swing freely about a vertical axis or pivot.*

It was several centuries after the introduction of the compass in Europe before this deviation of the magnetic meridian from the true meridian was discovered, and the discoverer was no less a man than Christopher Columbus. We all doubtless remember reading of the consternation caused on board ship when it was observed that the compass had shifted its direction from *east* of north to *west* of north. Columbus had, in fact, crossed the line, on September 13th, 1492, along which the needle pointed true north, *i. e.*, the line of no magnetic declination or variation, or the so-called *agonic* line. To the east of this line the needle pointed east, and to the west the needle bore west.

This line lay a little to the west of Fayal Island of the Azores.[1] It will be remembered that this line figured quite prominently for many years in political geography as the line of demarcation between the kingdoms of Portugal and Castile.

It is only lately that Columbus has been properly credited with this discovery. Generally he is given credit merely for the discovery of the line of no declination. This is due to an error made by an Italian, Formaleoni, who declared that the compass charts in Bianco's famous atlas of 1436 contained on them values of the magnetic declination. Humboldt, relying on Formaleoni, repeated the error in his "Cosmos." Later researches have shown beyond a doubt that Formaleoni was wrong, having misinterpreted a diagram on one of the charts. So likewise has it been conclusively proven that the value of 5° E. for the magnetic declination at Rome in 1269, which had been ascribed to one Petrus Peregrinus, had been inserted in the Leyden manuscript in the early part of the sixteenth century.

An examination of the early compass charts made by the writer would indicate that during Columbus' time and a century or two before, the needle pointed approximately to the true north or by a small amount *east* over the entire Mediterranean. For this reason, probably, the magnetic declination was not discovered for so long a time after the European mariner had begun to rely on the bit of magnetized steel to guide the wanderings of his ship. Frequently statements are seen, with deductions based on them, that the needle pointed by a large amount (15°–20° and more) *west* in the Mediterranean in about the 14th or 15th century. This, however, cannot be the case.

It was not until near the middle of the sixteenth century that the fact of the "misdirection" of the needle—to translate literally the German word, *missweisung*, for magnetic declination—received general acceptance. It was believed, namely, that the needle's deviation from the true north was due to mechanical imperfections, and the compasses of

[1] According to Mr. Schott's computations, the place on Columbus' voyage where the needle pointed true north was in north latitude 28° 21′ and in longitude 29° 16′ west of Greenwich.—Coast and Geodetic Survey Report for 1888, Appendix 7, p. 305.

this period were frequently corrected for this deviation so that they would point to the true north.

The earliest land observation which has thus far come to our notice was made at Rome by Georg Hartmann, vicar at Nuremburg, of whom we shall again have occasion to speak, in the early part of the sixteenth century, probably in the first decade. The needle bore 6° E. In Paris in 1541, according to Bellarmartus, the declination of the needle was 7° E. and, in London, in 1580, William Boroughs found 11¼° E.

Observations now began to multiply, and *the year 1600 marks a distinct epoch in terrestrial magnetism*, for in this year, nearly three centuries ago, appeared one of the most remarkable books ever written. It was epoch-making not alone for its contents and the marvellous conclusions reached, but also for the truly philosophical art of reasoning employed. Not a conclusion was reached without being subjected to a rigorous experimental demonstration. In this respect it stood notably apart from similar books of its day, and in many respects it is still a standard work. The book to which I refer was none other than the great treatise on magnetism, "De Magnete," by Dr. William Gilbert of Colchester, physician-in-ordinary to Queen Elizabeth.[1]

The final conclusion reached by Gilbert with regard to the cause of the magnetic phenomena observed up to that time was summed up in the following sentence: "*Magnus magnes ipse est globus terrestris*" —"The terrestrial globe itself is a great magnet."

This was the first rational explanation of the action of a compass needle. Before that all sorts of fanciful theories were in vogue. Thus, for example, it was said that it was the attractive influence of the *pole star* which made the needle point approximately to the north.

The only modification that modern science could make with regard

[1] This was written in Latin, and strange to say, was translated into English only within the last few years. This translation was performed by P. Fleury Mottelay and published by Wiley and Sons, New York. It is entitled: WILLIAM GILBERT OF COLCHESTER, Physician of London, On the Loadstone and Magnetic Bodies and on The Great Magnet the Earth. A new Physiology, demonstrated with Many Arguments and Experiments.

to Gilbert's dictum would be that the earth *acts* like a great magnet, if it is not in itself a magnet. We do not as yet know definitely *whether the earth is a magnet or an electro-magnet, i. e.*, whether the earth acts upon a freely suspended magnetic needle as a permanently magnetized body, with definite magnetic poles or centers of attraction, or whether it acts like a soft piece of iron rendered temporarily magnetic by a current of electricity circulating around it. To put the matter tersely, no satisfactory answer has as yet been given to the question: "*Is the earth's magnetism permanent or induced?*" We know that the earth possesses magnetism in some form, but the *how* and the *whence*, in spite of innumerable attempts of some of the most brilliant minds to solve the riddles, are still mysteries.

Helmholtz characterized the earth's magnetism *as one of the most puzzling of natural forces.*

Since it can be mathematically demonstrated that it is always possible to distribute electric currents within the earth's crust in such a way that the *external* magnetic effect of these currents will be precisely the same as that due to a system of permanent magnets embedded in the earth, it follows that we can equally as well satisfy the magnetic phenomena observed on the earth's surface, on either hypothesis.

The electric current theory has many points in its favor, but thus far no adequate cause has been found, that is, one that would explain not only qualitatively but also *quantitatively* the currents and the *direction* in which they would have to proceed, *i. e.*, roughly from east to west around the earth. And Professor Schuster's question as to whether every large rotating mass is a magnet has not yet been experimentally attacked. There is a strong suspicion that the earth's rotatory motion has an important share in the production of the earth's magnetism.

Furthermore, we as yet have no knowledge *whatever* with regard to the actual distribution of magnetism within the earth's crust; nor shall we ever have so long as we confine our observations entirely to the *surface* of the earth. For an infinite number of distributions of magnetism can be found which will satisfy *surface* phenomena. What is needed is observations in the region above us—in balloons—

and in the depths below us—at the bottom of the sea. Let us hope that the means will soon be forthcoming to permit the making of such observations, so that continued progress, another step forward, may be made in the subject of the earth's magnetism!

The Secular Variation of the Magnetic Declination.

The year 1634 witnessed the discovery of the next remarkable fact with regard to the magnetic declination, the so-called *secular variation*, whereby the earth's magnetism suffers most remarkable changes in the course of time. It was an accepted fact by this time that the needle's deviation from the true north was not the same at all places, but varied with geographical position. But now an entirely new fact was clearly demonstrated. Henry Gellibrand, a professor of mathematics at Gresham College, after a careful determination made on June 12, 1634, at Deptford, about three miles southeast of London Bridge, found that the needle pointed 4° 6′ east, while Gunter, on June 13, 1622, had found the value of 5° 56½′ east, and, as above cited, Boroughs found the declination to be in London in 1580, 11° 15′ east. It was therefore clearly apparent that the declination or variation was changing and getting smaller. Gellibrand gives his conclusion thus:

"Hitherto, according to the tenets of our magnetical philosophers, we have supposed the variation of all particular places to continue one and the same. . . . But most diligent magnetical observations have plainly offered violence to the same, and proved the contrary, namely, that *the variation is accompanied with a variation.*"

He embodied his observations in a little treatise published in 1635.[1]

This fact of the "diminution of the variation" was likewise shown by the Paris observations. It seemingly was ascribed, however, to

[1] The title was, Henry Gellibrand: A Discourse Mathematical on the Variation of the Magneticall Needle, together with its admirable diminution lately discovered. London, 1635.

This interesting book has just been reprinted in facsimile under the editorship of the well-known meteorologist and bibliographer, Prof. Hellmann, of Berlin. It constitutes No. 9 of Hellmann's "Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus." A. Asher & Co., Berlin. Price, 3 marks.

defects in the earlier observations, and this likewise explains why Gunter had not reached the same conclusion as Gellibrand. The latter appears to have been the first one to publish the fact. Up to this time no particular pains had been taken to note the date of observation of the needle's declination, but now the importance of giving the date was made apparent.

The phenomenon of the secular variation—called *secular* for the reason that it requires many centuries for its fulfillment—is the one which most intimately concerns the land surveyor, who is obliged to retrace old lines referred to the compass direction. We shall enter more fully into this matter in the chapter specially devoted to its exposition.

The cause of this striking phenomenon constitutes one of the most refractory enigmas in the whole domain of geophysics. The best minds have given it their undivided attention. Innumerable and ingenious theories have been evolved, but the pearl of truth still lies hidden. Its discovery promises to disclose many another of nature's secrets. It also seems probable that the two causes, that of the origin of the earth's magnetism, as well as that of the secular variation, are so intimately connected that the discovery of the one will include that of the other. The question proposed by Schuster, as cited above, should be carefully investigated by experimental physicists and an exhaustive examination should be made of the resultant effect, by reason of the earth's rotation, of that part of the earth's magnetism which is not symmetrical about the rotation axis. No greater nor grander task has ever confronted the human mind than this of the investigation of the consequences and interactions which must necessarily result from the motions of our mighty geomagnet. The solution of this problem will do for *geophysics* what the accomplishment of the great task which Laplace set for himself did for *celestial physics.*

The phenomenon of the secular variation has been nowhere so carefully and thoroughly investigated as in this country and, in consequence, in no other country can such precise corrections for the secular shifting of the magnetic meridians be made, of which we shall give evidence in another chapter. This has been almost entirely due to the fact that in no other country has it been necessary to give the subject of the secular variation so much attention from the purely *practical* standpoint, as in this country. All the earlier surveys were referred to the magnetic meridian instead of the true meridian. And since in but very few cases the deviation of the magnetic meridian from the true one was determined by the early surveyor, it becomes a *practical* problem to know how much allowance shall be made for the shifting of the reference meridian of the early survey in order that the "metes and bounds" of the original plat can be re-located at some future date. One of the Eastern states is still so far behind the times as to recognize on its statute-book the *magnetic* meridian as the meridian of reference for land surveys! Even in Maryland no systematic effort has been made by the state to put the matter of its land surveying on a practical and scientific basis, so as to prevent costly and annoying litigations as far as possible in the future.

We are now acquainted with two of the practical objects of a magnetic survey:

a. The determination of the angle between the *true* north and south line and the *magnetic* north and south line.

b. The determination of the angle by which the magnetic meridian has shifted its direction during given intervals of time.

The accomplishment of these two objects suffices for the *practical* needs of the surveyor. The prosecution of a magnetic survey along these lines alone, however, will never materially advance our knowledge of the laws underlying and controlling the secular variation. There are, namely, other manifestations of the earth's magnetic force which demand recognition if we desire to make continued progress in the hope of being able ultimately to improve and perfect the laws which at present must be wholly empirical.

The Magnetic Inclination.

In the year 1576 a London mathematical instrument maker, Robert Norman, made the following important discovery, the account of which I shall give in his own words:[1]

[1] Quoted from his book: The New Attractive shewing the Nature, Propertie, and manifold Vertues of the Loadstone with the Declination of the Needle touched therewith under the Plaine of the Horizon, found out and

"Having made many and diverse compasses, and using alwaies to finish and end them before I touched the needle, I found continuallie that after I had touched the yrons with the stone, that presentlie the North point thereof woulde bend or decline downwards under the horizon in some quantitie; insomuch that to the flie of the compass, which was before levell, I was still constrained to put some small piece of ware on the South point and make it equall againe. Which effect having many times passed my handes without anie great regard thereunto, as ignorant of anie such propertie in the stone, and not before having heard nor read of anie such matter, it chaunced at length that there came to my hands an instrument to be made with a needle of sixe inches long, which needle after I had polished, cut of a just length, and made it stand levell upon the pin, so that nothing rested but onlie the touching it with the stone, when I had touched the same, presentlie the North part thereof declined down in such sort that being constrained to cut awaie some of that part to make it equall againe, in the end I cut it too short, and so spoiled the needle wherein I had taken so much paines. Hereby being stroken into some cholar, I applied myself to seeke further into this effect, and making certaine learned and expert men, my friends, acquainted in this matter, they advised me to frame some instrument to make some exact triall how much the needle touched with the stone would decline, or what greater angle it would make with the plaine of the horizon.

"Whereupon I made diligent proofes, the manner whereof is shewed in the chapter following."

Norman then proceeds to describe the instrument with which he determined the "declining" or dipping of the north end of the needle below the horizon. He found a dip of 71° 50′.

George Hartmann, of whom we have already spoken, had observed this dipping of the needle previous to Norman, in 1544 at Nuremburg, but he failed to make a precise determination, the value which he gave being about one-sixth of the true value at that time.

discovered by Robert Norman. London, 1576. Reprinted and attached to William Whiston's The Longitude and the Latitude found by the Inclinatory or Dipping Needle. London, 1721. We trust that this book will likewise form one of Hellmann's reprints.

The dip of the needle or the magnetic inclination is the second element involved in a magnetic survey. Scientifically defined *the magnetic inclination is the angle, measured in the vertical plane passing through the magnetic meridian, which a magnetized needle, mounted so as to move freely about a horizontal axis, makes with the plane of horizon.* The dip measured in the plane at right angles to the magnetic meridian would be 90°, *i. e.*, the needle would stand exactly vertical, while in the plane of the magnetic meridian it would have a *minimum* value for the place at which the measurements are made.

At the so-called " magnetic equator " the dip is zero, and hence the dipping needle perfectly horizontal. As we advance northward along a magnetic meridian of the earth the north end begins to dip downward by an amount continually increasing until we reach that point on the earth's surface usually designated as the north magnetic pole; here the needle stands precisely vertical with the north end down, just as it did at any place in the plane of the magnetic prime vertical—in the plane at right angles to the magnetic meridian. In the southern hemisphere the *south* end is the one which dips down, and precisely the same phenomena are exhibited by the south end in the magnetic southern hemisphere as by the north end in the northern.

In Maryland the magnetic dip or inclination varies from about 69½° in the extreme southern portion to about 71° in the extreme northern.

The magnetic dip, like the declination, is also subject to a secular variation.

Reference has been made above to the magnetic poles of the earth. This term is so generally misunderstood—the term being really an unfortunate one—that it will not be amiss to explain here what is meant. The so-called magnetic poles of the earth are those points *on the earth's surface* where the dipping needle stands exactly vertical. At these points the compass needle has no fixed direction, the declination having any value from 0° to 360°. This is due to the fact that at these places the part of the earth's magnetic force which acts on a compass needle has dwindled to nothing. Thus far two such points are known to us, one in the northern hemishphere and one in the southern. These points do not coincide with those points where the attractive force of the earth's magnetism is the greatest. There are *four* foci of maximum intensity, two in the northern hemisphere and two in the southern, none of which, as stated, fall together with the foci of vertical dip. The stronger of the two intensity foci in the northern hemisphere, according to Lefroy's observations in 1843–44, lies somewhat south of Hudson's Bay, in latitude 52° 10′ N. and in longitude 99° 59′ W. of Greenwich, whereas the point where the direction assumed by the dipping needle coincides with that of gravity is, according to Sir James Ross's observations of 1831, in Boothia Felix, in latitude 70° 05′ and longitude 90° 46′ west of Greenwich.

The "magnetic poles" of the earth are not to be compared with those of a bar magnet. *There are no points on the earth's surface which possess the same properties as the poles of a bar magnet.* Some time ago the writer received a letter in which a seemingly plausible argument was advanced to overthrow Gilbert's theory that the earth is a great magnet, the fallacy in the line of reasoning being due to the overlooking of the very fact just pointed out. The earth is a great *spherical* magnet and, as well known, the external action of such a magnet is analogous to that of a bar magnet at the centre of the sphere—a bar magnet whose magnetic moment is equal to that of the magnetized sphere, whose poles are infinitesimally close to each other and whose axis coincides with the axis of magnetization of the sphere.[1] The equivalent magnetic poles of the earth would therefore both lie near the centre of the earth.

[1] To obtain some slight conception of the magnetic moment of the earth, the figures below are given. Suppose we take as our unit, a bar magnet of the hardest steel, magnetized as strongly as possible, which shall be 14 inches long, one and a quarter inch wide—such a bar magnet would weigh one pound. According to Gauss, it would take the following number of such bar magnets placed at the earth's centre in order to produce the same external effect as the earth:

8,464,000,000,000,000,000,000.

Or if we assume that the earth's magnetism is uniformly distributed throughout the earth, then will the magnetic intensity of each cubic yard be equal to six of the one-pound steel magnets.

To put the same fact in still another form. The radius of a soft iron sphere magnetized to saturation, and concentric with the earth, which shall have the same magnetic effect as that of the earth, is, according to Overbeck, 243.2 kilometers, or 132.4 geographical miles, or 151 statute miles, or $\frac{1}{26}$ of the earth's radius.

If now the earth were homogeneously magnetized throughout instead of being heterogeneously magnetized, the line joining the equivalent magnetic poles, if prolonged, would pass through the points on the earth's surface where the dip is equal to 90°, and this line would be the magnetic axis of the earth. Now only about $\frac{7}{10}$ of the total force of the earth's magnetism can be referred to a homogeneous magnetization, the remainder being due to the inequalities in the earth's magnetization. Hence we must neither expect the points of vertical dip to lie diametrically opposite to each other nor the magnetic axis of that uniform magnetization part to coincide with a straight line passing through the earth and connecting the vertical dip foci. The former line passes through the earth's centre and connects the points on the surface, lying respectively in latitude 78°.3 N., longitude 67°.3 W., and in latitude 78°.3 S., longitude 112°.7 E., while the latter does not pass through the centre of the earth, but off to one side.

In consequence of the heterogeneous magnetization of the earth, a magnetic meridian line is not a straight line leading to the focus of vertical dip, but a very devious line indeed. And thus a great circle passed through the direction pointed out by a compass needle at any given place will not pass through the dip focus or so-called magnetic pole, and the intersection of two of such circles will not coincide with the magnetic pole of Ross. The average position of the successive intersections of the great circles thus drawn would coincide more nearly with the points above given, where the magnetic axis penetrates the earth's surface.[1]

[1] Before leaving the matter of the "magnetic poles" of the earth, it will be well to call to mind the definition due to Gauss, viz., that the magnetic poles are the points where the potential of the earth's magnetism has a maximum and minimum value. Now *if* the entire force of the earth's magnetism could be referred to a potential; if, for example, no part of terrestrial magnetism is due to electric currents which pass from the air into the earth or *vice versa*, *then* the points of maximum and minimum potential would coincide with those of the dip foci. But if a part of the earth's magnetism cannot be referred to a potential, then the two sets of points need not necessarily coincide. There would appear to be some indication that a small part of the earth's magnetism is of this nature.

Knowing the magnetic declination and the dip at any place, we can completely define the direction at that place along which the earth's magnetism acts. This direction would be that assumed by a magnetic needle so suspended that it would be free to move in every possible direction, not alone in the horizontal plane like the compass needle, nor alone in the vertical plane like the dip needle. We shall have occasion later on to investigate how this direction of the earth's magnetic force varies with the lapse of time.

The Diurnal Variation of the Earth's Magnetism.

In the year 1722 another remarkable fact came to light, namely, that the magnetic declination is subject to an appreciable *diurnal variation*. The discovery was made by Graham, a London instrument maker. It has been found since that not only the declination, but also the inclination and the force are subject to this diurnal variation. The precise cause of the diurnal variation has not as yet been satisfactorily demonstrated. That the Sun plays an important part is unquestionable, but the *modus operandi* is not yet known.

The Intensity of the Earth's Magnetic Force.

There remains one element more to be referred to before we have observed the earth's magnetism in its totality, namely, the *strength* or *intensity* of the attractive pull exerted on the magnetic needle by the earth as a magnet.

Let us suspend by a fine silk fibre a compass needle and enclose the same within an air-tight enclosure, so that there will be no air currents acting on the needle to disturb any position of rest it may assume. Let us now draw it aside from its position of rest with the aid of a bit of magnetized steel and then remove the latter. The needle, the moment it is free from the influence of the second magnet, endeavors to return to its original position, and thereby it performs a series of vibrations back and forth, the amplitudes of which continually decrease until finally the needle has come to rest in the position first occupied. At any given place it will be found that a definite number of complete swings or oscillations will be performed in a given interval of time. This number will be a constant or nearly so for a given place, except for slight variations, of which we will speak later, but will vary with change of place. The number of vibrations will decrease or, what amounts to the same thing, the time of one vibration will increase with approach towards the "magnetic pole." *The time of one vibration thus found is a measure of the intensity of the earth's magnetic force as exerted in the horizontal plane in which the needle swings,* the exact relation being that H, the horizontal component of the earth's magnetism, is equal to a constant divided by a square of the time, T, of one vibration. Suppose we obtain the value of T at two different places with the same magnet. Let these values be T_1 and T_2; then will the respective values of H at these two places be inversely to each other as the squares of the times of vibration, or

$$H_1 : H_2 : : T_2^2 : T_1^2,$$

hence,

$$H_2 = H_1 \frac{T_1^2}{T_2^2}.$$

We can thus obtain the horizontal intensity at any place in terms of some known or unknown value at some initial station. This is the principle of relative measurement of the earth's magnetic force.

The first one to apply this principle was William Whiston, chiefly famous as the translator of Josephus. His achievements in the domain of terrestrial magnetism have only recently been set forth. His researches were animated by his desire to determine the latitude and longitude at sea with the aid of magnetic observations, chiefly of dip. It will be recalled that the problem of determining longitude at sea was a perplexing one for a long time, and large prizes were offered for the best solutions. It is largely owing to this endeavor of the early magneticians to determine geographical position magnetically that observation data were so thoroughly multiplied and new facts brought to light.

Just so was it with Whiston. In his desire to win the coveted prize, and having apparently considerable influence at court and being, therefore, richly favored with money grants, he made a series of dip observations in various parts of southern England, and drew the earliest isoclinics—the lines connecting the places of equal magnetic dip—of which we have any record. At the same time he determined the time of vibration of a horizontally suspended needle at the stations where he observed the dip. This occurred in 1720. Had Whiston likewise observed the magnetic declination he would have had the honor of making the first complete magnetic survey on record. As it is we must credit him with the following achievements:

1. He drew the earliest isoclinics (1720).
2. He invented the vibration method for determining the dip.
3. He made the first relative intensity observations (1720).
4. The first intensity observations (1722) revealing the law of decrease of horizontal terrestrial magnetic force with approach towards magnetic pole were made under his instructions.

It is, furthermore, owing to Whiston's enthusiasm that we have a dip observation in this country dating back to 1722.

Improvements in the method of determining relative intensity were made by various magneticians and additional observations were made, notably by Humboldt and by Hansteen. No really marked advance, however, was made until Gauss, in the early part of the third decade of the present century, invented his method for determining the intensity *absolutely*. This gave a new and powerful impulse to the subject of terrestrial magnetism.

This method in principle was to eliminate the magnetic moment, m, of the suspended magnetic needle from the formula for the value of the horizontal intensity, H, with the aid of another formula, which involved the same quantities, m and H, but in different relations. In this second formula the known quantities were the angle of deflection caused when the magnetic needle, whose time of vibration had been determined, acted upon a second magnet at a definite distance and in a known relative position. Thus with the aid of two distinct sets of operations—one consisting of measurements of deflection angles and the other of noting the times of vibration—Gauss determined the absolute value of the strength of the earth's magnetic pull.

The second grand epoch in terrestrial magnetism is now ushered in. A wonderful enthusiasm and quickening spreads throughout the civilized world. A magnetic association is formed, magnetic observatories are established, magnetic surveys are begun, etc., etc. The magnitude, frequency, and simultaneity in time over large areas, of the magnetic disturbances or storms become known for the first time. It is perceived that the earth's magnetism is in sympathetic touch with a variety of hitherto unsuspected forces, and that gravitation is not the only bond that binds us in friendly union with our sister planets and our parent Sun. To quote from one of the most active workers of that period, Sabine:

"We have hitherto known magnetism only as a telluric force of much less apparent simplicity than gravity, and greatly requiring a key to enable us to apprehend its laws, as well as its purposes in the general economy of nature. But if, as we appear to have reason to believe, we are to view the magnetism not only as a *telluric* but also as a *cosmical* force, the interest and importance of our inquiries regarding it must undoubtedly be viewed as greatly augmented."

The total force, F, of the earth's magnetism is equal to the product of the horizontal component, H, into the secant of the magnetic inclination, I.

The Elements involved in Magnetic Surveys.

There are then three elements involved in a complete magnetic survey —the declination, the dip, and the intensity. These three quantities completely define the direction and magnitude of the earth's magnetic force. The determination of one element alone, for example, declination, does not any more constitute a magnetic survey than the determination of a number of latitudes would constitute a geographical survey. A latitude survey might fulfil certain definite and practical purposes, just as a declination survey will suffice for the practical needs of the surveyor. The more complete the geographical survey in all its details, the more complete the magnetic survey in all its details, the more to be obtained of direct benefit from such surveys.

In view of the fact that there is every evidence that the era of detailed magnetic surveys has set in in this country, it will not be amiss to set forth fully the desirability, if not indeed the absolute necessity, of making the survey a complete one at the very start, that is to say, of including in the survey the observation of the action of the earth's magnetism in its *entirety*, not simply to observe one angular component, *e. g.*, magnetic declination. Regarded from every possible point of view, from the *practical* as well as from the purely scientific, this course recommends itself.

What would we think of the astronomer who endeavored to adduce celestial laws by observing simply one celestial co-ordinate, *e. g.*, right ascension? By massing such right ascensions together in a statistical fashion he could compile certain statistical laws which would undoubtedly possess some value, but that he could never get at the real physical laws governing the phenomena is too apparent to require further argument. Nay, his statistical deductions might even lead him to adopt totally erroneous physical theories. Or, suppose the meteorologist should attempt to frame laws for weather prediction by observing and massing together simply one meteorological element, such as barometric pressure or temperature? True, this is the very thing that he must largely do in the present stage of meteorology, for the prime reason that he has not yet learned how to reach *all* the factors that control and shape the phenomena of the weather. He fully recognizes this and is making an earnest endeavor to get at the true physical laws by enlarging the scope of his methods of observation. And so the magnetician must be careful to start in the right way at the very beginning.

It is true that the practical needs of the land surveyor are largely satisfied, if not almost entirely, by a magnetic declination survey, such as for example the one so thoroughly carried out by the State Geological Survey of New Jersey, but erroneously designated a "magnetic survey." Declination surveys will supply the necessary data, such as declination, and when repeated, likewise the secular change of declination, but this data will always remain on the empirical plane, so long as simply declination data are at hand. We can never hope to reach the true laws of nature in this way.

The advantage to be derived in the deduction and verification of secular change data by a *combined* treatment whenever possible of *all* the magnetic elements involved, instead of the hitherto *independent* treatment of *each* element, has been clearly demonstrated by recent researches. We have in this way obtained a grasp of the secular variation phenomenon such as but a very few years ago we had no hope of possessing for many centuries to come. And the only reason why the grasp is not still more powerful is because of the very fact that we do not possess sufficient inclination and intensity data to go with the early observations of the magnetic declination.

If we next turn to the consideration of the so-called local disturbances we shall be most thoroughly convinced of the absolute necessity of observing the effect of the earth's magnetism in its *totality*. And this question of local disturbances is of no less interest to the practical needs of the land surveyor than that of the actual value of the magnetic declination or that of the secular change of declination.

The outcome of all detailed magnetic surveys has been that the lines of equal magnetic declination are very far from being smooth and beautifully curved lines. The more numerous the observations on which the chart is based, the more sinuous the magnetic lines. Compare the successive isogonic charts of the Coast and Geodetic Survey and note how the sinuosities have multiplied with increase of data. Or behold the extremely devious isogonic lines which resulted from the most thorough state declination survey thus far made in this country—that of New Jersey. There was a time when these sinuosities were looked upon as unnatural, due doubtless to defective data and what not, and hence to be cut out and eliminated. But the magnetician has begun to recognize that these sinuosities are the very things he wants and that *they* represent the normal state of things, and the *smooth* curves, the abnormal. To cut out, therefore, entirely, or at best smooth down "local disturbance" phenomena, does not satisfy even the *practical* needs, much less the demands of science.

A glance over the values of the magnetic declination data, given on the chart in a later chapter, shows how impractical and misleading it is to give an *average* value, or an estimated value, from an isogonic chart for a county on the Piedmont Plateau, for example, a value which the surveyor would naturally think could be applied over his entire county if given by an authoritative publication. If there are local disturbances, he is the very one who should be made aware of the fact and be obliged by law to discard his compass entirely for accurate surveying over the disturbed region.

Now there are disturbances which manifest themselves principally in the vertical plane and which would hence largely fail to be revealed by a survey with a horizontal needle alone, *i. e.*, a declination survey. Such disturbances likewise demand attention.

Coming now to the geological standpoint, there can be no question whatsoever that if the geologist hopes to gain anything from geomagnetic investigations conducted under his auspices, *all* the elements must be observed, not simply declination. The declination survey can at its best only *indicate* the presence of the phenomena to be studied, and even at that, only a *part* of them. To frame any hypotheses with reference to the relationship between geological formations and disturbances in the distribution of terrestrial magnetism, as based upon declination data alone, can be of but little scientific value, and may even retard real progress in this direction. If, on the other hand, inclination and intensity data are added to the declination data, it is possible to approach the matter under discussion from a scientific and, therefore, practical standpoint. The magnitude of the deflecting forces and true direction of line of action can then be computed, and thus the real data to be utilized in the correlation of disturbances in geological structure and of magnetic distribution can be obtained.

From the purely economical standpoint, likewise, I believe experience will at once teach the desirability of a survey that is complete. The results of the Maryland magnetic survey will bear out the statement that it need not cost much more, either in time or money, to observe the three elements than to observe simply one. Fully 75 per cent of the time and money (if not more) are consumed in the *occupying* of a station. After the observer has once reached his station, it is comparatively a mere trifle to observe a little longer, and the additional observations will entail practically little extra expense. The heaviest part of a magnetic survey consists in the determination of the magnetic declination.

Again, experience will teach that it is just as economical to make observations with instruments especially designed for magnetic work as to employ instruments the results from which need a continual careful inspection. The observation data must be of such a degree of precision that the phenomena revealed by them can be accepted as having a physical existence, and therefore not to be ascribed to errors of observation. Data only fairly accurate may completely hide the very phenomena to be studied.

Historical Summary of Magnetic Surveys.

The first complete magnetic survey in which the three magnetic elements—declination, dip and intensity—were determined, and which was executed as a national piece of work and was co-extensive with the limits of the country surveyed, was that of the British Islands, corresponding to the epoch of January 1, 1837. This survey was undertaken in 1836 at the request of the *British Association for the Advancement of Science* and was completed in 1838. The example set by Great Britain was speedily followed by the execution of similar surveys in various portions of the globe—in Austria, Bavaria, Germany, Holland, Belgium, France, Canada, etc. At the present time nearly every civilized country has been surveyed magnetically to a greater or less extent.

But such surveys must be repeated after the lapse of a number of years on account of the slow, yet appreciable, change forever going on with regard to the earth's magnetic state, which change, as one of the most noted physicists has truly said, is a warning "that we must not suppose that the inner history of our planet is ended." Thus after the lapse of twenty years Great Britain—again at the instance of the British Association for the Advancement of Science[1]—repeated its original magnetic survey.[2] The observations were taken between

[1] Doubtless no national organization has done so much for the advancement of the subject of terrestrial magnetism as this most distinguished body of scientific men. Money grants have been freely made; committees on magnetics composed of the most eminent physicists have been formed from time to time, and co-operation has been extended and encouragement given to magnetic enterprises in many ways.

[2] Report on the Repetition of the Magnetic Survey of England by Major-General Edward Sabine. Report of the British Association for the Advancement of Science for 1861.

1857-62. In the *Philosophical Transactions of the Royal Society* for 1870 will be found a full account of this survey and likewise of the earlier one. In this paper Sir Edward Sabine combined the observations of the two surveys and drew the isomagnetic lines for the mean epoch of 1842-5. And now again Great Britain has just completed a *third* magnetic survey, far more elaborate than any of the preceding ones. This survey, one of the most carefully executed up to date, was conducted by two most eminent physicists, Professors Rücker and Thorpe.[1] It was a most fruitful piece of work. Observations of the three elements were made at first by the two distinguished professors themselves between the years 1884–88 at 205 places.[2] The Government Grant Committee of the Royal Society then made a liberal grant so that the survey might be carried out on a larger scale than hitherto attempted. Two assistant observers were then employed, and with their aid, in the four years 1889-92, the grand total of the number of stations was brought up to 882, making, on the average, one station to every 139 square miles of land area.[3] The isomagnetic lines corresponding to the epoch 1886-90, and based on the 205 observations made between the years 1884-88, were drawn, and likewise those as based on the 677 stations observed in 1889-92, were constructed for the epoch 1891, and finally the lines as resulting from *all* the stations were obtained. A splendid opportunity was thus afforded for testing the accuracy with which the positions of the isomagnetic lines, *e. g.*, the lines of equal magnetic declination or variation, can be inferred from observations in greater or less number. We shall have occasion to revert to this particular matter in a future report. In the meanwhile we refer the reader to Professor Rücker's interesting account[4] published in *Terrestrial Magnetism* for July, 1896.

[1] To Dr. Thorpe we owe a number of determinations of the magnetic elements in our own country.

[2] The results were published in the Phil. Trans. of the R. S, 1890, A, p. 53, the memoir constituting the Bakerian Lecture of that year.

[3] The results of this last work have just been published, Phil. Trans. R. S., vol. 188, A, 1896.

[4] A. W. RÜCKER: A Summary of the Results of the Recent Magnetic Survey of Great Britain and Ireland conducted by Professors Rücker and Thorpe:—I. On the Accuracy of the Delineation of the Terrestrial Isomag-

To give an intelligent and fair account of all the work done in recent years in this special field of human activity would require far more space and time than I have at my disposal. On the European continent, in nearly every country, elaborate magnetic surveys are either at present in progress or have just been finished or are in contemplation. The most detailed one that has come to our knowledge is that of Holland, by Dr. van Rijckevorsel, for the epoch 1891.0, embracing 278 stations over an area about equal to that of Maryland or averaging about one station to every 40 square miles. This survey of Holland was especially interesting from the fact that though it was made over an area *superficially* destitute of striking geological features, it nevertheless revealed marked disturbances. The author sums up his conclusions thus: "Little even as we know about the geology of the Netherlands, the magnetic maps must bring every one to the conviction that in some cases, in many perhaps, there must be a direct relation between geology and terrestrial magnetism, and that many of the magnetic features must be in some way determined by the geological structure of the underground. What these geological features might be we are at present unable to tell. What kinds of rock may be hidden at a depth of 300 metres or more under the peat bogs and heaths of the Netherlands, and the clay, sand and pebbles immediately underlying these, we do not know—rocks which, although under ground, are yet perhaps in some places so near the surface as to be an effective barrier against the inroads of the sea, which has fair play in other districts. It is for geologists to tell us. Magnetism will, in many cases, if carefully employed, be able to say to geology: 'There is something hidden on this particular spot, it is for you to tell us what it is.' This does not mean that every magnetic feature must needs have its counterpart in a geological one, still less the reverse. For we know perfectly that not every mineral is magnetic, or capable of being magnetized, and therefore rocks of any size may exist for which our needles show a supreme indifference.

netic Lines.—II. On the Accuracy of the Determination of the Local Disturbing Magnetic Forces.—III. On the Relation between the Magnetic and the Geological Constitution of Great Britain and Ireland.

On the other hand, it is possible that rocks are not the only cause of regional disturbances. But as soon as we find a [magnetic] ridge line, the first rational thing to do is to look for a geological fact which may be connected with it. And if we knew all that is hidden from us, it is probable that we should often find a connection." Another interesting outcome was the indication that marked disturbances in magnetism will most likely be found on *ocean* areas as well as on land areas.

An elaborate magnetic survey is just about to be executed for the North German provinces at a total cost of about $12,000. Five years are to be allowed for its completion, and work is to be begun this summer (1897) under Professor Eschenhagen's direction.

Enough has been given to prove that by undertaking similar work in this country we are simply keeping in touch with a general movement that is manifesting itself most actively in the civilized world to-day. We are at last beginning to recognize that in our eager and impatient endeavor to unravel the mysteries of the celestial regions we have shamefully neglected the *terrestrial* mysteries, of which we have manifestations every moment. The science of our earth is still in its infancy, and the astronomer has been made painfully aware of the fact that more attention must be given to the study of the physical history of the planet we inhabit. There is every evidence that a reaction in scientific thought in this regard has set in that is bound to grow, and it simply behooves us to put ourselves in line with this onward movement.

In conclusion, let us briefly refer to the history of magnetics in this country, so that we may form some opinion as to the place to be ascribed in the development of magnetic surveys in this country to the magnetic survey of Maryland.

The earliest attempt at a *detailed state* magnetic survey appears to have been made by Professor Alexander Dallas Bache in 1840-43, just before he was called to the superintendency of the Coast and Geodetic Survey. He called his survey a "Magnetic Survey of

Pennsylvania and parts of adjacent States."[1] Observations were made at 22 points within Pennsylvania; they did not in every case embrace the three elements. Professor Bache made these observations during his summer vacations from 1840-43 and at private expense.

When Bache became Superintendent of the Coast Survey, magnetics was incorporated in the work of the Survey. Since then magnetic observations have been made in every state of the Union by the Coast Survey, and the drawing of isomagnetic maps, and the furnishing of the data for allowance of the secular variation, have become regular functions of the Survey. Owing to its limited appropriation, the Survey cannot undertake, however, the making of observations in such number as would fulfil modern requirements of a magnetic survey. It can at best confine itself to the establishment of secular variation stations in each state, *i. e.*, stations, as permanent as possible, at which observations are made with great refinement and at which observations may be repeated after the lapse of a certain number of years, say about 10 years. Detailed surveys will at present have to be undertaken by the states separately, which course may have its advantages, but likewise has its disadvantages.

Magnetic observations, more or less complete, and magnetic tours, more or less extensive, had been made previous to Bache's work, referred to above, *e. g.*, by Long (1819), Nicollet (1832-36), Locke (1838-43) and Loomis (1838-41). The last made the first general collection of magnetic observations for this country and has the honor of having drawn the first magnetic maps. To be sure, these maps, covering the eastern part of the United States, owing to the scantiness of the material, were only rough approximations; nevertheless, when, 16 years later, a more complete map was made by the Coast Survey,

[1] By an oversight, Mr. Schott fails to make any mention of this work of Professor Bache in his article entitled "Magnetic Survey of North America," prepared for the Chicago Meteorological Congress of 1893. See Part II of the Report of that Congress, published as Bulletin No. 11 of the Weather Bureau. The records and results of Bache's survey are contained in *Smithsonian Contributions to Knowledge No.* 166.

Professor Bache declared that between his own map and that of Loomis, when proper allowance was made for the secular change, "the agreement was remarkable." This epoch of about 1840 is remarkable for the number of zealous, devoted and unselfish students of terrestrial magnetism.

From 1878-1883, Professor Francis E. Nipher, Professor of Physics at the Washington University of St. Louis, undertook a detailed magnetic survey of Missouri. Professor Nipher must be duly credited with the spirit and enterprise he exhibited in the inauguration of this survey. He was dependent entirely upon private aid for the defraying of the expenses of the work. The instruments were loaned by the Coast and Geodetic Survey. Professor Nipher has published thus far five reports of this work.[1] He has, however, not been able to complete the survey, and so no final report and no maps have been published. He had observed, with the aid of assistants, at 149 stations, or on the average at one station to 438 square miles.

At the same time some preliminary observations appear to have been made by Professor Gustav Hinrichs in Iowa, but the survey does not seem to have progressed far beyond a mere beginning.

We next come to the declination survey carried out—this time under state auspices—under the direction of Professor George H. Cook, then State Geologist of New Jersey, now deceased. The epoch of the survey was 1888-90, all the observations to the extent of 158 stations having been made within a few years of this date. There was thus on the average one declination station to about 52 square miles. The observations were not made with special magnetic instruments, but good surveying transits were used. The observers appear to have executed the work as carefully as the methods and instruments would permit. "During October, 1887, two parties were placed in the field, each supplied with good surveying transits, the needles of which were six inches in length, and had been put in perfect order and carefully compared with each other and with a standard needle. . . . In this way observations were obtained at 121 localities within a period of six weeks." Let us say that each party consisted of two

[1] Transactions of the St. Louis Academy of Sciences, 1878-1886.

men. That means it took four men to obtain 121 mean declinations in 36 working days, or one man for 30 declinations in 36 days, or roughly, it took one man and one day for one declination, which was the mean of several made over a locality covering but a few square miles of area. Now a skillful magnetic surveyor equipped with special magnetic instruments, if the weather is favorable, can occupy two stations a day, distant say 10 to 15 miles from each other, and observe besides *all* the magnetic elements, not simply declination. He can certainly easily average one complete station a day, if the weather is fairly propitious. This has been repeatedly done. Dr. Rijckevorsel, for example, in his survey of Holland, between the end of July, 1889, and first days of October of same year, without an assistant, observed the three magnetic elements at nearly 80 stations, or on the average about 1⅓ stations a day. Counting out the days which the observer of the magnetic survey of Maryland had to devote to other duties, it is found that he averaged one complete station a day, and this, too, with stations so far from each other that the aggregate mileage traveled was about 2000 miles. In some instances, owing to the inaccessibility of the stations, it took more than a day to reach them. These facts are merely mentioned in order to bear out previous remarks, *that if the magnetic instruments can be procured, it will be found that there will be practically little saving in time or money to make only a partial survey.* The New Jersey survey was a beautiful piece of work as far as it went, but no further use, from a geological standpoint, can be made of it than as an indicator of a certain class of local disturbances. If that work be supplemented in the near future by inclination and intensity data, New Jersey will have made a noteworthy contribution to the advancement of our knowledge with regard to the correlation of disturbances in geological structure and disturbances in magnetic distribution.

The next chapter is devoted to a special account of the Maryland magnetic survey. It will be seen that this survey embraces the determination of the three elements and is more detailed than any state magnetic survey thus far made in this country. There is probably no state that includes within so small an area—less than 10,000 square miles of land area—such a variety of geological formations as Maryland. To quote from the report of the State Geologist: "The most ancient rocks which make up the earth's crust as well as those still in the process of deposition are here found, while between these wide limits there is hardly an important geological epoch which is not represented." The investigation of the local disturbances, which are quite marked in certain regions, and their correlation with geological structure will, therefore, be of peculiar interest and value in this state.

GENERAL ACCOUNT OF THE MAGNETIC SURVEY OF MARYLAND.

Introductory Remarks.

In the summer of 1896, while spending a vacation at a little village, Linden, nine miles north of Washington City, I made some magnetic observations which clearly showed that the distribution of the earth's magnetism is quite irregular in the vicinity of Washington—a fact already noticed to some extent by the observers of the Coast and Geodetic Survey. It seemed to me most desirable to extend the investigations over a larger area, if possible, and, accordingly, I laid my plans for a detailed magnetic survey of Maryland before Professor William Bullock Clark, in charge of the recently organized Geological Survey of Maryland. Professor Clark heartily endorsed the idea of a detailed magnetic survey and authorized me in a letter dated July 25, 1896, to proceed as soon as possible with the survey, putting a sum of money at my disposal which, with careful management, it was hoped would suffice to make magnetic observations at one or two stations in each of the twenty-three counties comprising the state. With the aid of additional funds, obtained as already stated in the Introduction, the number of stations at which observations were made during 1896 could finally be increased to 46, thus averaging one station to every 265 square miles (687 square kilometres) of the *total* area[1] of Maryland.

Application was next made to the Honorable John G. Carlisle, then Secretary of the United States Treasury, under which department the Coast and Geodetic Survey is placed, for the loan to the State of Maryland of a complete Coast and Geodetic Survey magnetic outfit. In return for the loan of the instruments it was agreed that the Coast and Geodetic Survey should be furnished with the results of the magnetic survey.

This application was favorably acted upon and the instruments were turned over to me by the Coast and Geodetic Survey, at the request of the State Geologist. After some preliminary investigations conducted at Linden, it was possible to begin active operations early in September.

The instruments furnished by the Coast and Geodetic Survey were:

Dip Circle No. 56/4440 and stand.

Magnetometer No. 18 and stand.

Theodolite No. 163 and stand.

Mean Time Chronometer Bond No. 195.

Tent No. 25 "A" and poles.

50-foot Steel Tape No. 86.

On October 23d, the above-mentioned chronometer, which proved to be not in the very best condition, as it stopped at frequent intervals, it was possible to exchange for Mean Time Chronometer Dent No. 2256.

The C. & G. S. tent was found too heavy (weighing with poles easily 100 lbs. and possibly more) and took too much time and labor to put up and take down and pack for transportation. I therefore purchased one of Copeland's small, light lawn tents supported in the centre by a single pole. This tent gave every satisfaction and proved a great convenience. About five minutes were required to erect it or take it down and wrap for transportation. It was 7 x 7 feet square at the base and about 7½ feet high in the centre. The tent might

[1] Total area of Maryland is 12,210 square miles (31,624 square kilometres), of which 9860 square miles (25,538 square kilometres) consist of land area and 2350 square miles (6086 square kilometres) of water area.

advantageously have been a trifle larger, about 8 x 8 feet. A few alterations had to be made, such as the substitution of all the iron parts by copper, brass or wood. For the iron frame spreading out the tent at the base of the pyramid on top, I substituted two light pieces of wood fastened together in the centre by a brass screw, about which the two pieces could turn and be spread out in the form of an X. They were held in place by small brass hooks in each corner of the base of the pyramid. The pine rod (2 inches in diameter) was somewhat over 8 feet long and consisted of two pieces which, when joined together, were held in place by a piece of brass tubing. The rod terminated in a copper tip which passed through the brass ring of the tent on top. About the copper tip could be passed guy ropes to hold the tent in time of strong winds or for the purpose of allowing the centre pole to be placed at an angle from the vertical and thus to be shifted away from the centre of the tent. With the aid of these guy ropes the whole tent could be easily tilted back far enough to allow making azimuth observations on the sun. The tent was held down by seven light pegs (2 x $\frac{1}{2}$ x 8 inches). Very often four—one at each corner—were sufficient.

The conditions under which the magnetic survey had to be commenced were such that it was highly essential that the observer should be as independent and as free in his movements as possible. As stated, the funds had to be carefully managed, it was not known how long the Coast and Geodetic Survey could spare its instruments, and the time which the observer could devote to the survey was restricted. As a first step, the amount of baggage to be transported from place to place was reduced as much as possible and disposed in such a way that no package would weigh over 30 pounds, and hence could be easily handled. After a few trials, the instruments and personal effects were put up in three packages, each weighing 25 to 30 pounds. The chronometer was always in the special care of the observer. It fitted snugly in a leather case to which was attached a handle for holding or carrying it. In traveling on the railroad the packages could generally be safely entrusted to the baggage-master when specially cautioned.

The special Theodolite No. 163 the observer did not carry along with him, as there was an alt-azimuth instrument in connection with the magnetometer. After a few stations had been occupied, the stand for the dip circle was also discarded, an extra head or top having been prepared instead, which when fitted on the magnetometer tripod permitted the placing of the dip circle on it. Thus but one tripod was needed for the making of the entire set of observations.

Base Station.

Linden was selected as the base station of the survey. In addition to being the home of the observer, it was nearly in the centre of the area over which the observations were to be made and was moreover only within a few miles of the Washington Magnetic Observatory and the Coast and Geodetic Survey office. After some preliminary investigations had been made at the base station, and the magnetic elements well determined, I was ready to start out on magnetic trips, returning to the base station at various times during the period of the survey.

Itinerary of Magnetic Trips.

In the table below *D* stands for magnetic declination, *I* for magnetic inclination, *H* for horizontal component of earth's magnetic force, and *TS* for time signals transmitted telegraphically at noon by the Naval Observatory at Washington over the Western Union telegraph wires. These time signals were used to obtain the rate of the chronometer.

Date. 1896.	Approx. Distance.[1] (Miles.)	Station.	Elements observed.	Remarks.
Sept. 1	..	Silver Spring,	TS	Two miles from Linden.
4	..	Linden,	I	The elements repeatedly determined during July and August.
7	..	"	D, H, TS	TS received at Silver Spring as before.
9	21	Upper Marlboro,	D, I, H	Fine, clear day, moderate wind.
10	23	La Plata,	D, I, H	" " " light wind.
10	14	Brandywine,	I	While waiting for train to Mechanicsville.
11	19	Mechanicsville,	D, I, H	While waiting for stage to Leonardtown.
11–12	11	Leonardtown,	D, I, H	Weather fine on 11th; light rain next morning.

[1] From station to station in a straight line; for example, La Plata is 23 miles from Upper Marlboro.

Date. 1896.	Approx. Distance. (Miles.)	Station	Elements observed.	Remarks.
Sept. 14	55	Linden,	I, TS	TS received at Silver Spring.
16	55	Easton,	D, I, H	Rain part of day. Temporary station.
17	19	Centreville,	D, I, H	Heavy rain in morning; bright in the afternoon when observations were made; wind moderate.
18	22	Massey,	D, I, H	Day fine.
19	24	Ridgely,	D, I, H	" "
19	22	Hurlock,	D, I, H	Traveled 18 miles in buggy over very sandy roads; barely completed observations when a violent rain storm set in.
21	47	Ocean City,	D, I, H	Fine weather. Rain next day.
23	8	Berlin,	D, I, H	Rain early in morning but cleared off somewhat about 9 a. m.; strong wind. Elements observed while waiting for train to Snow Hill.
23	14	Snow Hill,	D, I, H	Owing to limited time had to observe too close to Court House. Weather fair, strong wind.
24	12	Pocomoke City,	D, I, H	While waiting for train to Princess Anne. This station may take the place of Snow Hill, if necessary. Fine day.
24	11	Princess Anne,	D, I, H	Weather and site splendid; light wind.
25	14	Salisbury,	D, I, H	Fine, clear day. Station slightly affected by artificial local disturbance. See later station (Dec. 3–4).
25	7	Parsonsburg,	D, I, H	While waiting for train; weather good.
26	98	Cockeysville,	D, I, H	In the afternoon; weather good.
28	39	Linden,	D, I, H, TS	Determination of constants, etc.
Oct. 5	34	Frederick City,	D, I, H	On State Deaf and Dumb Asylum grounds; cloudy at times.
6–7	..	" "	D, I, H	Established a meridian line on Court House grounds, and determined elements at this place; weather fair, strong wind.
8	25	Westminster,	D, I, H	Weather fair, moderate wind.
9	38	Hagerstown,	D, I, H	Weather good.
10	56	Cumberland,	D, I, H	" "
12	38	Oakland,	D, I, H	Cloudy at times; severe magnetic storm.
13	100	Point of Rocks,	I, H	No D observations because of clouds.
13	10	Dickerson,	I, H	" " " " "
14	32	Washington,	TS	
15	81	Elkton,	D, I, H	Weather fair, strong wind.
17–19	85	Prince Frederick	D, I, H	Weather good, wind moderate.
20	71	Bel Air,	D, I, H	" " " "
21	41	Annapolis,	D, I, H	Fine, clear day.
22	26	Ellicott City,	D, I, H	" " "

By this time at least one station had been located in every county of Maryland in accordance with the State Geologist's instructions. Hereafter the observations were made either to fill out large gaps between some of the previous stations or to verify the marked irregularities in the distribution of magnetism in central Maryland which had made itself very apparent by this time.

Date. 1896.		Approx. Distance. (Miles.)	Station.	Elements observed.	Remarks.
Oct.	23	28	Washington,	TS	Exchanged chronometer (Bond 295) for Dent 2256.
	29	..	"	TS	
	29–31	9	Linden,	..	Constants determined.
Nov.	4–5	32	Baltimore,	H, I	No D observations on account of rain.
	6	25	Belcamp,	D, H, I	The purpose of these observations was to make a preliminary examination of the local disturbances in the neighborhood of Bel Air; weather fair.
	6	2	Harford Furnace	I	
	6	2	Creswell,	I	
	6	2	Fountain Green,	I	
	7	2	Bel Air,	I	
	7	13	Cardiff,	D, I, H	While waiting for train; weather good.
	7	9	Forest Hill,	D, I, H	Weather fair, wind moderate.
	9	60	Washington,	TS	At C. & G. S. office.
	13	16	Stabler,	I	No D nor H observations on account of fierce snow storm.
	14	11	Unity,	D, I, H,	Weather good, wind moderate.
	14	9	Damascus,	D, I, H,	" " " "
	19	29	Washington,	TS	At C. & G. S. office.
	24	9	Linden,	D, I, H	Examined evidences of local disturbances about Linden.
	25–27	1	Forest Glen,	D, I, H	
Dec.	1	9	Washington,	TS, I	Compared dip circle with the new ones recently obtained by C. & G. S.
	3	..	"	TS	En route to Salisbury, saw brilliant aurora; magnetic disturbance next day.
	4–5	86	Salisbury,	D, I, H	Meridian line established here.
	7	32	Crisfield,	D, I, H	Extreme southerly station in Md.; weather good, light wind.
	9	90	Washington,	TS	Moment of inertia of long magnet redetermined.

General Summary of magnetic work in 1896.

Number of different stations at which declination was observed	38
" " " " " " inclination " "	46
" " " " " " horizontal component was observed	39
" " days on which the elements at Base Station were observed	14
Average air line distance in miles between stations	20–25
Approximate total distance traveled in reaching stations, in miles	2000

Selection of the Stations.

To carry out the provisions contained in the letter to me from the State Geologist, the first aim was to select a station at the county-seat of each county or as near thereto as circumstances would permit. This provision was strictly carried out. Only in a few cases was it impossible to locate the station at the county-seat. In these cases the necessary connections with train or steamer could not be made without the loss of considerable time. The station was then placed as near to the county-seat as circumstances would permit. Additional stations were added as opportunity offered, *e. g.*, while waiting for railroad or steamboat connections. Later, when the survey had extended over the entire state and it was known where stations were most needed, additional points were placed in those regions. From an inspection of the isogonic map it will be seen that the distribution of the stations is fairly uniform. Every county is represented by one or more stations. Stations need to be multiplied in Central and Western Maryland. The 1896 survey will be valuable in indicating where future stations can be placed to the best advantage.

The stations were not generally occupied in any logical order, the observer allowing his movements to be controlled entirely by the timetables of the railroad and of the steamboat companies. No time was therefore ever lost in waiting for a steamer or a train to carry the observer to a station which would logically come next. This explains some of his apparently erratic movements as indicated by the itinerary. Nor did he allow his movements to be checked to any extent by cloudy or rainy weather. Such observations were made as were possible, the observer then pushing on and returning to his base station in spells of continued bad weather. Such rainy spells were not unwelcome at times, for they gave the needed opportunity of working up the field notes. On the whole the weather was propitious.

On arrival at a station, the first cab or vehicle sighted was hired.[1] The driver was next questioned with regard to the large open places in the town. Usually such a place could be found around the court house, around a public school, or around a hotel, and the driver was directed thither. As the observer was an official representative of the State Geological Survey, he readily received the necessary permission from the authorities in possession of the grounds to be occupied. After a casual inspection and a few inquiries, *e. g.*, with regard to the presence of iron pipes, etc., the grounds were selected, if condi-

[1] In some cases, of course, no vehicle was to be had, but as the instruments were packed in an easily transportable shape, there was no difficulty in having them transported by a carrier.

tions were favorable. Only in two or three cases the stations had to be decided upon—if observations were to be made at all—under conditions not the very best. In these cases, however, an additional station was occupied in the same county when possible, or somewhere in the vicinity. The descriptions and locations of the stations are given in another chapter.

Methods of Observation.

The highest refinement possible at any one station was not sought. It was believed, for example, that it is far more valuable to obtain two declinations to within a few minutes at two stations some distance from each other than to observe one declination at one station to the nearest minute. It is absolute folly, as far as the matter of distribution of declination is concerned, to occupy a station two or three days with the view of determining the declination to the nearest minute and then not observe the declination again to within 25 to 50 miles or more of this first station. Even in undisturbed regions the error made by a linear interpolation between the values at two distant stations is generally much greater than the error of the station observation. In disturbed regions the extremely refined methods, when pursued at the expense of limiting the number of stations, are entirely out of place. In the establishment of *secular variation stations* the utmost refinement should of course be employed.

At the same time it was the aim to arrange the observations at two distant stations in such a way that, while they individually might be in error by several minutes, they would not necessarily both be in error in the same direction, so that in making an adjustment, graphical or otherwise, of all the observations, these station errors would be in the nature of "accidental errors," *i. e.*, some would be plus and others minus. If it had been possible to carry out this scheme perfectly, the isogonics drawn with a free hand, for example, as based on observations defective in this way, might be just as accurate, or nearly so, as those based on observations made with the utmost refinement at an equal number of stations, and would be *more* accurate than those based on refined observations at the number of stations which could be occupied in the *same* period of time. This is made clear in the next paragraphs.

Aside from the actual error of observation at the *time* of observation, in the determination of a magnetic element, declination for example, we have in addition the error introduced in reducing the observation to the epoch selected. A part of the observation error of the declination is entirely astronomical, *i. e.*, due to an error in the determination of the true meridian. Throughout the survey the meridian was determined by means of alt-azimuth observations on the sun, using the alt-azimuth attachment belonging to Magnetometer No. 18. The sun was observed, on the average, at about two hours before or after noon. Occasionally it happened, owing possibly to the sun having been obscured previously, or on account of lack of time, that the solar observations had to be made, if made at all, within an hour of noon. When possible, such times were invariably avoided. If the instrument was in good adjustment and carefully leveled, and the solar observations were made so as to eliminate, as far as possible, any outstanding defects in the adjustment of the instrument, then the error in the determination of the true meridian consisted of the error of pointing on the sun and the error due to an imperfect value of the latitude assumed in the formula of computation.[1] Now the *pointing error*, by suitably arranging the observations, can be reduced so that the error therefrom will fall within the reading error of the vertical and horizontal circles attached to the instrument used. If these circles read by opposite verniers to the nearest minute of arc, so that half-minutes can be estimated, the error of pointing can be reduced so as not to exceed one minute, which degree of accuracy must at present suffice for magnetic work. *The latitude error* is a function of the hour angle, and is of contrary sign for observations made before and after noon. In order to eliminate the latitude error it is necessary either to observe at such an hour angle that the error will fall within the limit of accuracy, or to make observations in the morning and in the afternoon at about the same hour angle.

[1] The present maps of Maryland, with the exception of certain portions, cannot be assumed as furnishing sufficiently accurate values of the geographical co-ordinates.

The table below gives an idea of the magnitude of the error at various hour angles.

Error in the observed solar azimuth when the assumed latitude is 1′ greater than the true latitude.

Latitude.	Apparent Time.									
	A. M.					P. M.				
	7	8	9	10	11	1	2	3	4	5
	′	′	′	′	′	′	′	′	′	′
35	−0.32	−0.70	−1.22	−2.12	−4.55	+4.55	+2.12	+1.22	+0.70	+0.32
40	−0.35	−0.75	−1.30	−2.26	−4.87	+4.87	+2.26	+1.30	+0.75	+0.35
45	−0.38	−0.82	−1.42	−2.45	−5.28	+5.28	+2.45	+1.42	+0.82	+0.38

The formula by means of which the above figures have been obtained, is—

$$c_a = c_l \sec l. \cot t.$$

where c_a is the correction to be applied to the sun's azimuth counted positive in the direction N, E, S, W.

c_l is difference between the assumed latitude and the true latitude, or the quantity to be applied to the latter to get the former.

l is the approximate latitude.

t is the hour angle or number of hours in angular measure counted from apparent noon, *minus* when *before* noon and *plus* when *after* noon.

When the assumed latitude is 1′ less than the true latitude, the quantities in the table would, of course, have their signs reversed.

The latitudes of the stations were scaled from the best maps at present to be had. In the table of geographical positions, given in another chapter, the sources from which the positions were obtained are given. From some tests made it would seem that the error in the adopted latitudes will generally fall below one minute.

Since an error of 1′ in latitude causes an error for latitude 39° varying from 0.′7 to 4.′8 between the hours from 8 A. M. to 11 A. M. and from 1 P. M. to 4 P. M., this was an error that should be taken into account, if thereby the increased refinement was not obtained at the cost of an additional station. To take this error into account it was necessary either to make fore- and afternoon observations at about the same hour angle as already stated, or to observe the latitude by means of circum-meridian altitudes of the sun. The former method would very often have necessitated the loss of an additional station, and the second method involved additional observation and computation and often considerable annoyance, as other work would have to be abandoned for the sake of the latitude observation. The latitude error is besides a temporary error which can be allowed for when more correct positions have been obtained. I therefore decided that generally I would not attempt to eliminate the latitude error at any one station, but endeavor to arrange the work so that at some of the stations the azimuth observations would be made in the morning and some in the afternoon. Some of the errors to be ascribed to defective latitudes would be plus and some would be minus. I believe I can safely trust that an isogonic line which, in a certain sense, represents an adjustment of all the observations on either side of it, will not be in error by *reason of imperfect latitudes* to an amount greater than 1′, if as much as that. The error due to direct interpolation between two stations will far exceed any error that may be due to defective latitudes of the station. It was my endeavor, therefore, to reduce the *interpolation* error rather than the *latitude* error. And the only way to reduce the interpolation error is by increasing the number of points of observation, or what amounts to the same thing, by decreasing the distance between the stations.

We next come to the *observing error of the purely magnetic part* of the determination of the magnetic declination. Here we must remember in the first place that we are not observing a fixed object, but one in ceaseless motion. All we can aim at is an average position corresponding to a definite moment of time. At some other moment the average position assumed by the needle will be a different one. If the interval of time over which the observations are made is too long, then will the arithmetical mean of the different positions assumed not correspond to the arithmetical mean of the times of observation. For an interval of about 15-30 minutes this will generally, however, be the case, except of course in times of magnetic storms. This was about the interval used in this work. A reading of position of needle with scale erect, for example, would be taken, then the needle would be turned around 180° in the stirrup—this by reason of the octagonal form of the magnet and stirrup was a very simple matter—and the reading of the new position obtained, about 8-10 readings on the average being taken in all. The inversion of the magnet in the stirrup gave the means of correcting for non-coincidence of the magnetic axis and of the geometric axis of the magnet. Generally, additional readings for declination would be taken at the close of the other observations, usually at the end of the oscillation observations for intensity. A factor of prime importance, however, is the elimination of the torsion in the silk fibre by which the magnet is suspended. This torsion must either be removed or allowed for in some manner. The general method is to remove it before making the declination observations by suspending instead of the magnet a copper bar of the same weight. Every one who has made observations in the field knows that generally the removal of the torsion is a tedious matter, especially if the observer is obliged to wait for it and is prevented from doing something else in the meanwhile. In times of windy weather the removal of the torsion by this method is especially likely to put the observer in a bad humor. It was my endeavor, therefore, to reduce the torsion factor to such an extent that the error due to the probable amount of torsion in the fibre at any time would not cause a greater error in the declination than the reading error of the horizontal circle, which was divided by two opposite verniers to whole minutes and allowed ½ minute to be estimated. The number of silk fibres supporting the magnet was reduced from two to one and the fibres invariably soaked in glycerine before using. For this purpose a small bottle of glycerine containing silk fibres was always carried along. If the amount of torsion in the single silk fibre was such that the position of rest assumed by the copper weight was at right angles to the magnetic meridian, then this amount of torsion was equivalent, on the average, to an angular deviation of the magnet from the position it would have assumed had there been no torsion of somewhat over 1′. For 30° of torsion the angular deviation would be about 0.′4. The torsion, with the exception of a few special instances, was rarely removed in the field, but instead was carefully taken out every night at the hotel. The next morning before making the observations, if there was no wind stirring, the copper weight was suspended, the arc of vibration bisected and the torsion removed by means of the torsion head; the amount of torsion developed in the single fibre over night and while preparing for the observations was such a trifle that it could be easily removed in this way when it was deemed worth while. If the weather was windy, no further attempt was made to remove the torsion beyond what had been done the night before at the hotel. And so likewise when proceeding from one station in the morning to another station in the afternoon, I generally made no attempt to remove the torsion developed since the morning observation. From a series of experiments made at the base station, extending over a week in all kinds of weather, sunshine and heavy rains, with the magnet suspended by the single fibre all day within the observing tent, I have convinced myself that the method pursued with regard to the torsion did not introduce a larger error than a fraction of a minute.

Sometimes it must be confessed, however, that the single fibre proved disadvantageous in that it would occasionally break—on the average about once for every six stations occupied.[1] In such a case the torsion of the new fibre, previously soaked in glycerine, had to be removed in the field. In this event the other observations, *e. g.*, magnetic inclination, would be proceeded with while the torsion was being taking out. To provide for such emergencies, one part of the work was usually kept in reserve to be carried out in case of accident to the suspension fibre. In times of strong wind, however, it was next to impossible to wholly remove all the torsion from a new fibre. The observations were then proceeded with and on returning to the hotel the amount of torsion in the fibre determined. Such accidents might also occur, to be sure, not so frequently, with two fibres, and in this case the uneliminated torsion would introduce a greater error

[1] It would undoubtedly prove of great advantage to have two glass tubes with a fibre in each. It would be a simple matter to arrange the method of fastening of the tube to the suspension box so that, in case of breakage of a fibre, the tube could be readily replaced by the second tube with a fibre whose torsion had already been largely removed.

than that of the single fibre. Of the 46 stations there was but one station—Damascus—where the error due to uneliminated torsion may amount to several minutes. But this station is in a disturbed region and additional observations might well be added in this locality, even if the accuracy reached is not more than one-tenth of a degree. It would seem, therefore, that we have no reason for supposing that the observation error of the magnetic portion of the determination of a declination should in general have exceeded the reading error of the horizontal circle of the magnetometer.

A consideration of the *reduction* error follows next. This consists of several parts:

a. The diurnal variation.

b. The disturbance variation.

c. The secular variation.

d. The annual variation.

In reducing the observation made at a specified time to some other time, all of these factors enter in, and all need to be taken into account, with the exception of the last, which for stations in mid-latitudes has a total range of only about 1′. The general method of procedure amounts practically to reducing the observation to the mean of day, making the necessary allowance in case the observation appears to have been made at a magnetically disturbed period, and then applying the correction for secular variation. To carry out this scheme as perfectly as possible it is necessary to have near the base of operation of the magnetic survey a magnetic observatory where by photographic means a continuous record of the variations of the magnetic elements is obtained. It is necessary that this observatory shall be sufficiently close to the area surveyed so that it can be assumed that the diurnal variation as observed at the observatory is practically the same over the entire area. The diurnal variation progresses according to local time, and hence it is not meant by the statement "that the diurnal variation is to be assumed the same over the entire area," that at the same instant of *absolute* time the *correction* for diurnal variation is the same over the whole area, but that at the same instant of *local* time the correction is assumed the same. The disturbance variation on the other hand may be assumed as practically the same at the same instant of *absolute* time over the whole of such an area as that of Maryland, for example. And so may the secular variation for a period of time covering a few years be taken as practically the same over the whole of Maryland. At present the westerly declination is increasing at the rate of about 3′ per year.

The magnetic survey of Maryland was fortunate in that the Washington Magnetic Observatory was so close by. Unfortunately, however, the sphere of usefulness of the latter in this respect was somewhat diminished partly by the fact of the electric car disturbance which affects the work of this Observatory and partly by the inadequacy of the working force of the Observatory.

In consequence it has not been possible as yet to make an accurate reduction of the observations of the magnetic survey for diurnal variation and disturbance variation. The data called for that was necessary for this purpose the Washington Magnetic Observatory has up to date failed to supply.

As it was highly essential that this first part be issued this year, I had to content myself, for the present, with the following method of procedure. I determined the mean diurnal variation for the months of the survey from the four years of observation 1887-91 made by the Washington Magnetic Observatory before its unfortunate removal to the new (and disturbed) site. The quantities are given in a later chapter. This was applied and regarded as the normal diurnal variation. I next obtained the permission of Commander Phythian, in whose charge the Magnetic Observatory is placed, to make a personal inspection of the magnetograph traces during the period of the survey and by a mere superficial inspection made a list of the more or less disturbed days. The list of magnetically disturbed days kindly furnished by the Director of the Toronto Observatory, Professor Stupart, practically agreed with the list prepared from the Washington traces. I next inspected the hourly readings, such as were tabulated, and formed the hourly means where this was possible. I assumed that these hourly readings for any particular month would give practically the same diurnal variation as that which I had derived from the four years 1887-1891. The variation now of the hourly reading on any individual day in that month on the mean hourly reading for that month was regarded as the correction to be applied for that hour and that day to the normal diurnal variation as obtained from the four years 1887-91. This correction might in a certain way be looked upon as that which it was necessary to apply to an *assumed* normal diurnal variation in order to obtain the actual diurnal variation for that particular period. This correction was generally between 1′ and 2′. In a few cases when a heavy disturbance had been in progress it was necessary to resort to the actual traces in order to apply a disturbance correction. On September 18, for example, for Massey a correction of —6′ was needed, and on October 12 at Oakland corrections —16′, —10′, —2′, 0′, or a mean correction of —7′ had to be applied. On December 4th at Salisbury a severe magnetic disturbance was encountered and the correction on this day will doubtless be about —6′ to —7′. All of these corrections had to be made in the course of a few hours at the Magnetic Observatory. When the Observatory furnishes the data called for, more accurate and more careful reductions can be undertaken. It is not believed, however, that any error due to defective reduction amounting to over a couple of minutes will be attached to the figures herewith presented.

And in this connection it should again be recalled that by reason of the general plan of the survey, whereby at some of the stations the observations were made in the morning and at others in the afternoon, some of the reduction errors, as far as the diurnal variation at least is concerned, will be plus and others be minus. So that while it cannot be said that an accuracy of one or two minutes in the declination has been reached at every one of the individual stations, nevertheless it is believed that the general result will be nearly, if not entirely, of the same high order as though the utmost refinement had been reached at each station. And when it is remembered that the great desideratum is to increase the number of the stations and that by practising the utmost refinement, the number of the stations must necessarily be cut down, if appropriation and time are limited, it is believed that the best results possible under the conditions imposed have been obtained.

Some objections might be raised to the method of reducing each magnetic element to its particular daily mean. Now the mean declination takes place at a certain instant or instants, the mean inclination at other times, and the mean horizontal intensity at still another time during the day. And yet the method of discussion would lead one to suppose that they all referred to the same instant of time. When we combine three such mean quantities the resulting vector cannot be physically interpreted; we are combining quantities that really do not belong together, but this is a matter that need not concern us at the present moment.

No fixed order was followed in making the entire set of observations. It was believed that the utmost freedom in this regard would be most conducive to success. The order followed at any particular station was controlled by the conditions prevailing at the time. When possible, the endeavor was made to follow that particular order which at the time of day when the observations were made would give the best results for each element.

It is not possible to describe in detail in this paper the methods of observation employed for *dip* and *intensity*. Essentially the same methods in general use were adopted. Absolute observations of the *intensity* were made at each station. By means of the observations made from time to time at the base station it will be possible likewise to treat each set of intensity observations—deflections and oscillations—separately and thus the two results may be compared. The deflection experiments were frequently made with two distances, so that the distribution coefficient can be determined from a large number of field observations. In the *dip* observations the polarity of the needle was reversed at every station. At the beginning of the work two different dip needles were used and the dip determined independently with each. The results with Needle No. II exhibiting decided peculiarities, it was subjected to an examination and the pivots found to be imperfect. I therefore worked entirely with Needle No. I, making generally two independent determinations at every station. Since entire reliance had to be put upon this one needle, it was necessary to examine whether any constant error, due, for example, to irregularity of shape of pivots, which the method of observation would not eliminate, was inherent in the results obtained with it. This matter was tested in two independent ways:

(*a*) By observing the dip in different azimuths. Here different parts of the pivots came into play while making the dip observations. This test was made in about the middle of the period of the survey.

(*b*) By comparing the results obtained with my dip circle and Needle No. I with the results obtained with new Kew dip circles, just received by the Coast and Geodetic Survey, which had as yet seen no field use and which had been examined and certified to at the Kew Observatory. The comparison was made in the Coast and Geodetic Survey office at Washington at the close of the magnetic survey in 1896. The result of both tests was that no constant correction need be applied to the results with the dip needle used in the magnetic survey and that furthermore any correction that could be applied to refer the dip results to the Kew standard would lie within the probable error of a dip determination.

The Epoch selected for the Magnetic Maps.

The epoch to which the results of the magnetic survey are to be reduced has been selected as January 1st, 1900. This was done for three reasons:

(*a*) The Coast and Geodetic Survey has undertaken to issue new magnetic charts of the United States for the year 1900.

(*b*) The secular variations of the magnetic elements have been so thoroughly determined by the researches of the Coast and Geodetic Survey that it is possible to make very accurate reductions for a period of from five to ten years.

(*c*) There is every reason to suppose that the attempt is going to be made to issue new magnetic charts for the year 1900 for the entire earth. In this event the results of this magnetic survey will be in shape directly available.

Magnetic Instruments.

The instrument used to determine the magnetic declination and the intensity of the earth's magnetic force is shown in Plate XV, Fig. 1. It is a combination magnetometer and theodolite, being one of the four new instruments constructed at the Coast and Geodetic Survey office in 1893 and known as No. 18. In its general form the instrument is similar to those that have been in use in the Coast and Geodetic Survey for some years, an illustration of the earlier form being given in the Survey Report for 1881, Appendix No. 8, plate 36. The new instruments are a little larger than the old ones and are improvements upon them in details of design, and especially in stability and perfection of workmanship.

The magnetometer proper, ready for determining the magnetic declination, is shown in the left of the figure. The magnet, octagonal in shape, is a hollow steel bar about three inches long and nearly one-half inch thick. This takes the place of the magnetic needle in the ordinary surveyor's compass. Instead of swinging about on a pivot-point it is suspended by one or two fine silk fibres, and the friction is thus practically eliminated. These fibres are hung in the glass tube projecting above the box in which the magnet is enclosed; one side of this box is removed, so as to permit seeing the magnet. The fibres are tied at the lower end to a copper stirrup likewise octagonal in shape, so that the magnet can easily be slipped inside the stirrup and rest there securely. When the little pin at the bottom of the stirrup fits in the small groove cut in the magnet, the latter is in position. The fibres are fastened at the upper end to an adjustable torsion head, permitting the fibres to be raised or lowered until the magnet is at the proper height in the box. For the removal of the torsion in the fibres a copper bar of the same weight and shape as the magnet is provided and suspended in place of the magnet in the air-tight box. The small amount of torsion left after the copper bar comes to rest can be quickly removed by properly turning the torsion-head on top and thus the plane of no torsion be made coincident with the plane through the magnetic meridian. By this arrangement all error to be ascribed to friction of the compass needle on the pivot is

INSTRUMENTS USED IN MAGNETIC OBSERVATIONS.

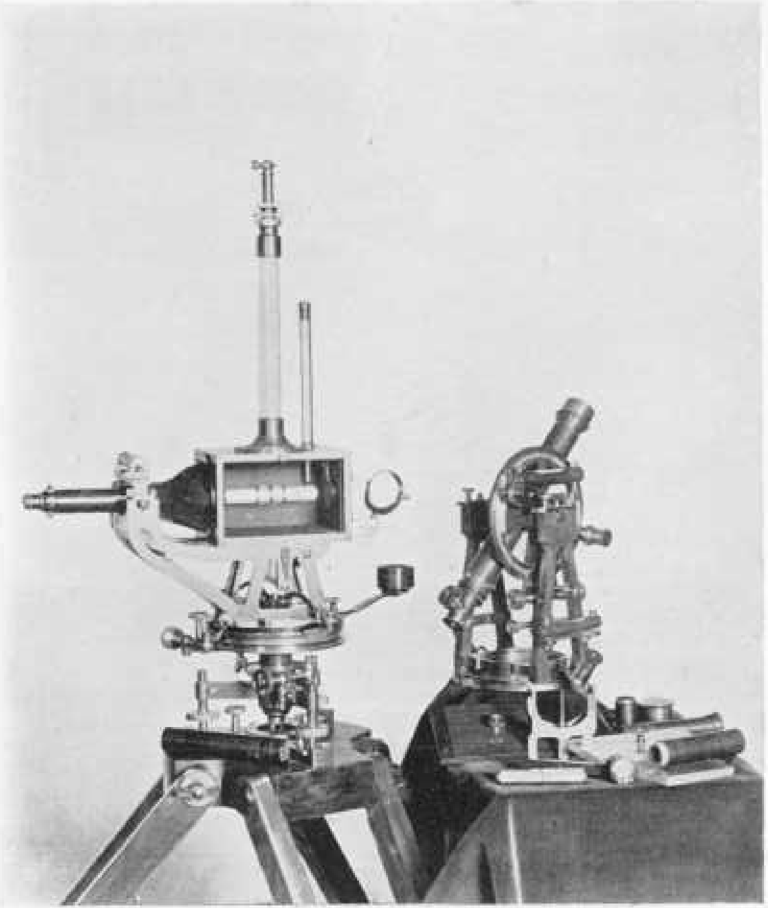


Fig. 1. Coast and Geodetic Survey Magnetometer No. 18.

Fig. 2. Kew Dip Circle.

eliminated. To overcome the dip of the north end of the needle downwards, the ordinary compass needle has attached to the south arm of the needle a bit of brass wire at the proper distance from the pivot, so that the needle will swing horizontally. In the instrument before us this is accomplished by fastening the fibres to an arm extending about one-half of an inch above the body of the stirrup, thus causing the point of suspension to be raised so high above the centre of gravity of the magnet that the latter is little affected by the dip and will hang sensibly horizontal in ordinary latitudes.

On the south end of the magnet is a graduated scale, divided into 60 equal parts, one division being equal to two minutes of arc, and on the north end is a small lens of such shape as to bring the scale into focus in the small observing telescope when the latter has been focused on a distant mark. This telescope, as will be noticed, is mounted eccentrically on the same support as the magnet box. It is provided with collimation and wye adjustments. The instrument is leveled by means of the striding level resting on the pivots of the telescope. The azimuth or reference mark may be sighted with the telescope by looking directly through the box, the magnet having either been removed or lowered out of the way, and by turning aside the glass window and reflector placed at the south end of the box to throw the necessary light on the graduated scale. On the north end of the box is simply a round opening—no glass window—and hence both the mark and the scale can be observed directly without looking through any glass windows. To shut out air currents the dark hood is fastened to the box and fitted tightly over the telescope tube.

To eliminate the error in the declination that may be due to non-coincidence of the *geometric* and of the *magnetic* axes of the magnet, the magnet is turned around 180° in the stirrup, so that the part which was on top before is now at the bottom. The scale at the south end will now be inverted and the figures read from right to left. The mean of the readings taken with magnet erect and with magnet inverted determines the magnetic axis.

The small tube on the right of the glass tube containing the suspension fibres is a thermometer for noting the temperature inside the box when making the intensity observations, and the small counter-weight directly below the reflector serves as a counter-balance to the telescope.

The upper part of the magnetometer bearing the magnet box and telescope is fastened to the base and horizontal circle by two screws and may thus be quickly removed, and the theodolite for determining the true astronomical direction may be substituted. The theodolite or alt-azimuth attachment is shown in the right of the figure. Thus the same base horizontal circle serves for both the magnetometer and the theodolite attachments. The horizontal circle has a diameter of 11.2 centimetres (4.4 inches), and the vertical circle, of 9.8 centimetres (3.85 inches). Both circles are graduated to half-degrees and read by opposite verniers to minutes.

The horizontal circle is graduated clock-wise from 0 to 360°, while the vertical circle is graduated anti-clockwise from 0 to 90° in each quadrant. For vertical circle east, when sighting south, the readings of the vertical circle give at once the altitude of the object, and in the reversed position, the zenith distance.

For the intensity observations, when the magnet above described is used as a deflector, two graduated wooden arms (not shown in the illustration) are inserted beneath the magnet box. On the arms rests a slider supporting the deflector at the same height as the auxiliary magnet in the box and at any desired distance.

The next figure (Plate XV, No. 2) illustrates an instrument similar to that used in determining the magnetic inclination or dip. It is of the usual Kew pattern and known in the Coast and Geodetic Survey as Casella Dip Circle No. 56/4440. In this instrument the needle is flat, tapers to a point on each side, is $3\frac{1}{2}$ inches long and is mounted so that it swings in a vertical plane instead of in a horizontal plane, as in the case of the surveyor's compass. The pivots of the needle swing on agate planes and are ground as accurately as possible. The needle is enclosed in a glass case to shut out all air currents and is provided with a lifter for lifting the needle off the agates or letting it down on them preparatory to observing. The angle of dip is read off on the vertical circle outside the glass box. The pointings on the ends of the needle are made with the aid of microscopes. The box with the circle can be turned in azimuth and set in the plane of the magnetic meridian by means of the horizontal circle. Both circles are about 5 inches in diameter and the vertical circle is provided with two opposite verniers reading to minutes, while the horizontal circle can be read to minutes with a lens. These are the main features of the dip circle.

THE VARIATIONS OF THE MAGNETIC DECLINATION.

The Special Purpose of this Chapter.

The mysterious force of the earth's magnetism is forever changing its direction and magnitude. It seems quite safe to assert that at no two periods of the earth's history has the state of its magnetism been precisely the same and that at no future period will the magnetic condition of the earth return to precisely the same condition prevailing to-day. The tides, the trade winds, while subject to definite periodic fluctuations, nevertheless will not change their general character for thousands of years, but a half-century will suffice to change materially a cartographical representation of the earth's magnetism.

A survey run on the bearings taken but a comparatively short time ago will result in mapping out a totally different area from the previous one. In this way arise the overlappings of areas and the presence of gores and quadrangles between areas surveyed by the magnetic needle at different times, when the proper allowance for the change of the magnetic meridian during the interval, for some reason or another, was not made.

It is the purpose of this chapter to endeavor to put this matter of proper allowance for secular change in Maryland on a better basis than has hitherto existed. While it is not professed that the tables presented in this connection are perfect or not subject to improvement, nevertheless the assertion can be made that they are very much better than the rules of thumb practised quite generally by surveyors throughout the state. The general custom is to allow a change in the direction of the magnetic meridian of about 1° in 20 years, or 3′ per year. Again it is often assumed that everywhere in Maryland the needle pointed truly north shortly after the year 1800. The appended tables will give the means of judging as to the amount of error made by these assumptions. It will readily be seen that over a large part of Maryland the direction of the needle seemingly never pointed to the true north during the eighteenth and nineteenth centuries, but bore west throughout this interval.

The tables are based on the researches of the Coast and Geodetic Survey and represent the very best information at present to be had. They have been arranged especially for Maryland. The endeavor was to put the matter in such a shape so that the surveyor could readily make use of the information the tables contain.

Before passing to our special subject, let us recount briefly the main fluctuations to which the earth's magnetism is subject. Some of these fluctuations are periodic in their nature, that is, the fluctuation takes place during a definite interval of time, at the lapse of which the needle returns approximately to the position it occupied at the beginning of the interval. Others have no definite period and are more or less spasmodic in their occurrence.

Periodic Variations.

Of the regularly recurring variations of the magnetic declination, the most pronounced and striking is the *solar-diurnal* variation. An idea as to how the needle varies in the course of the solar day by reason of this variation can best be obtained from an actual example. Below we have the mean hourly values of the westerly declination as obtained at the Washington Magnetic Observatory during the year 1890. The hours refer to the 75th Meridian or Eastern time.

TABLE I.

Mean hourly values of the magnetic declination at the Washington Magnetic Observatory during the year 1890.

4° West + tabular quantity.

Hour.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.
1 A. M.	4′.0	3′.9	3′.9	4′.3	4′.6	5′.0	5′.6	5′.7	6′.1	6′.6	8′.3	9′.7	5′.5
2	4.0	4.3	3.9	4.0	4.6	5.1	5.0	5.7	5.8	6.8	7.6	8.1	5.4
3	4.1	3.9	4.1	3.6	4.2	4.9	5.6	5.9	5.5	6.3	7.9	7.9	5.3
4	3.7	3.7	3.9	3.3	4.0	4.8	5.5	4.7	5.3	6.4	7.3	7.4	5.0
5	3.8	3.7	3.5	3.2	3.2	3.8	4.2	4.4	5.1	7.0	7.5	7.7	4.8
6	4.1	3.5	3.3	2.2	2.2	2.4	2.6	2.6	4.1	6.5	7.3	7.5	4.0
7	3.6	3.3	2.2	1.4	2.0	1.2	1.2	0.6	2.5	5.0	6.9	7.5	3.1
8	2.7	2.6	1.2	**1.0**	**1.6**	**1.0**	**1.1**	**0.2**	**2.1**	**3.4**	**6.2**	7.9	**2.6**
9	**1.4**	**2.2**	**1.0**	1.7	2.6	2.0	1.9	1.9	3.4	3.6	6.5	**6.0**	2.9
10	1.4	2.2	2.6	3.9	5.0	4.4	4.1	5.9	5.2	5.2	7.1	6.0	4.4
11	3.0	3.2	4.7	6.5	6.8	8.5	6.6	8.7	8.2	7.4	8.4	7.4	6.6
Noon,	5.2	4.9	6.8	8.9	7.4	9.5	9.2	11.0	10.4	9.6	9.9	9.0	8.5
1	6.8	6.2	7.9	**9.4**	**10.2**	10.6	**10.3**	**11.4**	**11.1**	**10.6**	**10.6**	10.0	**9.6**
2	**7.0**	**6.8**	**8.1**	9.4	10.0	**10.6**	10.2	10.9	10.9	10.6	10.3	**10.1**	9.6
3	6.3	6.7	7.6	8.5	8.9	9.8	9.7	9.5	9.8	9.7	9.5	9.8	8.8
4	5.4	5.8	6.5	7.0	7.2	8.4	8.5	7.8	8.6	8.5	8.9	9.2	7.6
5	4.6	5.1	5.6	5.8	5.8	7.1	7.2	6.8	7.4	7.6	8.8	8.3	6.7
6	4.0	5.0	5.0	5.0	5.2	6.3	6.1	5.9	6.9	7.2	8.2	7.7	6.0
7	3.8	3.6	4.6	4.8	5.4	6.0	5.8	6.0	6.6	6.6	7.3	7.4	5.7
8	3.5	3.7	4.4	4.4	5.4	5.8	5.5	5.9	5.6	6.2	6.7	7.1	5.4
9	3.3	3.5	3.9	4.4	4.9	5.8	5.1	5.8	5.8	5.2	6.3	6.8	5.1
10	2.8	3.2	3.4	4.2	4.9	5.8	5.3	5.7	5.8	6.0	5.8	7.1	5.0
11	3.0	3.3	3.6	4.0	4.9	5.2	5.3	5.8	5.8	6.2	6.3	7.3	5.0
Midn't,	3.5	3.4	3.8	4.0	4.7	5.3	5.3	6.0	5.9	6.0	6.7	7.4	5.2
Mean,	4.0	4.1	4.4	4.8	5.2	5.8	5.7	6.0	6.4	6.8	7.8	7.9	5.8
Range,	5.6	4.5	7.1	8.4	8.7	9.6	9.3	11.2	8.9	7.2	4.4	4.1	7.0

The diagram (Fig. 3) gives a graphical representation of the diurnal variation, on the average for the year, for the years 1888, 1889 and 1890. As will be seen, the chief characteristics of this remarkable variation are, first, that at about sunrise the north end of the needle swings to the eastward until about 8 or 9 A. M., when it has reached its most easterly elongation. If the declination is west of north, as it is at present, over the entire state, then the declination will have reached its *lowest* value for the day at this time. Secondly, the needle, after hovering about the easterly extreme for a while, turns about and begins to march westward. About 10 or 11 A. M. it crosses the mean or average position for the entire day (24 hours). It does not stop here, but still pursues its onward march and at this moment with the greatest velocity until about 1 to 2 P. M., when the most

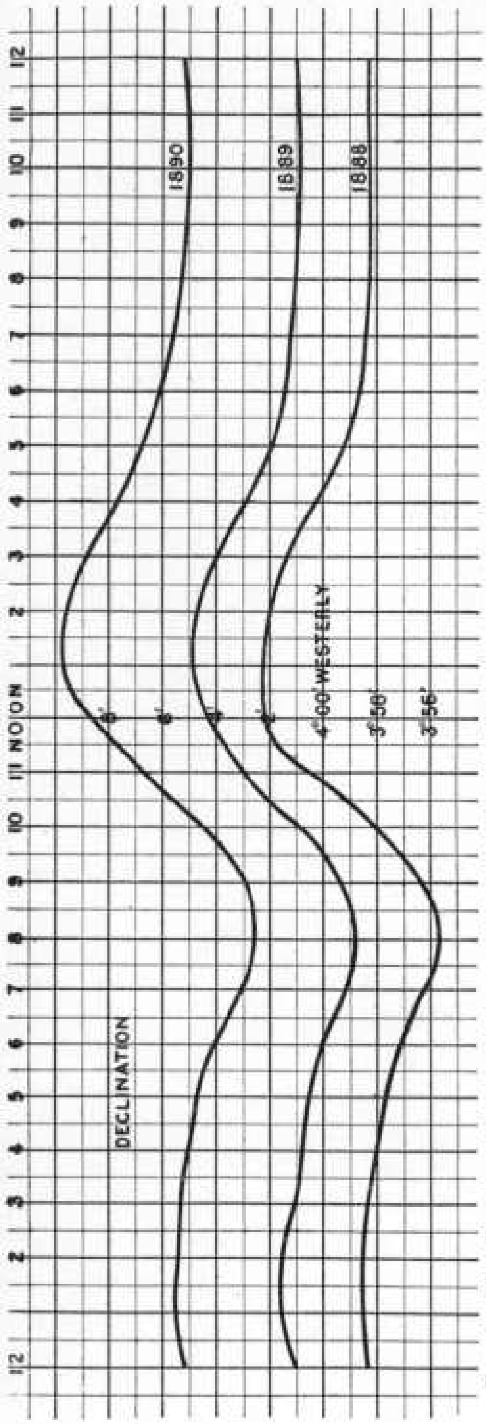


FIG. 3.—The diurnal variation of the magnetic declination at Washington, D. C., for the years 1888, 1889 and 1890. The curves represent the mean diurnal variation for the year.

westerly extreme position has been reached. At this time the westerly declination will have reached its *highest* value. And now the needle turns once more to the eastward, recrosses the mean position about sunset and gradually returns with occasional interruptions or reversals approximately to the position it started out from in the morning.

We can follow with our eyes the sun in its apparent motion around the earth and can behold many of the manifold changes ever taking place in our starry firmament, but here is a something in the earth, invisible to us, that we call magnetism, which day by day, year in, year out, passes through *its* cycle of changes — a force powerful enough to bend every bit of magnetized steel out of the regular course and to compel the needle to march in perfect obedience to its will!

The total change between the morning and afternoon extremes, as will be noticed from the bottom row of figures of the table, is about 11′ in mid-summer and about half this amount in mid-winter. It is a quantity then that should be taken into consideration for precise work. In Germany, mine surveying has been brought to such an art that some of the principal mines maintain small magnetic observatories where the declination is recorded continuously throughout the day by photographic means. The mine surveyor then uses the value of the declination to the nearest minute as prevailing at the very time of day when he is running his line. The land surveyor generally ignores the diurnal variation, though it is a quantity that may at times make itself appreciably felt in his work. In the determination of the declination or in the comparison of compasses the diurnalvariation should be taken into account. Below is a table giving the correction to be applied to a declination observed at any time between 6 A. M. and 6 P. M., in order to reduce it to the mean value for the day (24 hours). Apply the tabular quantities to the observed westerly declination with the sign as affixed.

TABLE II.

Correction of an observed declination for diurnal variation.

Month.	6 A. M.	7	8	9	10	11	Noon.	1	2	3	4	5	6 P. M.
Jan.....	—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
Feb	+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
Sept....	+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
Oct.....	+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
Nov....	+0.5	+1.2	+1.7	+1.8	+1.1	—0.5	—2.0	—2.7	—2.6	—1.8	—1.0	—0.2	+0.2
Dec	+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

These figures represent the mean results of the continuous magnetic observations made at the old site of the Washington Magnetic Observatory—the old Naval Observatory Grounds—during the four years 1888–91. The hours are for the seventy-fifth meridian, or Eastern time, which is 8 minutes and 12.09 seconds fast of Washington meridian time. The diurnal variation progresses according to the hours of *local* mean time, and this fact, theoretically, ought to be taken into consideration in applying the diurnal variation as obtained in Washington to various parts of Maryland. However, the correction that would have to be made on this account is but a small fraction of a minute.[1] There are other errors, larger than this, committed in the application of the table. *It will suffice, therefore, for practical purposes to make all corrections of declination obtained in this state according to standard time.*

It will be seen from the bottom row of figures of Table I that the *range* between the extreme values of the declination is subject to an *annual* variation, being in mid-winter just about half of that in mid-summer, the mean value for the year being about 7′ for that particular year (1890) and for the latitude of Washington. This mean value is likewise subject to a fluctuation, being greater in years of maximum sun-spots and less in times of minimum sun-spots. The next table exhibits this. *R* stands for the relative number of sun-spots. Thus the year 1843 was a year of minimum number of sun-spots, and we find that the range of declination at Philadelphia reached its smallest value. The year 1883–84 was a time of maximum number of sun-spots, and we see that the range at Los Angeles, California, reached its maximum value at this period.

TABLE III.

Showing how the diurnal range of the declination varies during the sun-spot period.

PHILADELPHIA.			LOS ANGELES.		
Year.	Range.	R.	Year. (Oct. to Oct.)	Range.	R.
1840	9′.1	61.8	1882–'83	6′.5	60.7
1841	8.1	38.5	1883–'84	**7.1**	**68.2**
1842	7.8	23.0	1884–'85	6.9	53.7
1843	**7.5**	**13.1**	1885–'86	5.8	32.4
1844	7.5	19.3	1886–'87	5.4	14.3
1845	8.5	38.3	1887–'88	5.4	7.3
			1888–'89	5.1	7.4

[1] To be theoretically correct, the standard time of observation would have to be corrected as follows: For extreme eastern part of Maryland add 8 minutes; for extreme western part of Maryland subtract 9 minutes. The table would then be entered with the times thus corrected.

How the daily range varies with magnetic dip is shown by the next table. The best indication of approach to the magnetic pole is given by the increase in the value of the magnetic dip or inclination, and hence the column of dip values has been added. For Fort Conger, where the dip is 85°, the diurnal range amounts to 1° 39′.

That the diurnal range increases as we proceed towards the magnetic pole is due to the fact that the magnetic force which acts on the compass needle diminishes with approach to the pole, and hence the deflecting forces which cause the diurnal variation have a more powerful effect near the pole than farther away.

TABLE IV.

Showing the variation in the diurnal range of the declination with approach to magnetic pole.

Station.	Lat.	Long. W. of Gr.	Magnetic Dip.	Range.	Years of observations.
Key West	24° 33′	81° 48′	54° 32′	4′.7	1860.2–'66.2
Los Angeles	34 03	118 15	59 30	5.8	1882.8–'89.8
Washington	38 54	77 01	71 19	7.5	1840.5–'42.5
Philadelphia	39 58	75 10	71 58	7.8	1840.5–'45.5
Madison	43 04	89 24	73 56	6.7	1877.2–'78.2
Toronto	43 39	79 24	75 15	8.8	1842.5–'48.5
Sitka	57 03	135 20	75 55	10.6	1848–'62
Uglaamie Point	71 18	156 40	81 24	40.1	1882.7–'83.6
Plover Point	71 21	156 16	81 36	38.6	1852–'54
Fort Rae	62 39	115 14	82 54	41.4	1882.8–'83.7
Kingua Fiord	66 36	67 19	83 51	43.7	1882.8–'83.7
Fort Conger	81 44	64 44	85 01	98.8	1881.7–'82.6

The times when the declination reaches its extreme values, or when it reaches its average value, as will be evident from Table I, are subject to fluctuations in the course of the year, being generally retarded about a half-hour or more during the months when the sun is south of the equator. These changes, which undergo a complete cycle in the course of one year, likewise manifest themselves in the magnitude of the diurnal range as already pointed out.

The approximate local mean time when the mean declination is reached in the morning is, on the average for the year, as follows:

	H.	M.	
At Toronto	10	17	A. M.
Philadelphia	10	20	
Washington	10	25	
Key West	10	51	
Madison	10	43	
Los Angeles	10	35	

If the monthly values of the magnetic declination, as given at the bottom of Table I, be corrected for the secular change in the course of the year, they likewise exhibit a slight variation, having the year as the period. This is termed *the annual variation of the magnetic declination.* This is not to be confounded with the *annual change* of the declination, which means the change in one year due to the secular variation. The latter is a *progressive* change, so that the needle at the end of the year does not point the same way as it did at the beginning, while the annual variation is a *cyclical* change, that is, as far as the annual variation is concerned, the needle returns to the same position virtually at the end of the year that it had at the beginning. The next table shows how minute a quantity this annual variation is and that it can be neglected for all practical purposes.

TABLE V.

Annual variation of the magnetic declination at several places in the northern magnetic hemisphere.[1]

[A + sign denotes a deflection of the north end of the magnet to the *eastward*, a — sign, the contrary direction.]

Month.	Los Angeles, Cal. 1882–'89.	Key West, Fla. 1862–'65.	Washington, D. C. 1840–'42. 1867–'68.	Philadelphia, Pa. 1840–'45.	Toronto, Canada. 1845–'51. 1856–'64. 1865–'71.	Dublin, Ireland. 1841–'50.	Kew, England. 1858–'62.
January	+0′.6	—0′.6	+0′.6	—0′.5	0′.0	+0′.4	0′.0
February....	+0.2	—0.6	+0.3	—0.4	+0.2	+1.6	—0.6
March	—0.4	+0.1	+0.2	+0.1	+0.1	+1.7	—0.5
April.......	—0.4	+0.3	—0.1	+0.1	0.0	+1.9	0.0
May........	—0.4	+0.3	—0.4	—0.2	+0.3	+1.3	+0.7
June........	—0.4	+0.2	—0.1	+0.6	+0.5	0.0	+0.8
July	—0.4	+0.3	+0.2	+1.0	+0.4	—1.2	+1.2
August	—0.1	+0.8	+0.7	+0.9	0.0	—2.2	+0.3
September..	+0.2	+0.7	—0.4	0.0	—0.4	—2.1	—0.2
October.....	+0.4	—0.5	—0.2	+0.2	—0.6	—1.4	—0.8
November ..	+0.5	—0.5	—0.2	—0.9	—0.4	—0.3	—0.6
December...	+0.6	—0.3	—0.3	—0.7	—0.1	+0.2	—0.7

It is seen that the total range of the annual variation is a very small quantity, about 1′ for the North American stations. The character of the variation appears to be different for each station. This

[1] From Coast and Geodetic Report for 1890, p. 249. The matter contained in Tables III and IV was taken from the same source.

may possibly be due to the fact that the tabular results do not refer in each case to the same interval of time and they were not deduced by one common method.

Minor Periodic Fluctuations.

Of these may be mentioned the *variation depending upon the solar rotation*, having a period of about 26 days, and the *variation depending upon the position of the moon with reference to the sun and the earth.* The ranges, or differences between extreme values of both of these variations, are so minute that it requires many years of continuous and carefully made observations to detect them.

Magnetic Storms.

Generally speaking, these may occur at any time and are frequently accompanied by auroral displays. Such storms may at times have a very wide circle of action and occur practically simultaneously over the whole area. Thus on December 3d, 1896, while I was on my way to Salisbury to establish a meridian line for Dorchester county, I saw in the evening a most brilliant aurora, and the next day while making magnetic observations the behavior of my needle plainly indicated that a magnetic storm was prevailing. I have since then received from a magnetic observatory at Bochum, Germany, established in connection with a mining plant, the tabulated hourly values of the magnetic declination during 1896 and I find that the magnetic storm of December 4 likewise made its appearance at this distant place.

The deviations caused by these spasmodic fluctuations in the earth's magnetism may in these latitudes occasionally amount to as much as 10′–20′ and even more. On October 12th, 1896, I made observations at Oakland at various times during the day. The diurnal variation on that day was completely reversed, the highest value occurring in the morning, instead of in the afternoon, and the lowest value in the afternoon, instead of the morning. My first observation in the morning required a correction of —16′.

Small spasmodic fluctuations occur frequently. Thus, according to a list of more or less disturbed days from July to December of last year, as furnished by the Toronto Magnetic Observatory, we have:

In July	17	more or less disturbed days.
August	20	
September	19	
October	14	
November	9	
December	8	

Fortunately for the surveyor, about 75–90 per cent of these disturbances were either small or they occurred at times when they would not appreciably affect his work.

It is due largely to these irregular disturbances, the coming of which we cannot as yet predict, that it is not possible to give accurate reductions of an observed declination to the mean value foı the day by a general system of rules.

The duration of the irregular fluctuations may be but an instant, a few hours or several days. They generally reveal their presence by a sudden and marked departure of the needle from its true normal position. While these fluctuations make their appearance apparently at random, nevertheless, when they are treated statistically it is found that they exhibit well-marked periodicities in their occurrences. Thus they are more frequent and more violent in the years of maximum sun-spots and less frequent and less violent in years of minimum sun-spots. In November, 1882, during the period of maximum sun-spots, a magnetic storm occurred which caused the magnetic needle at Los Angeles, California, to move over $1\frac{1}{3}°$ out of its normal position. The actual deviation beyond $1\frac{1}{3}°$ was lost because the photographic trace of the needle's fluctuation went beyond the sensitized sheet. Then again they appear subject to short periodic variations, such as the daily and the annual. They seem to occur more frequently towards evening. Perhaps the best idea of the frequency and magnitude of the irregular disturbances is obtained from Mr. Schott's table.[1] The table is based on the observations made every two hours at Philadelphia, under Bache, between the six years 1840 to 1845.

[1] Coast and Geodetic Survey Report for 1888, App. 7.

Deviations from normal direction.	Number of disturbances.
3.′6 to 10.′8	2189
10.′8 to 18.′1	147
18.′1 to 25.′3	18
25.′3 to 32.′6	3
Beyond,	0

It should be recalled that the period of sun-spot minimum occurred in the midst of this series; otherwise the disturbances would have been more frequent and greater. Mr. Schott cites the following maximum deflections:

At Key West, between 1860 and 1866..........	0°	21.′4
At Madison, Wis., on Oct. 12, 1877	0	48
At Madison, Wis., on May 28, 1877	0	24
At Lady Franklin Bay, during great storm in November, 1892, Greely noted a deflection of..	20	28

Mr. G. R. Putnam, Assistant of the Coast and Geodetic Survey, cites[1] a change of over three degrees in twenty minutes at Niantilik on September 18, 1896. "At 7h. 35m. A. M. local mean time, the needle pointed 60° 35′ W. of N., while at 7h. 55m. it pointed 63° 50′ W. of N., and the total range for the day was over four and a half degrees. On this date there was an unusual magnetic disturbance, the extreme range in declination at Washington being 38′ of the entire day, and 19′ for the portion of the day corresponding to the interval during which observations were made at Niantilik. It will be noted that the range in declination was nearly fifteen times as great as at Washington during the same interval." The geographical position of Niantilik is 64° 53.′5 N. and 66° 19.′5 W. of Greenwich, and the dip on September 18, 1896, was 83° 54.′8.

The Secular Variation.

This is the variation that concerns the surveyor most intimately. How much to allow for the *change* in the direction of the magnetic

[1] The Scientific Work of the Boston Party on the Sixth Peary Expedition to Greenland, Report II, by G. R. Putnam, Technology Quarterly (Massachusetts Institute), March, 1897, p. 79.

meridian during a given interval of time is generally of greater concern to him than the knowledge of the *absolute* value of the magnetic declination. Unfortunately the problem of proper allowance of change of declination is frequently complicated by other questions, such as, for example, the date of the early survey or the error of the compass used in the original survey; or, again, whether the bearings as recorded are those taken from some previous survey without allowing for secular variation; or, again, whether they are true bearings or magnetic ones. The early land records are frequently faulty in all the details that are absolutely necessary for the proper allowance of the secular change. No rules can, of course, be given for supplying such omissions. The surveyor must be guided entirely by the experience gained in the treatment of analogous cases. My purpose is simply to give tables enabling the surveyor to determine the change in the compass direction between any two years during the eighteenth and nineteenth centuries.

Whether the secular variation is of a strictly periodic character, that is, whether the needle will at some future time return to the very same position from which it started out, has not as yet been definitely settled, for the reason that we do not possess at any one station records of a complete swing of the needle. The researches thus far made would seem to indicate that after the lapse of many centuries the needle may return *approximately* to its original position, but that it ever again reaches the *identical* position does not seem probable.

At a number of stations we possess records of the magnetic declination for over three centuries. The table below will show how the declination has changed at some of these stations during this interval.

Thus at London, for example, we find that the needle pointed east of north during the interval 1540 to 1658, the easterly declination reaching its maximum value of 11° in 1580. About 1658 the needle bore due north, and thereafter westward of due north, the westerly declination reaching its maximum value of 24° 12′ in about 1812. Beginning with 1812, the westerly declination has been steadily diminishing, amounting in 1890 to 17°.57 or 17° 34′. Consequently,

TABLE VI.

Showing the secular change in the magnetic declination at various stations.

Date.	Northern Hemisphere.						Southern Hemisphere.			
	London.	Paris.	Rome.	Manila	San Francisco.	Baltimore.	Rio de Janeiro.	Ascension. I.	St. Helena. I.	Cape Town.
	°	°	°	°	°	°	°	°	°	°
1540	7.2 (?) E	8.2 E	10.47 E	..	..	..	..	..	..	..
1560	9.6 (?) E	9.3 E	11.61 E	..	..	..	..	..	..	..
1580	10.93 E	9.6 E	11.41 E	..	..	..	..	..	..	..
1600	10.13 E	8.8 E	9.88 E	..	..	..	..	..	..	..
1620	7.26 E	6.9 E	7.29 E	..	..	..	..	..	..	..
1640	3.27 E	4.42 E	3.86 E	..	..	5.00 W	..	..	..	..
1660	0.59 W	0.86 E	0.01 W	..	..	6.00 W	..	..	..	..
1680	3.89 W	3.47 W	4.01 W	..	..	6.01 W	..	..	..	..
1700	7.08 W	7.99 W	7.77 W	..	..	5.05 W	..	..	..	..
1720	10.97 W	12.27 W	11.02 W	..	..	4.05 W	..	..	..	..
1740	15.30 W	15.83 W	13.63 W	..	..	3.02 W	..	..	..	..
1760	19.57 W	18.76 W	15.51 W	..	..	1.95 W	7.44 E	8.4 W	11.70 W	20.5 W
1780	22.65 W	20.87 W	16.64 W	..	12.6 E	1.03 W	6.84 E	11.6 W	14.59 W	23.2 W
1800	24.07 W	22.12 W	17.06 W	0.18 E	13.6 E	0.66 W	5.42 E	14.0 W	17.51 W	25.4 W
1820	24.09 W	22.40 W	16.77 W	0.38 E	14.6 E	0.93 W	3.46 E	16.4 W	20.01 W	27.2 W
1840	23.22 W	21.38 W	15.84 W	0.54 E	15.43 E	1.77 W	1.01 E	18.8 W	22.00 W	28.8 W
1860	21.55 W	19.54 W	14.23 W	0.70 E	16.11 E	2.99 W	1.71 W	21.4 W	23.41 W	29.7 W
1880	18.73 W	16.76 W	11.77 W	0.78 E	16.57 E	4.30 W	4.52 W	22.9 W	24.11 W	29.6 W
1890	17.57 W	15.16 W	10.57 W	0.80 E	16.64 E	4.89 W	5.88 W	23.0 W	24.21 W	29.2 W
1900	..	..	..	..	16.7 E	5.04 W	..	..	..	..

between 1580 and 1812, in an interval of 232 years, the compass direction at London veered from 11° east to 24° 12′ west, or changed its direction by 35° 12′! *A street a mile long, laid out in London in 1580 so as to run parallel to the direction pointed out by the compass would be 3725 feet, or $\frac{7}{10}$ of a mile, too far to the east at the north terminus according to the compass direction of 1812!*

By looking over the figures for Paris and Rome we find similar changes to those at London. At Paris the maximum easterly declination of 9° 36′ was reached near the year 1580, and the maximum westerly declination of 22° 36′ in about 1809, the needle pointing due north in 1664. At Rome the declination of the needle reached its maximum amount east, 11° 36′, in 1570 approximately, and its maximum amount west, 17° 06′, in about 1810, coinciding with the true meridian in 1660. At Manila, on the Philippine Islands, the needle changed from 11′ east in 1800 to 48′ east in 1890, and at San Francisco, Cal., from 12° 36′ east in 1780 to 16° 41′ at the present time. We next come to Baltimore and find that at this station between 1640 and the present time the needle bore west all the time and did not at any time point due north or east of north as surveyors frequently assume to be the case for this part of Maryland. Looking over the figures we find that at Baltimore the compass needle pointed about 6° 06′ west in 1670 and that in about 1802 it pointed the least amount west, namely, 39′; hence, in an interval of 132 years, the needle changed its direction by 5° 27′. *A street a mile long laid out in Baltimore in 1670 so as to run parallel to the compass direction would have its north terminus 504 feet, or about $\frac{1}{10}$ of a mile, too far to the west in 1802!* This is a fact especially interesting because in some of the old towns of Maryland the streets were laid out by the compass, or prominent public buildings, such as court houses, erected so that the front face would run paralled to a cardinal direction as given by the compass. For example, while establishing a meridian line for the use of surveyors at Chestertown, the county-seat of Kent county, I found that High street, the main street, ran very nearly magnetically northwest and southeast. Assuming that the street was originally laid out with the compass so as to run northwest and southeast, and knowing from the data at Baltimore and some other stations that the needle bore the same amount west in the early part of the eighteenth century that it does at present, the conclusion to be drawn was that the town of Chestertown was laid out in the early part of the last century. Upon looking up the records, the assumptions made and the conclusions drawn were verified. The town was laid out in 1702 and the streets run with the compass northwest and southeast and at right angles thereto.

The table likewise gives the change in the compass direction at some stations in the Southern Hemisphere. One fact at once noticeable from this table is, *that during a given interval of time the compass direction changes not only by different amounts in different parts of the earth, but, likewise, the changes occur in some parts in opposite directions.* Let us compare, for example, the changes which have occurred between 1800 and 1890 at the various stations.

Station.	North end of compass needle veered between 1800 and 1890.
London	6° 30′ to the east.
Paris	6 58 " "
Rome	6 29 " "
Manila	0 37 " "
San Francisco	3 02 " "
Baltimore	4 14 " west.
Rio de Janeiro	11 18 " "
Ascension Island	9 00 " "
St. Helena "	6 42 " "
Cape Town	3 48 " "

The compass needle accordingly while swinging to the *eastward* at London between 1800 and the present time was swinging in the opposite direction, *westward*, at Baltimore during the same interval of time, the amount of swing not being the same at the two stations.

Another striking fact disclosed by looking over the figures for any one station, for example, Baltimore, is *that at the same station the change per year, as frequently assumed by the surveyor, is not a constant quantity.* The annual change for this particular station may vary all the way from zero to four minutes. At the times of maximum or minimum values of the declination the annual change is practically zero for about five years on either side of these epochs. The annual change then begins to increase until about midway between the epochs of maximum and minimum values, for example, about 1730 or about 1870, when it reaches its maximum value of about four minutes; it then diminishes again.

The secular motion of the compass needle may be likened to the swinging of a pendulum. At the extreme positions of the pendulum, on either side of the position it would occupy if at rest, the velocity with which the bob moves in its orbital path vanishes. As the pendulum moves towards its mean position, from the right let us say, it does so at a constantly accelerating pace until it reaches the mean position midway between the two extreme positions. Here the velocity is a maximum, and as the pendulum swings past the mean position it begins to slacken its pace until reaching the extreme position on the left, when the velocity of motion again vanishes. As stated, at no station has as yet a complete swing, for example, from right to left and back again from left to right, been observed. At some stations, however, a little over half a swing has been obtained. Comparing the time interval between the two extreme positions, *i. e.*, half a swing, at various stations we are brought face to face with another remarkable fact, *that the time intervals between the extreme positions of the needle are of different lengths in different parts of the earth.* To illustrate: At London, Paris and Rome the time interval between dates of extreme positions of the needle is about 230-240 years, while for stations in the Eastern states of this country it is on the average about 150 years. If we take into consideration all the facts at present known to us with regard to the secular variation, we find that it is not possible to explain all those facts on the assumption that there is a secular variation period common to all parts of the earth of about 300-500 years in length. The indications are that for a common secular variation period we must have a much longer one than 300-500 years. But if this is so, it means that the secular variation is a far more complicated matter than generally supposed. Besides the main swing as described above, there are a number of minor swings whose periods are not as yet definitely known. These minor swings have the effect of slightly altering the annual change due to the main secular variation.

Fig. No. 4 illustrates graphically the change in the magnetic declination for various points in the northern hemisphere. I have selected such stations as would be typical of the regions represented by them. It will be seen that the stations encircle the globe. This one diagram exhibits at a glance all the characteristic features of the secular variation of the magnetic declination in the northern hemisphere as at present known. It is presented here for the first time, the data having been collected from various sources. With the aid of the table (No. VI) the meaning of the curves will be readily understood. Thus, for example, selecting the date 1800 and running the eye along the horizontal line marked 1800 until it intersects the London curve, let us say, casting the eye now upward from this point of intersection along the vertical line, we find that the declination of the needle was a trifle over 24° west. For Paris, the observations known to us up to the present time have been indicated by dots. It will be seen that the curve, which is due to Mr. Schott, represents the existing data satisfactorily. In the case of Fayal Island it will be

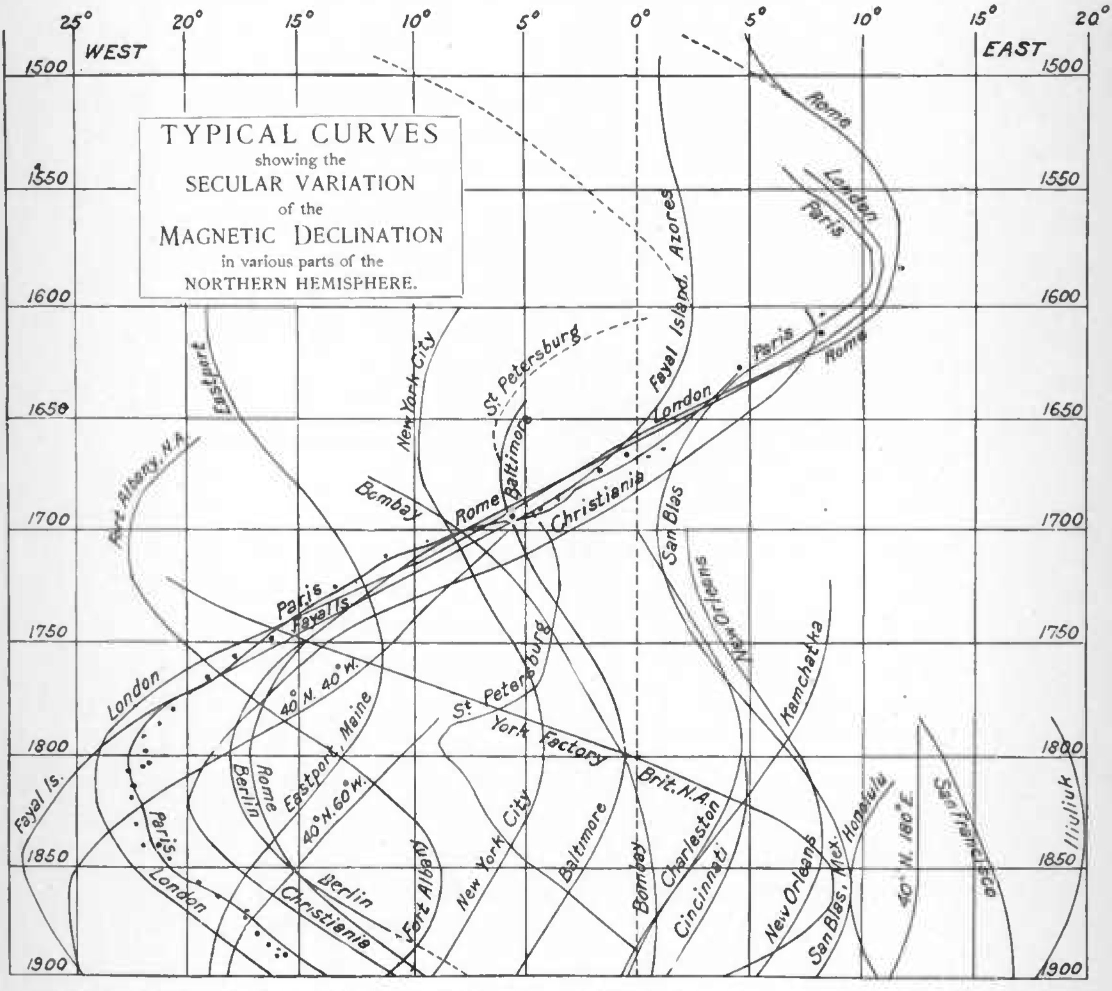


FIG. 4.—A comparison of the Baltimore secular variation curve of the magnetic declination with those obtained at various stations in the northern hemisphere.

noticed that prior to 1600 I have given two curves, one in full and the other broken; the broken curve represents a repetition of the same law which governed the secular variation at this station between 1600 and present date, while the full curve has been drawn to harmonize with the observations back to the time of Columbus. It will be seen that there is a marked difference between the two curves for the date 1500. A similar state of things is revealed at Rome, the broken curve again representing the law from 1510 to present date, while the full curve represents the observations which can be obtained with the aid of the early "compass charts" of the fourteenth and fifteenth centuries. The departure between the broken curve and the full one amounts to about 17° for the year 1400! We have similar indications at other stations of a change in the law of the secular variation prior to 1600.

The special purpose of the diagram has been to show what relation the secular variation as obtained at Baltimore bears to the general phenomenon. Each station bears a somewhat different testimony of the phenomenon we are studying, and it is only by considering the collective evidence that we can hope to make headway and be enabled to say what likely transpired at any one station prior to the records, or what is likely to occur at this station in the future. By following the curves systematically around the globe it is quite possible to construct a composite curve, with the aid of which we can obtain a clearer conception of this most perplexing phenomenon.

The laws actually governing the secular variation cannot be discovered by simply considering the changes in the magnetic declination alone, as already explained in another place. We can only hope to make progress by studying the phenomenon in its *entirety*, namely, if we take a magnetized needle and suspend it at its centre of gravity in such a way that it is free to move in any direction whatsoever, to the left or to the right, up or down, then we shall find that, under the influence of the earth's magnetism, the *north* end of the needle while still pointing approximately towards the north also points *downward* and the *south* end *upward*. The actual direction assumed by the needle lies somewhere between a true vertical line and a true horizontal line, nearer to the former than to the latter in these latitudes. This is the true direction in which the earth's magnetic force acts. On the *compass needle* we only have the *horizontal* component of that force acting, the *vertical* component having been counteracted by adding an additional weight to the south arm of the needle, generally a bit of brass wire. The changes that are taking place in the *true* direction of the earth's magnetic force and in the *magnitude* of the force constitute the real facts to be studied.

It is an interesting problem to inquire: How does the north end of the freely suspended magnetic needle move with the lapse of time, if we behold the motion from the point of suspension of the needle? Does it move clockwise or anti-clockwise. Would needles similarly suspended in all parts of the earth move in the same direction? What is the nature of the curve described in space by the north end? These are some of the fascinating questions we can ask ourselves under the new point of view.

It has been found by the writer that over the greater portion of the earth the north end of a freely suspended magnetic needle during the past two or three centuries has been moving in a *clockwise* direction. In the Pacific Ocean and along the western coast of our country we have evidences of small irregularities in the general law of motion as announced above. Some of the stations in this region exhibit small *anti-clockwise* motions. No station has thus far been found where the reversed motion has prevailed for any such length of time as has been the case with the direct motion.

Fig. No. 5 exhibits the curves resulting in the manner described above for London and for Baltimore.

I have given at such length the main facts at present known to us with regard to the variations of the earth's magnetism, believing that a fuller exposition than can be obtained from text-books would not be unwelcome to the surveyor or to those desiring to make themselves more intimately acquainted with the subject of terrestrial magnetism. The questions that I have endeavored to answer have been such as I have been asked almost daily throughout the progress of the magnetic survey by all classes of men, notably surveyors, lawyers and teachers.

We are now prepared to present all the data at present known, with the aid of which it has been possible to give in a convenient tabular form, for various points in Maryland, the figures enabling the surveyor to obtain the difference in the direction of the magnetic meridian between any two dates for the eighteenth and nineteenth centuries.

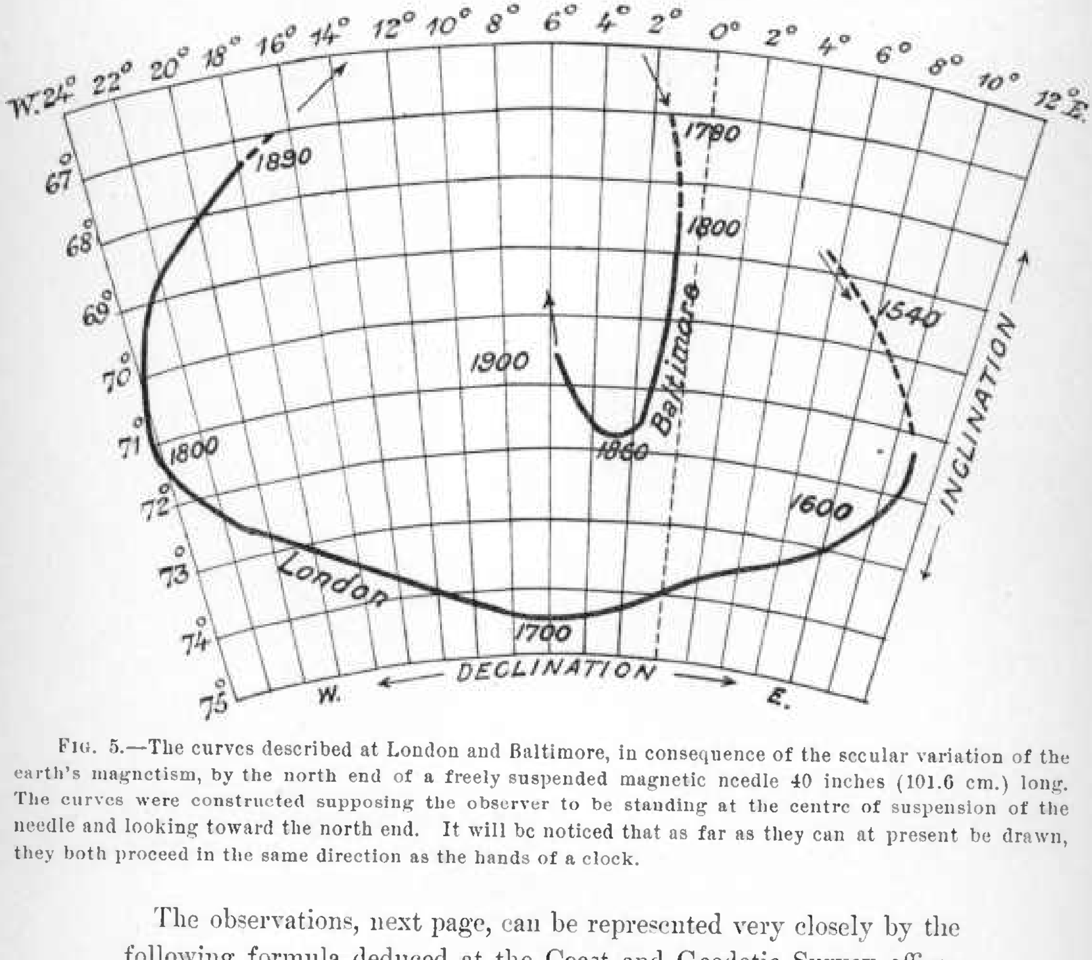


FIG. 5.—The curves described at London and Baltimore, in consequence of the secular variation of the earth's magnetism, by the north end of a freely suspended magnetic needle 40 inches (101.6 cm.) long. The curves were constructed supposing the observer to be standing at the centre of suspension of the needle and looking toward the north end. It will be noticed that as far as they can at present be drawn, they both proceed in the same direction as the hands of a clock.

The observations, next page, can be represented very closely by the following formula deduced at the Coast and Geodetic Survey office:

$$D = +3^\circ.38 + 2^\circ.72 \sin (1^\circ.4\, m - 22^\circ.3), \qquad (1)$$

where D stands for magnetic declination, plus when west, and m is the time interval in years and decimals of between date of observation, t, and the year 1850. We have $m = t - 1850$. The coefficient of m,

TABLE VII.

Observations of the magnetic declination at Baltimore.[1]

Latitude = 39° 17′.8. Longitude = 76° 37′.0 W. of Greenwich [Washington Monument].

No.	Date.	Declination.	References and Remarks.		
	1620, about	11°(?)′ W	According to R. Dudley's Arcano del Mare, 1646–47. Not used.		
1	1640—	9 W	De Isogonen in de XVI en XVII Eeuw; Proefschrift door W. van Bemelen. Utrecht, 1898.		
			Given values.[2]		
2	1679.0	5.25 W	D. of 1679.0=D. of 1814.5+4°.50		+0.75
3	1683.5	6.25 W	1683.5 1814.5+5.50		+0.75
4	1703.5	5.12 W	1703.5 1811.8+4.43		+0.69
5	1720.5	4.21 W	1720.5 1816.0+3.42	adopted	+0.79
6	1729.2	4.02 W	1729.2 1807.1+3.39	value	+0.63
7	1754.5	2.28 W	1754.5 1855.5—0.37	for	+2.65
8	1756.9	2.88 W	1756.9 1815.0+2.12	later	+0.76
9	1771.0	1.11 W	1771.0 1846.5—1.00	epoch.	+2.11
10	1776.1	1.75 W	1776.1 1811.4+1.07		+0.68
11	1780.5	0.77 W	1780.5 1861.5—2.25		+3.02
12	1787.5	0.37 W	1787.5 1851.0—2.00		+2.37
13	1808.5	0 12.5W	D. Byrnes, from numerous observations, at Baltimore, in different localities; Sill. Jour., vol. xviii, 1830.		
14	1840, Aug. 27	2 16.5W	Dr. A. D. Bache, Coast Survey Report for 1862, p. 213.		
15	1847, April 29	2 18.6W	Capt. T. J. Lee, U. S. E., Assistant Coast Survey, at Fort McHenry in lat. 39° 15′.8, long. 76° 34′.8 W.; Coast Survey Report for 1854, p. 144.		
16	1856, Sept. 13	2 29.3W	C. H. Schott, Assistant Coast Survey; just outside Fort McHenry in lat. 39° 15′.9, long. 76° 34′.9 W.; Coast Survey Report for 1858, p. 191.		
17	1875.5	3.74 W	T. Kelbaugh.[2] D. of 1875.5=D. of 1857.0+1°.00. Adopted value for 1857.0, +2°.74.		
18	1877, Oct. 10, 11, 12	4 10.8W	J. B. Baylor, Assistant U. S. Coast Survey, at Fort McHenry, near station of 1856, in lat. 39°15′.9, long. 76°34′.9; Coast and Geodetic Survey Report for 1881, App. 9.		
19	1885, Aug. 5, 6, 7	4 29.3W	J. B. Baylor; same station as 1877.		
20	1895, Sept. 27, 28	5 20.3W	J. B. Baylor; at a different station in grounds of Fort McHenry.		

[1] According to collections given in Coast and Geodetic Survey Reports for 1888, App. 7, pp. 214-215, and for 1895, App. 1, p. 219.

[2] "Mr. Thomas Kelbaugh, surveyor at Mount Carmel, Baltimore County, Maryland, communicated to the Coast Survey office (letters dated August 17 and 24, 1877, and April 28, 1879) 52 cases of observed (or allowed for) changes of magnetic declinations between two given dates. These differences were mostly from redeterminations of magnetic bearings of old lines made with the common surveyor's compass by different individuals and with different instruments. Their locality was generally known within a radius of 15 statute miles of the city of Baltimore, and on the N., the N. E.

namely, 1.°4, is the quotient of 360° divided by twice the time interval between epochs of maximum and minimum declination. How closely the formula represents the existing data is seen from the next table.

TABLE VIII.

Comparison between observed and computed values of the magnetic declination at Baltimore

Date.	Obs'd D.	Weight.	Comp'd D.	C.—O.	Date.	Obs'd D.	Weight.	Comp'd D.	C.—O.
1640.5	+9°.00	¼	+5°.28	—3°.72	1780.5	+0°.77	1	+1°.02	+0°.25
1679.0	5.25	½	6.07	+0.82	1787.5	0.37	1	0.82	+0.45
1683.5	6.25	1	6.01	—0.24	1808.5	0.21	1	0.70	+0.49
1703.5	5.12	1	5.38	+0.26	1840.7	2.27	1	1.81	—0.46
1720.5	4.21	1	4.47	+0.26	1847.3	2.31	1	2.18	—0.13
1729.2	4.02	1	3.92	—0.10	1856.7	2.49	1	2.77	+0.28
1754.5	2.28	1	2.27	—0.01	1875.5	3.74	1	4.01	+0.27
1756.9	2.88	1	2.13	—0.75	1877.8	4.18	1	4.16	—0.02
1771.0	1.11	1	1.39	+0.28	1885.6	4.49	1	4.64	+0.15
1776.1	+1.75	1	+1.17	—0.58	1895.7	+5.34	1	+5.19	—0.15

Fig. No. 6 gives a graphical representation of the formula and of the observed values as indicated by the dots. The formula must not be regarded as actually representing the real law governing the secular variation, but simply as a mathematical approximation to the law. On the other hand, the differences between values computed from formula and the observed values must not be regarded as representing in every instance a real fact. The observations, especially the older ones, are themselves more or less defective. The formula should not be used for many years before or after the extreme dates of the series of observations.

The time when the maximum or minimum declination is reached

and N. W. of it. These surveys were made by order of the Baltimore County Circuit Court in consequence of disputed land boundaries. Other values Mr. Kelbaugh copied from the record books of the county surveyor and his assistants, between 1805 and 1825."—C. and G. S. Report, 1888, p. 215.

These 52 different values were carefully scrutinized by Mr. Schott and finally combined to 12 mean results, as given in the above table, Nos. 2-14 and No. 17. To these several differences Mr. Schott added the respective values adopted by him for the declination at the time of the resurvey, as resulting from his 1877 formula.

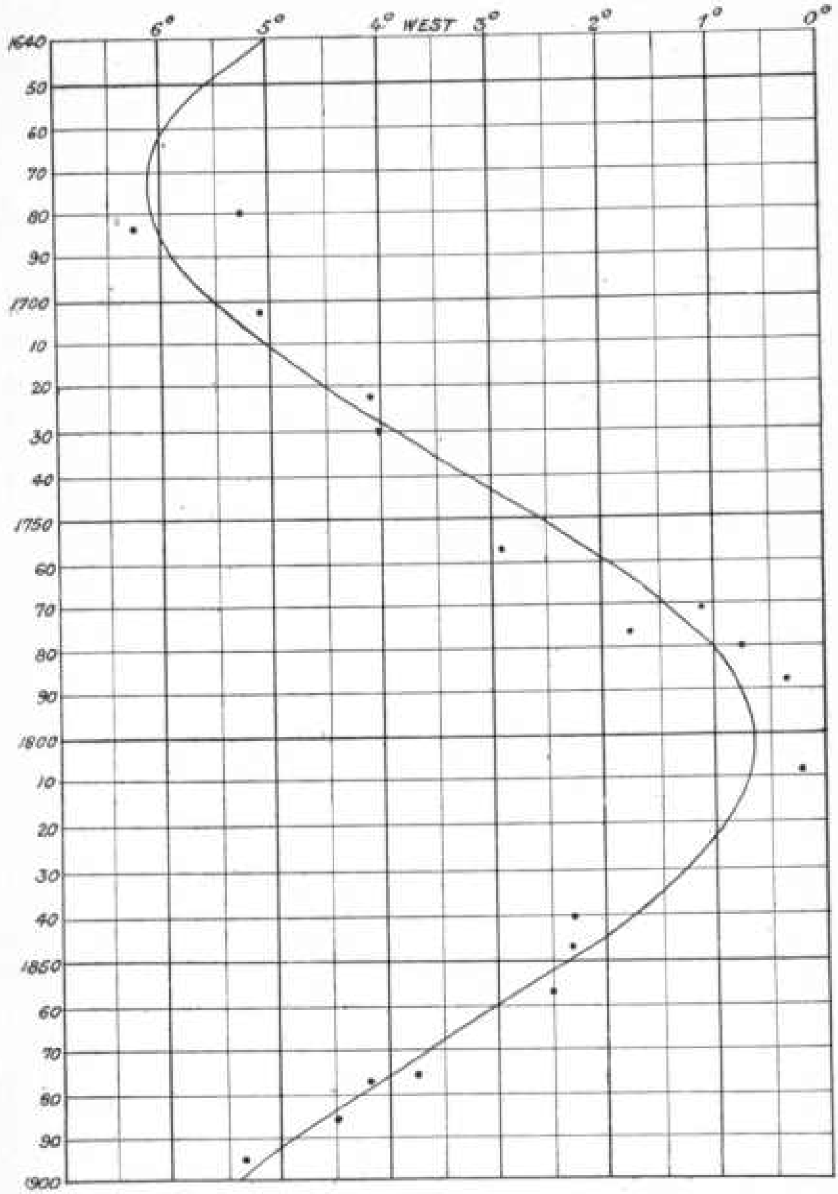


Fig. 6.—Illustrating the secular variation of the magnetic declination at Baltimore. The curve represents the values computed according to formula and the dots represent the observations.

and the amount of the declination at that time are easily derived from above formula. D will have a minimum value, for example, when

$$\sin(1^\circ.4\,m - 22^\circ.3) = -1\,, \qquad (2)$$

that is when

$$1^\circ.4m - 22^\circ.3 = -90^\circ,$$

or

$$m = (t - 1850) = -\frac{67.7}{1.4} = 48.4\,.$$

Hence

$$t = 1801.6\,,$$

and

$$D = 3^\circ.38 - 2.72 = 0^\circ.66 \text{ W.}$$

The minimum westerly declination of 40′ W. was, consequently, reached at Baltimore in about 1802.

The formula will also enable us to obtain the amount of annual change at any time between 1640 and present date. The expression to be used for this purpose can readily be obtained by differentiation of the original formula. If a is the amount of annual change, expressed in minutes,

$$a = 60 \sin 1^\circ \times 2.72 \times 1.4 \cos(1^\circ.4m - 22^\circ.3)$$
$$= 3'.99 \cos(1.4m - 22.3)\,. \qquad (3)$$

We see in the first place that if the quantity in parenthesis is equal to 90°, then the value of a is zero. Since we found $(1.4m - 22.3)$ was equal to -90° in 1801-6, it follows that at the time of minimum declination the annual change vanished. Again, a will have its maximum value of 4′ nearly when

$$1.4m - 22.3 = 0\,,$$

or when

$$m = t - 1850 = \frac{22.3}{1.4} = 16\,,$$

that is in 1866.

The figures as obtained in this way will be close approximations to the real facts.

Similar collections to those at Baltimore at stations in the adjoining states have been made by the Coast and Geodetic Survey. As the reports of the Survey can be readily obtained, it would be useless to reproduce here these collections. Simply so much can be given in each case as will make it unnecessary for any one who wishes to make a practical application of the data to refer to the original source. The student of terrestrial magnetism who wishes to refer to the original observations may consult Appendix 1, Coast and Geodetic Survey Report for 1895. All the data that could be of possible service to the surveyor in this state will be found in the tables below. As already stated, the *plus* sign attached to a value of the declination signifies *west* declination, while the *minus* sign stands for *east* declination. It will be noticed that some of the stations have two sine terms in the secular variation expression. In these particular cases a better representation of the existing data could thus be obtained.

TABLE IX.

Secular variation expressions of the magnetic declination for stations in Maryland and vicinity.

No.	Station.	Expression.
1	Baltimore	$D = +3^\circ.38 + 2^\circ.72 \sin (1^\circ.4m - 22^\circ.3)$
2	Beaver........	$= +1.41 + 2.72 \sin (1.40m - 39.6)$
3	Pittsburg.....	$= +1.85 + 2.45 \sin (1.45m - 28.4)$
4	S. Bethlehem..	$= +5.27 + 3.05 \sin (1.46m - 34.8)$
5	Huntingdon ..	$= +3.76 + 2.93 \sin (1.48m - 35.2)$
6	Harrisburg....	$= +3.12 + 2.98 \sin (1.55m - 4.2)$
7	Hatboro	$= +5.17 + 3.16 \sin (1.54m - 16.7) + 0^\circ.22 \sin (4^\circ.1m + 157^\circ)$
8	Philadelphia..	$= +5.36 + 3.17 \sin (1.50m - 26.1) + 0.19 \sin (4.0m + 146)$
9	Chambersburg	$= +2.79 + 3.10 \sin (1.55m - 30.6) + 0.20 \sin (4.6m + 124)$
10	N. Brunswick..	$= +5.11 + 2.94 \sin (1.30m + 4.2)$
11	Jamesburg....	$= +6.03 + 2.94 \sin (1.40m - 22.4)$
12	West Creek...	$= +5.50 + 2.78 \sin (1.5m - 18.4)$
13	Cape May.....	$= +4.31 + 2.40 \sin (1.4m - 26.7)$
14	Washington...	$= +2.53 + 2.64 \sin (1.45m - 16.6)$
15	Cape Henlopen	$= +4.01 + 3.22 \sin (1.35m - 25.2)$
16	Williamsburg .	$= +2.20 + 2.48 \sin (1.5m - 32.2)$
17	Cape Henry...	$= +2.42 + 2.25 \sin (1.47m - 30.6)$
18	Marietta	$= +0.02 + 2.89 \sin (1.4m - 40.5)$
19	Athens........	$= -1.51 + 2.63 \sin (1.4m - 24.7)$

TABLE X.

General data for the secular variation stations in Maryland and vicinity.

No.	State.	Latitude.	Longitude.	Year of first observation.	Number of observations.	Approximate epoch of last eastern elongation.	Approximate declination at last eastern elongation.	Annual Change.	
								1895.	1900.
1	Md.	39° 17′.8	76° 37′.0	1640 (?)	20	1802	0°.7 W	+3′.0	+2′.7
2	Pa.	40 44	80 20	1786	5	1814	1.3 E	+3.7	+3.6
3	Pa.	40 27.6	80 00.8	1840	6	1808	0.6 E	+3.0	+2.7
4	Pa.	40 36.4	75 22.9	1742	16	1812	2.2 W	+4.0	+3.7
5	Pa.	40 31	78 02	1750 (?)	14	1813	0.8 W	+3.9	+3.5
6	Pa.	40 15.9	76 52.9	1795	15	1795	0.1 W	+2.0	+1.4
7	Pa.	40 12	75 07	1680 (?)	18 (?)	1797	1.8 W	+3.3	+3.3
8	Pa.	39 56.9	75 09.0	1701	18	1802	2.1 W	+4.4	+2.8 (?)
9	Pa.	39 56	77 39	1736	45	1809	0.5 E	+4.8	+4.5
10	N. J.	40 29.9	74 26.8	1800	19	1778 (?)	2.2 W	+1.8	+1.4
11	N. J.	40 21	74 27	1761	7	1802	3.1 W	+3.3	+2.9
12	N. J.	39 38	74 19	1687	6	1802	2.7 W	+2.9	+2.4
13	N. J.	38 56.0	74 57.6	1700 (?)	12	1805	1.9 W	+2.8	+2.6
14	D. C.	38 53.3	77 00.6	1791	40	1799	0.1 E	+2.7	+2.3
15	Del.	38 46.7	75 05.0	1700 (?)	8	1802	0.8 W	+3.7	+3.4
16	Va.	37 16.2	76 42.4	1694	7	1811	0.3 E	+3.2	+2.9
17	Va.	36 55.6	76 00.4	1700 (?)	14	1810	0.2 W	+2.8	+2.5
18	Ohio.	39 25	81 28	1810	7	1815	2.9 E	+3.9	+3.7
19	"	39 19	82 02	1796	6	1803	4.1 E	+3.0	+2.7

TABLE XI.

Tabular values of the magnetic declination for the secular variation stations in Maryland and vicinity.

Year. (Jan. 1.)	Baltimore.	Beaver.	Pittsburg.	S. Bethlehem.	Huntingdon.	Harrisburg.	Hatboro.	Philadelphia.	Chambersburg.	N. Brunswick.	Jamesburg.	West Creek, Little Egg Harbor.	Cape May.	Washington.	C. Henlopen.	Williamsburg.	Cape Henry.	Marietta.	Athens.
1640	+5°	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .	° . .
1650	5.5	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
1660	6	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
1670	6	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .	. .
1680	6.1	. .	. .	. .	. .	. .	+8.3	. .	. .	. .	. .	+8.3	. .	. .	. .	. .	. .	. .	. .
1690	5.9	. .	. .	. .	. .	. .	8.2	. .	. .	. .	. .	8.2	. .	. .	+7.	+4.7	. .	. .	. .
1700	5.5	. .	. .	. .	. .	. .	7.9	+8.2	. .	. .	. .	8.0	+6.	. .	6.4	4.6	+4.6	. .	. .
1710	5.1	. .	. .	. .	. .	. .	7.5	7.8	. .	. .	. .	7.6	5.9	. .	5.8	4.4	4.3	. .	. .
1720	4.5	. .	. .	. .	. .	. .	7.0	7.4	5.3	. .	. .	7.0	5.5	. .	5.2	4.0	3.9	. .	. .
1730	3.9	. .	. .	. .	. .	. .	6.4	6.8	+4.45	. .	. .	6.4	4.9	. .	4.4	3.5	3.4	. .	. .
1740	3.2	. .	. .	+6.1	. .	. .	5.7	6.2	3.83	. .	. .	5.66	4.3	. .	3.7	2.9	2.9	. .	. .
1750	2.55	. .	. .	5.3	+3.9	. .	4.8	5.3	3.18	. .	+4.7	4.94	3.8	+1.7	2.9	2.3	2.3	. .	. .
1760	1.95	. .	. .	4.5	3.2	. .	3.9	4.4	2.45	. .	4.5	4.24	3.2	1.1	2.3	1.65	1.8	. .	. .
1770	1.43	. .	. .	3.8	2.5	. .	3.1	3.6	1.64	. .	3.93	3.65	2.7	0.6	1.7	1.05	1.2	. .	. .
1780	1.03	−0.4	. .	3.2	1.8	. .	2.4	2.8	0.82	. .	3.49	3.18	2.3	+0.2	1.2	0.52	0.8	. .	. .
1790	0.77	0.85	. .	2.7	1.33	+0.2	2.0	2.3	+0.12	+2.3	3.21	2.86	2.1	0.0	0.9	+0.10	0.45	. .	−4.0
1800	0.66	1.15	. .	2.4	0.99	0.2	1.8	2.09	−0.35	2.54	3.09	2.73	1.9	−0.1	0.8	−0.17	0.24	. .	4.1
1810	0.72	1.30	. .	2.2	0.84	0.4	2.0	2.16	−0.48	2.93	3.15	2.78	1.9	0.0	0.9	−0.28	0.17	−2.9	4.1
1820	0.93	1.28	. .	2.3	0.88	0.8	2.5	2.44	−0.28	3.43	3.38	3.01	2.1	+0.2	1.1	−0.22	0.25	2.8	3.9
1830	1.29	1.11	. .	2.5	1.11	1.4	3.0	2.91	+0.17	4.02	3.77	3.42	2.35	0.65	1.5	+0.01	0.47	2.7	3.60
1840	1.77	0.78	+0.18	3.0	1.52	2.1	3.7	3.46	0.75	4.66	4.28	3.97	2.75	1.17	2.00	0.38	0.82	2.33	3.15
1850	2.35	0.32	+0.68	3.53	2.07	2.90	4.3	4.07	1.38	5.32	4.91	4.62	3.23	1.77	2.64	0.88	1.27	1.86	2.61
1855	2.67	−0.06	0.96	3.86	2.40	3.31	4.6	4.39	1.70	5.66	5.25	4.97	3.50	2.10	2.99	1.16	1.53	1.57	2.31
1860	2.99	+0.23	1.26	4.22	2.74	3.70	5.0	4.73	2.02	5.98	5.60	5.34	3.78	2.43	3.36	1.47	1.80	1.27	2.00
1865	3.32	0.54	1.56	4.59	3.10	4.09	5.3	5.08	2.35	6.29	5.96	5.70	4.07	2.77	3.73	1.78	2.08	0.94	1.68
1870	3.65	0.86	1.87	4.98	3.48	4.46	5.7	5.44	2.70	6.59	6.32	6.06	4.37	3.10	4.11	2.10	2.37	0.60	1.36
1875	3.98	1.19	2.18	5.36	3.85	4.81	6.2	5.81	3.06	6.87	6.67	6.41	4.66	3.42	4.49	2.43	2.66	−0.26	1.04
1880	4.30	1.52	2.49	5.75	4.23	5.12	6.7	6.20	3.44	7.12	7.01	6.76	4.94	3.72	4.86	2.75	2.94	+0.10	0.73
1885	4.60	1.85	2.78	6.12	4.60	5.40	7.1	6.59	3.84	7.35	7.35	7.06	5.22	4.01	5.22	3.06	3.22	0.45	0.43
1890	4.89	2.18	3.06	6.49	4.95	5.64	7.6	6.97	4.25	7.55	7.65	7.35	5.48	4.28	5.56	3.35	3.48	0.79	−0.14
1895	5.15	2.49	3.3	6.83	5.3	5.83	7.9	7.45	4.65	7.7	7.94	7.6	5.73	4.51	5.9	3.6	3.7	1.1	+0.12
1900	+5.4	+2.8	3.5	+7.2	+5.6	+6.0	+8.0	+7.7	+5.03	+7.9	+8.2	+7.8	+6.0	+4.7	+6.2	+3.9	+4.0	+1.4	+0.4

With the aid of the preceding data the final table (No. XII) has been prepared, giving the values of the magnetic declination in degrees and minutes, for every five years between 1700 and 1900 at each of the county-seats. This table was obtained thus: First, an auxiliary table was constructed giving the secular changes in the declination for every five years during the interval 1700 to 1900 at eight different localities well distributed over the state. These eight localities were obtained by suitable combinations of the C. and G. S. secular variation stations, as given in the preceding table. They are as follows:

I.	N. W. corner of state:	$\frac{1}{2}$ [$\frac{1}{2}$ (A + M) + $\frac{1}{3}$ (2 Ch + Hu)].
II.	Near Hagerstown:	$\frac{1}{3}$ [$\frac{2}{3}$ (2 Ch + Hu) + III].
III.	Near Laurel:	$\frac{1}{2}$ [Wa + B].
IV.	N. E. corner of state:	$\frac{1}{3}$ [$\frac{2}{3}$ (Ph + Ht + Wc) + III].
V.	Near Denton:	$\frac{1}{5}$ [III + IV + VI + VII + VIII].
VI.	Capes May and Henlopen:	$\frac{1}{2}$ [May + H'n].
VII.	Near Leonardtown:	$\frac{1}{3}$ [2 III + $\frac{1}{2}$ (Wi + H'y)].
VIII.	Near Crisfield:	$\frac{1}{2}$ [VI + $\frac{1}{2}$ (Wi + H'y)].

The formulae explain the various combinations, the letters standing for the stations used. For example, in I, *A* stands for Athens, *M* for Marietta, *Ch* for Chambersburg, and *Hu* for Huntingdon. First, Chambersburg and Huntingdon were combined, giving the former double weight; next the mean of Athens and Marietta was taken; and finally, the mean of the two means was formed. In order to check the results obtained for each locality they were represented graphically and compared. In this way slight improvements were obtained.

The auxiliary table is exhibited below in a somewhat condensed form. If D_{1900} and D_t represent, respectively, the values of the magnetic declination on January 1st, 1900, and at some time t between 1700 and 1900, and c is the change in the declination between t and 1900, we have

$$D_t = D_{1900} + c.$$

West declination is reckoned as *positive* and *east* declination as *negative.* The quantities c are given in the auxiliary table with the proper sign. Suppose the value of the declination at Hagerstown on January 1st, 1900, is 4°.73 W., then the value on January 1st, 1750, for example, with a fair degree of approximation, was

$$D_{1750} = +4°.73 - 2°.17 = +2°.56 = 2°\ 34'\ \mathrm{W}.$$

TABLE XI A.

Specimen of auxiliary table giving the secular changes in Maryland between 1700 *and* 1900.

Year.	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	V-II.
	°	°	°	°	°	°	°	°	°
1700	..	+0.74	+0.03	+0.15	+0.20	+0.10	+0.24	+0.38	—0.54
10	..	+0.43	—0.39	—0.26	—0.19	—0.25	—0.12	+0.08	—0.62
20	..	—0.10	—0.97	—0.79	—0.72	—0.75	—0.64	—0.37	—0.62
30	..	—0.87	—1.59	—1.39	—1.41	—1.45	—1.22	—0.97	—0.54
40	..	—1.51	—2.27	—2.07	—2.08	—2.10	—1.86	—1.57	—0.57
1750	..	—2.17	—2.93	—2.85	—2.75	—2.75	—2.50	—2.20	—0.58
60	..	—2.85	—3.53	—3.61	—3.40	—3.35	—3.09	—2.78	—0.55
70	..	—3.53	—4.03	—4.26	—3.90	—3.90	—3.63	—3.36	—0.37
80	—4.15	—4.19	—4.43	—4.83	—4.42	—4.35	—4.05	—3.82	—0.23
90	—4.57	—4.69	—4.67	—5.15	—4.44	—4.60	—4.33	—4.13	+0.25
1800	—4.81	—4.98	—4.72	—5.32	—4.81	—4.75	—4.45	—4.32	+0.17
10	—4.86	—5.07	—4.69	—5.24	—4.78	—4.70	—4.46	—4.35	+0.29
20	—4.83	—5.04	—4.49	—4.95	—4.56	—4.50	—4.30	—4.21	+0.48
30	—4.40	—4.65	—4.08	—4.50	—4.18	—4.18	—3.95	—3.94	+0.47
40	—3.92	—4.00	—3.58	—3.94	—3.68	—3.72	—3.50	—3.53	+0.32
1850	—3.37	—3.40	—2.99	—3.33	—3.10	—3.16	—2.95	—3.01	+0.30
60	—2.75	—2.75	—2.34	—2.65	—2.46	—2.53	—2.33	—2.42	+0.29
70	—2.07	—2.06	—1.67	—1.95	—1.78	—1.86	—1.68	—1.78	+0.28
80	—1.37	—1.36	—1.04	—1.20	—1.12	—1.20	—1.06	—1.15	+0.24
90	—0.66	—0.65	—0.47	—0.50	—0.50	—0.58	—0.49	—0.55	+0.15
1900	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

On glancing over this table one must be impressed with the general agreement of the tabular quantities among themselves, derived as they were from such various sources. Yet it will be noticed that if we compare the quantities for any particular year, for example, 1820, the figures may differ among each other by about 0°.8. Such differences should not be ascribed entirely to defective data; they very likely represent in a large degree an actual physical fact. In other words, the amount of secular change, c, at any particular time will not be quite the same in all parts of Maryland. If we subtract series II (Western Maryland) from series V (Eastern Maryland) we notice that the differences vary systematically with the lapse of time (see figures in last column).

Next follows the final table, which requires but little additional explanation. The secular changes at the county-seats were obtained by proper combinations of the values given in the auxiliary table, and the values of the declination for 1900 at the county-seats were derived from the observations made by me in 1896[1] and reduced to the year 1900, as given in Table XIII. The quantities are given in degrees and minutes for the surveyor's convenience, and being tabulated for every five years, interpolations can readily be made. The problem confronting the land surveyor, when called upon to re-run old compass lines, has thus been simplified to the utmost. In no other state has the information been so thoroughly systematized.

[1] The values for Rockville and Chestertown were obtained from observations made in 1897. As no observations have as yet been made at Denton, it was necessary to adopt a value resulting from a consideration of the observations made in the vicinity.

TABLE

The values of the magnetic declination at the County

Year. (Jan. 1.)	Oakland.	Cumberland.	Hagerstown.	Frederick.	Rockville.	Westminster.	Ellicott.	Towson.	Bel Air.	Elkton.	Chestertown.	Centreville.
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
1700			5 26 W	5 19 W	5 43 W	5 41 W	5 01 W	6 03 W	6 01 W	5 31 W	6 10 W	6 13 W
05			5 22	5 13	5 32	5 33	4 51	5 54	5 50	5 19	5 59	6 02
10			5 10	5 01	5 20	5 21	4 38	5 41	5 38	5 06	5 47	5 51
15			4 56	4 46	5 04	5 07	4 22	5 26	5 23	4 52	5 33	5 37
20			4 38	4 28	4 46	4 49	4 04	5 08	5 06	4 35	5 15	5 20
25			4 15	4 06	4 26	4 27	3 46	4 49	4 48	4 19	4 58	5 02
30			3 52	3 47	4 07	4 05	3 26	4 28	4 28	3 59	4 38	4 42
35			3 32	3 25	3 46	3 46	3 05	4 08	4 08	3 39	4 18	4 23
40			3 13	3 05	3 26	3 26	2 45	3 48	3 47	3 18	3 58	4 03
45			2 54	2 46	3 06	3 06	2 26	3 28	3 27	2 56	3 38	3 43
1750	1 16 W	2 03 W	2 34	2 26	2 46	2 45	2 04	3 06	3 03	2 31	3 16	3 22
55	0 54	1 41	2 12	2 07	2 27	2 23	1 44	2 45	2 40	2 07	2 56	3 02
60	0 35	1 22	1 53	1 50	2 11	2 05	1 27	2 27	2 20	1 45	2 38	2 44
65	0 16 W	1 03	1 34	1 31	1 54	1 47	1 11	2 10	2 02	1 26	2 22	2 28
70	0 06 E	0 41	1 12	1 09	1 37	1 27	0 54	1 52	1 43	1 06	2 04	2 10
75	0 26	0 21	0 52	0 51	1 22	1 09	0 40	1 36	1 26	0 48	1 48	1 54
80	0 45	0 02 W	0 33	0 35	1 09	0 53	0 27	1 22	1 11	0 32	1 35	1 42
85	0 59	0 13 E	0 16	0 20	0 59	0 42	0 16	1 10	1 00	0 22	1 24	1 32
90	1 10	0 25	0 03 W	0 10	0 52	0 30	0 10	1 02	0 52	0 13	1 16	1 24
95	1 19	0 35	0 08 E	0 02 W	0 48	0 22	0 03	0 57	0 46	0 07	1 12	1 20
1800	1 25	0 42	0 15	0 03 E	0 45	0 17	0 05	0 54	0 43	0 03	1 09	1 16
05	1 27	0 45	0 19	0 05	0 45	0 16	0 05	0 54	0 44	0 05	1 08	1 16
10	1 28	0 46	0 20	0 05	0 46	0 16	0 06	0 55	0 47	0 08	1 10	1 17
15	1 27	0 45	0 19	0 03 E	0 50	0 19	0 10	0 59	0 51	0 14	1 14	1 21
20	1 25	0 43	0 17	0 00	0 56	0 25	0 17	1 06	1 00	0 25	1 21	1 28
25	1 15	0 33	0 08 E	0 10 W	1 06	0 35	0 27	1 16	1 11	0 37	1 31	1 38
30	1 02	0 20	0 05 W	0 23	1 19	0 49	0 40	1 29	1 24	0 51	1 43	1 50
35	0 46	0 03 E	0 24	0 40	1 33	1 05	0 55	1 45	1 40	1 08	1 58	2 04
40	0 31	0 15 W	0 44	0 59	1 51	1 24	1 14	2 04	1 59	1 26	2 16	2 22
45	0 14 E	0 33	1 03	1 18	2 09	1 43	1 32	2 22	2 17	1 44	2 32	2 38
1850	0 02 W	0 49	1 20	1 36	2 28	2 00	1 49	2 39	2 34	2 02	2 50	2 56
55	0 20	1 08	1 39	1 54	2 46	2 20	2 09	2 59	2 54	2 22	3 09	3 14
60	0 39	1 27	1 59	2 14	3 06	2 40	2 29	3 19	3 15	2 43	3 29	3 34
65	0 59	1 47	2 19	2 34	3 26	3 00	2 48	3 38	3 34	3 03	3 48	3 53
70	1 20	2 08	2 40	2 55	3 47	3 21	3 09	3 59	3 56	3 25	4 09	4 14
75	1 41	2 29	3 01	3 15	4 06	3 42	3 29	4 20	4 18	3 48	4 28	4 34
80	2 02	2 50	3 22	3 36	4 25	4 03	3 48	4 40	4 39	4 10	4 49	4 54
85	2 23	3 11	3 43	3 56	4 44	4 23	4 07	5 00	5 00	4 31	5 08	5 12
90	2 44	3 32	4 04	4 15	5 01	4 43	4 24	5 18	5 19	4 51	5 26	5 30
95	3 05	3 53	4 26	4 35	5 18	5 02	4 40	5 35	5 37	5 08	5 44	5 48
1900	3 24 W	4 12 W	4 44 W	4 51 W	5 32 W	5 17 W	4 54 W	5 50 W	5 50 W	5 22 W	5 58 W	6 02 W

XII.

Seats, for every five years between 1700 *and* 1900.

Denton.	Easton.	Cambridge.	Annapolis.	Upper Marlboro.	Prince Frederick.	La Plata.	Leonardtown.	Salisbury.	Princess Anne.	Snow Hill.	Year. (Jan. 1.)
° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	
6 05 W	5 49 W	5 46 W	5 32 W	5 17 W	5 31 W	4 57 W	5 07 W	5 33 W	5 32 W	5 32 W	1700
5 54	5 39	5 37	5 21	5 07	5 22	4 48	4 58	5 24	5 24	5 22	05
5 43	5 27	5 26	5 09	4 54	5 09	4 35	4 46	5 14	5 14	5 12	10
5 29	5 12	5 12	4 54	4 39	4 54	4 20	4 32	5 01	5 02	5 00	15
5 12	4 56	4 56	4 36	4 21	4 37	4 03	4 15	4 45	4 46	4 44	20
4 55	4 37	4 39	4 18	4 03	4 20	3 46	3 58	4 27	4 28	4 27	25
4 35	4 17	4 20	3 58	3 45	4 02	3 28	3 40	4 07	4 09	4 07	30
4 16	3 57	4 01	3 38	3 25	3 42	3 08	3 21	3 49	3 52	3 49	35
3 56	3 37	3 42	3 18	3 05	3 22	2 48	3 01	3 29	3 32	3 30	40
3 36	3 18	3 22	2 58	2 45	3 02	2 28	2 41	3 11	3 14	3 10	45
3 15	2 58	3 02	2 38	2 26	2 44	2 10	2 23	2 51	2 54	2 51	1750
2 56	2 40	2 43	2 18	2 07	2 24	1 50	2 04	2 31	2 35	2 33	55
2 38	2 22	2 26	2 01	1 51	2 08	1 34	1 48	2 15	2 18	2 16	60
2 21	2 06	2 08	1 46	1 35	1 52	1 18	1 31	1 57	2 00	1 58	65
2 04	1 50	1 52	1 29	1 19	1 36	1 02	1 15	1 41	1 44	1 41	70
1 49	1 36	1 38	1 14	1 06	1 23	0 49	1 02	1 27	1 30	1 27	75
1 36	1 24	1 25	1 03	0 55	1 12	0 38	0 50	1 14	1 17	1 14	80
1 27	1 15	1 16	0 53	0 45	1 02	0 28	0 41	1 05	1 08	1 05	85
1 19	1 08	1 08	0 47	0 39	0 55	0 21	0 33	0 57	0 59	0 56	90
1 15	1 05	1 02	0 44	0 36	0 52	0 18	0 29	0 51	0 52	0 51	95
1 12	1 02	1 00	0 42	0 34	0 49	0 15	0 26	0 47	0 48	0 47	1800
1 11	1 01	0 58	0 42	0 33	0 48	0 14	0 25	0 47	0 48	0 46	05
1 13	1 04	0 59	0 43	0 35	0 49	0 15	0 25	0 48	0 49	0 46	10
1 17	1 08	1 03	0 47	0 39	0 53	0 19	0 29	0 51	0 51	0 49	15
1 24	1 15	1 09	0 54	0 45	0 59	0 25	0 35	0 57	0 56	0 55	20
1 34	1 24	1 18	1 04	0 55	1 09	0 35	0 45	1 05	1 04	1 05	25
1 46	1 36	1 30	1 17	1 07	1 20	0 46	0 56	1 15	1 14	1 13	30
1 59	1 48	1 42	1 30	1 20	1 33	0 59	1 08	1 27	1 26	1 25	35
2 15	2 04	1 57	1 48	1 37	1 49	1 15	1 23	1 41	1 39	1 38	40
2 31	2 20	2 12	2 06	1 53	2 04	1 30	1 38	1 57	1 54	1 54	45
2 49	2 38	2 30	2 24	2 11	2 22	1 48	1 56	2 13	2 10	2 10	1850
3 07	2 56	2 48	2 42	2 29	2 40	2 06	2 14	2 31	2 28	2 27	55
3 27	3 16	3 08	3 02	2 49	3 00	2 26	2 33	2 51	2 48	2 46	60
3 46	3 36	3 26	3 21	3 08	3 19	2 45	2 52	3 10	3 06	3 06	65
4 07	3 56	3 47	3 42	3 29	3 40	3 06	3 12	3 29	3 26	3 25	70
4 27	4 15	4 06	4 02	3 47	3 58	3 24	3 31	3 49	3 45	3 45	75
4 46	4 33	4 25	4 21	4 06	4 16	3 42	3 49	4 09	4 04	4 04	80
5 05	4 52	4 44	4 38	4 23	4 34	4 00	4 06	4 27	4 23	4 23	85
5 23	5 10	5 02	4 56	4 40	4 50	4 16	4 23	4 45	4 40	4 40	90
5 40	5 26	5 18	5 12	4 55	5 06	4 32	4 39	5 02	4 57	4 57	95
5 54 W	5 42 W	5 32 W	5 26 W	5 09 W	5 20 W	4 46 W	4 53 W	5 19 W	5 14 W	5 14 W	1900

All that the surveyor has to do when he wishes to know the amount of change of the magnetic meridian between any two dates is to turn to the series at the nearest county-seat to the locality under consideration and subtract from each other the values of the magnetic declination at that county-seat for those dates as obtained from the table.

If he wishes to be more precise he can make various combinations of the county-seats surrounding the particular locality. It is believed that this table will suffice for all practical needs. To facilitate interpolations the following dates in decimals of year are appended:

Date.	Decimal of year.	Date.	Decimal of year.
January 1	0.00	August 7	0.60
February 6	0.10	September 13	0.70
March 14	0.20	October 19	0.80
April 20	0.30	November 25	0.90
May 26	0.40	December 31	1.00
July 2	0.50		

EXAMPLE OF THE PRACTICAL APPLICATION OF THE TABLE.

For this purpose I shall select an actual case submitted to the Geological Survey. We received last March (1897) a letter from Watersville, Carroll County, from which we quote as follows:

"Will you please inform me what variation of the needle should be used in tracing old lines, say 1750 to 1800, also when the needle was true to the pole and whether or not the needle was east prior to 1800. What is the correct variation for 1897?"

In reply to this letter, which was received before table No. XII was constructed, the following table was furnished:

Approximate values of the magnetic declination (variation) at Watersville, Maryland.

Year.	Declination.	Year.	Declination.
	° ′		° ′
1750	2 28 W.	1855	2 09 W.
60	1 50	60	2 29
70	1 14	65	2 49
80	0 41	70	3 09
90	0 17	75	3 29
1800	0 06	80	3 49
10	0 05	85	4 09
20	0 17	90	4 28
30	0 42	95	4 46
40	1 14	1900	5 03 W.
50	1 50 W.		

From this table, which was prepared with the aid of the long series of observations at Chambersburg, Washington and Baltimore, we find that the needle veered about 2° 26′.5 to the west between 1750 and the middle of the present year. Let us see what values we shall get from the table of the changes for the county-seats. Watersville is about midway between Rockville and Westminster; likewise about midway between Frederick and Ellicott.

		Secular change between 1750.0 and 1897.5. ° ′
	From Westminster,	2 24.5 W.
	" Rockville,	2 39.0
I.	Mean,	2 31.8
		° ′
	From Frederick,	2 17
	" Ellicott,	2 43
II.	Mean,	2 30
	Mean of I and II,	2° 31 W.

Again, we notice from the table that the needle apparently remained west of the true meridian throughout the interval 1750 to 1900. If it ever was "true to the pole" during that interval this occurred not far from the year 1800. The needle may have pointed east for a brief period after this time, but if it did so, the easterly deflection was of small amount. No absolutely correct value of the declination at Watersville for the present year could be furnished, since no observations have, as yet, been made there and because of the prevalence of local disturbances in this part of Maryland. Properly grouping and combining the observations made at the stations surrounding Watersville, viz., Frederick, Damascus, Unity, Westminster, Ellicott City, Baltimore and Cockeysville, the following values were obtained:

	Magnetic Declination at Watersville in 1897.5. ° ′
By one combination,	4 58 W.
By a second combination,	59
By a third "	57
Mean,	4 58 W.

The table above gives 4° 54′.5.

THE DISTRIBUTION OF THE MAGNETIC DECLINATION IN MARYLAND.

Explanatory Remarks.

At no two periods of the earth's history is the distribution of magnetism within the earth's crust *precisely* the same. Any graphical representation of that distribution will therefore apply only to a particular time. In the present instance the *isogonic chart* or *chart of the lines of equal magnetic declination* (*variation*) for Maryland has been constructed for the year 1900. These lines, as is well known, connect all the places in Maryland where the angle of deviation of the compass direction from the true north and south direction is the same. They should not be confounded with the lines which would be traced if we were to start out, for example, from some point in southern Maryland and always follow the direction indicated by the north end of the compass. Such lines have been termed *magnetic meridians.*

Future reports will contain likewise the charts showing the distribution of the magnetic inclination and the intensity of the magnetic force. In order to supply the *practical demands* of the surveyor it was necessary to publish first the isogonic chart. It has been termed "preliminary," as in its construction only the 1896 results of the magnetic survey could be utilized. Still, though it is regarded as preliminary, it is nevertheless far superior to any chart embracing the same region hitherto published. The values of the declination given in the table below may undergo slight modifications in future reports, when the more precise reductions to the epoch of the chart are known. These changes, however, will be of such a nature as not to affect the practical use which the land surveyor may make of the present values.

Besides the data resulting from my last year's work and given in Table XIII, I have made use of all the material observed and collected by the Coast and Geodetic Survey in Maryland and vicinity. This information is contained in Table XIV. The total number of observations utilized is as follows:

	Maryland Geological Survey.	Coast and Geodetic Survey and others.
Maryland	38	28
District of Columbia	..	4
Delaware	..	9
Pennsylvania, near the Md. Boundary	..	23
Virginia, " " "	..	9
W. Virginia, " " "	..	10
Total	38	83=121

Taking the total number of observations in Maryland, 56, the stations averaged one to every 218 square miles (564 square kilometers) of the total area (land and water 12,210 square miles); or, for every area 15 miles square there was, on the average, one station.

The preliminary reductions of my observations to the mean of day (24 hours), and the corrections on account of magnetic disturbances, were made as fully explained elsewhere. The reasons have also been given for referring the chart to the year 1900. The corrections necessary to reduce the 1896 observations to January 1st, 1900, were made assuming for the present that the secular change is at the rate of 3′ per annum over the entire state. From the auxiliary table XIA we find that the average annual change between 1895 and 1900 is as follows:

	′		′
I.	3.8	V.	2.8
II.	3.6	VI.	3.4
III.	2.6	VII.	2.8
IV.	3.2	VIII.	3.4
	3.0		3.1

The geographical positions which I assign to my stations are for the time being taken from the following sources:

Stations 1, 1A, 2, 3, 4, 5, 6, 19, 20, 20A, 26, 28, 31, 34, 32A, 40, 41, 42, from the topographic sheets of the U. S. Geological Survey.

Stations 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 17A, 18, 21, 22, 24, 27, 29, 33, 35, 36, 37, 38, 43, from Martenet's map ($3\frac{1}{2}$ miles to the inch) for 1886.

Stations 12, 23, 32, 39, from Coast and Geodetic Survey data.

Station 30 from data supplied by Superintendent of Naval Academy.

Station 25 from Rand & McNally's map of 1895.

The question of more precise geographical positions may be given attention in a future report. As already explained in another part, some of the declinations obtained may require corrections amounting from 1′-3′ by reason of appreciable errors in the geographical positions which at present had to be adopted. Such corrections, however, are of no special concern to the surveyor.

The Coast and Geodetic Survey table is given in precisely the same form as furnished by them. The stations in italics are secular variation stations; *west* declination is marked by a *plus* sign; D stands for declination and ΔD is the correction which was necessary to obtain the reduced value, D_{1900} for January 1st, 1900. In this table, it will be noticed, D is given in decimals of a degree. The values as given refer to the mean of day (24 hours).

Table XIII.

Summary of the magnetic declinations observed by Maryland Geological Survey in 1896.

No.	Station.	County.	Latitude.	Long. W. of Gr.	Date, 1896.	Declination[1] for date.	Declination[1] for Jan 1. 1900.	Remarks.[2]
			° ′	° ′		° ′	° ′	
1	Linden, B. S.....	Montgomery..	39 00.5	77 03.1	July–Dec.	3 27.4 W	3 37 W	Mean of 14 days.
1 A	Linden, A. S.....	Montgomery..	39 00.7	77 03.1	Nov. 25	3 39.0	3 48	At 3:38
2	Upper Marlboro..	Prince George.	38 49.0	76 45.2	Sept. 9	4 59.0	5 09	At 9:49, 10:34, 3:58
3	La Plata[3]	Charles.......	38 31.8	76 58.7	" 10	4 36.8	4 46	At 10:24
4	Brandywine.....	Prince George.	38 41.7	76 50.8	" 10	..	..	Dip observed only.
5	Mechanicsville..	St. Mary's....	38 26.6	76 44.7	" 11	4 43.4	4 53	At 10:09
6	Leonardtown....	St. Mary's....	38 17.4	76 38.1	" 12	4 43.2	4 53	At 8:44
7	Easton[4].........	Talbot........	38 46.4	76 04.4	" 16	5 32.3	5 42	At 1:32, 2:51
8	Centreville[5].....	Queen Anne's.	39 02.5	76 03.7	" 17	5 47.4	5 57	At 3:43, 4:14
9	Massey.........	Kent.........	39 18.5	75 48.5	" 18	6 25.0	6 35	At 10:52
10	Ridgely.........	Caroline......	38 57.4	75 52.6	" 19	5 44.3	5 54	At 8:14
11	Hurlock........	Dorchester....	38 38.0	75 52.7	" 19	5 24.9	5 35	At 3:58, 4:34
12	Ocean City......	Worcester....	38 20	75 05.8	" 21	5 27.5	5 37	At 3:54, 4:55
13	Berlin..........	Worcester....	38 19.9	75 13.3	" 23	5 25.3	5 35	At 9:55, 10:23
14	Snow Hill[6]......	Worcester....	38 10.5	75 23.8	" 23	5 03.8	5 14	At 3:42, 4:33
15	Pocomoke City..	Worcester....	38 04.8	75 33.8	" 24	5 11.8	5 22	At 10:01, 10:28, 11:03
16	Princess Anne...	Somerset.....	38 12.4	75 42.5	" 24	5 04.3	5 14	At 4:41, 5:31
17	Salisbury C. H...	Wicomico....	38 22.2	75 37.1	" 25	5 15.7	5 25	At 10:45, 11:30
17 A	" M. L...	Wicomico....	38 22.2	75 37.1	Dec. 5	5 09.7	5 19	At 8:52, 12:24
18	Parsonsburg.....	Wicomico....	38 23.8	75 26.6	Sept. 25	5 22.9	5 33	At 2:22
19	Cockeysville....	Baltimore.....	39 29.1	76 38.6	" 26	6 02.1	6 12	At 2:21
20	Frederick, Asy..	Frederick.....	39 24.7	77 24.8	Oct. 5	4 42.2	4 52	At 3:49, 5:18
20 A	" C. H..	Frederick.....	39 25.0	77 24.6	" 7	4 41.0	4 51	At 3:32, 4:07
21	Westminster....	Carroll.......	39 34.6	76 59.7	" 8	5 06.9	5 17	At 3:22, 4:01
22	Hagerstown.....	Washington..	39 38.4	77 42.8	" 9	4 34.2	4 44	At 3:01, 3:47
23	Cumberland.....	Allegany......	39 39.2	78 46.4	" 10	4 02.7	4 12	At 3:55, 4:29
24	Oakland........	Garrett.......	39 24.6	79 24.6	" 12[7]	3 14.5	3 24	At 8:57, 9:57, 0:51, 1:24
25	Point of Rocks..	Frederick.....	39 17.3	77 34.0	" 13	..	..	Clouds; I. and H. observed.
26	Dickerson.......	Montgomery..	39 13.3	77 25.4	" 13	..	..	
27	Elkton.........	Cecil.........	39 36.5	79 49.5	" 15	5 12.0	5 22	At 9:42, 10:24, 12:25
28	Prince Frederick.	Calvert.......	38 22.4	76 34.9	" 19	5 10.4	5 20	At 4:27, 4:59
29	Bel Air[8]........	Harford......	39 31.9	76 20.8	" 20	5 38.4	5 50	At 10:56, 11:31
30	Annapolis.......	Anne Arundel.	38 58.9	76 29.1	" 21	5 16.1	5 26	At 2:38, 3:11
31	Ellicott........	Howard......	39 16.2	76 48.2	" 22	4 44.3	4 54	At 3:51, 4:22
32	Baltimore, Fort..	..	39 15.9	76 34.9	Nov. 4–5	..	..	Clouds; I. and H.
33	Belcamp........	Harford......	39 28.4	76 14.5	" 6	6 05.7	6 15	At 1:31, 1:40
34	Harford Furnace.	Harford......	39 29.8	76 15.7	" 6	..	..	Only Incl'n obs'd.
35	Creswell........	Harford......	39 31.4	76 17.3	" 6	..	..	
36	Fountain Green..	Harford.....	39 32.6	76 18.4	" 6	..	..	
37	Cardiff[9].........	Harford......	39 43.3	76 20.1	" 7	..	..	At 11:27
38	Forest Hill......	Harford......	39 34.9	76 22.9	" 7	5 24.5	5 34	At 3:08
39	Stabler.........	Montgomery..	39 07.2	76 59.1	" 13	..	..	Snow storm; I, obs'd.
40	Unity..........	Montgomery..	39 13.7	77 03.5	" 14	5 36.0	5 45	At 10:09, 10:37
41	Damascus.......	Montgomery..	39 17.4	77 12.5	" 14	4 02.8	4 12	At 3:31, 3:55
42	Forest Glen......	Montgomery..	39 00.8	77 03.2	" 25	3 37.0	3 46	At 10:20, 10:56
43	Crisfield........	Somerset.....	37 59.5	75 49.9	Dec. 7	4 44.4 W	4 54	At 8:55, 10:04, 11:16, 1:12, 2:27, 4:19

[1] Reduced to mean of day (24 hours).

[2] The times given in this column are the local mean times when the observations were made.

[3] Observations made in 1897 when reduced to 1900.0 give same value, 4° 46′.

[4] Artificial local disturbance at the 1896 station. The value of declination as given was corrected with the aid of the 1897 observations on the Fair Grounds.

[5] Observations made when establishing surveyor's meridian line in 1897, on the *Court House* lot, reduced to 1900.0 give 6° 02′. Sept. 17 was a day of large disturbance.

[6] Artificial local disturbance suspected at this station.

[7] A day of large disturbance.

[8] The value given for 1900 has been obtained by making use also of the work of 1897.

[9] This station in a greatly disturbed region. The observations for 1896 will be presented in connection with the 1897 work.

TABLE XIV.

Declinations observed and collected by the Coast and Geodetic Survey in Maryland and vicinity.[1]

MARYLAND.

No.	Name of Station.	Lat.	Long.	Date.	D.	ΔD.	D_{1900}.	Observer.
		° ′	° ′		°	°	°	
1	Mason's Landing	38 14	75 15	1856.66	+2.38	+3.1	5.5W	C. A. Schott.
2	Davis	38 20	75 06	1853.73	2.55	3.3	5.8	J. E. Hilgard.
3	Calvert	38 22	76 24	1871.58	2.82	1.7	4.5	A. T. Mosman.
4	Oxford	38 41	76 10	1856.64	2.69	2.6	5.3	C. A. Schott.
5	Marriott..............	38 52	76 37	1849.46	2.08	3.0	5.1	J. Hewston.
6	Kent Island, South Base	38 54	76 22	1845.42	2.40	3.3	5.7	T. J. Lee.
7	Hill	38 54	76 53	1868.83	2.85	1.7	4.6	C. O. Boutelle.
8	Taylor................	39 00	76 28	1847.42	2.30	3.1	5.4	T. J. Lee.
9	Kent Island, station 1..	39 02	76 19	1849.49	2.50	3.0	5.5	J. Hewston.
10	Webb	39 05	76 40	1868.73	2.93	1.8	4.7	C. O. Boutelle.
11	Soper	39 05	76 57	1850.57	2.12	3.0	5.1	G. W. Dean.
12	Stabler	39 07	76 59	1869.65	2.66(?)	1.7	4.4(?)	C. O. Boutelle.
13	Bodkin Light.........	39 08	76 26	1847.31	2.03	3.2	5.2	T. J. Lee.
14	North Point	39 12	76 27	1847.32	1.66	3.2	4.9	T. J. Lee.
15	*Baltimore*, Fort McHenry	39 16	76 35	1895.74	5.34	..	5.4	J. B. Baylor.
16	Pool's Island..........	39 17	76 16	1847.48	2.49	3.2	5.7	T. J. Lee.
17	Rosanne	39 18	76 43	1845.44	2.18	3.3	5.5	T. J. Lee.
18	Maryland Heights......	39 20	77 43	1870.82	2.93	1.8	4.7	C. O. Boutelle.
19	Finlay................	39 24	76 32	1846.29	2.31	3.3	5.6	T. J. Lee & J. Locke
20	Osborne's Ruin........	39 28	76 17	1845.47	2.54	3.3	5.8	T. J. Lee.
21	Susquehanna Light	39 32	76 05	1847.51	2.23	3.2	5.4	T. J. Lee.
22	Cumberland	39 39	78 45	1864.22	1.53	2.7	4.2	A. T. Mosman.
23	Monie Bay	38 13	75 54	1860.60	2.58	2.6	5.2	D. S. Hersey.
24	Vienna, Dorchester Co..	38 29	75 49	1886.63	4.83	0.8	5.6	J. W. Thompson.
25	Cheltenham	38 44	76 50	1889.39	4.17	0.6	4.8	J. B. Kaufman.
26	Annapolis.............	38 59	76 29	1879.4	4.43	1.1	5.5	S. W. Very.
27	Ashton	39 08	77 01	1893.1	5.47	0.3	5.8	H. B. Looker.
28	Lonaconing...........	39 34	78 58	1879.56	+3.00	+1.0	4.0W	F. E. Bracket.

DISTRICT OF COLUMBIA.

No.	Name of Station.	Lat.	Long.	Date.	D.	ΔD.	D_{1900}.	Observer.
		° ′	° ′		°	°	°	
1	Washington, C. and G. S. Office	38 53	77 00	1896.37	+4.73	..	4.7W	C. C. Yates.
2	Causten, Georgetown Heights	38 56	77 04	1855.77	+1.07	+2.5	3.6	C. A. Schott.
3	U. S. Naval Observatory, old site.............	38 54	77 03	1892.50	+4.24	+0.3	4.5	Magnetic observatory.
4	U. S. Naval Observatory, new site............	38 55	77 04	1894.50	+3.67	+0.2	3.9W	Magnetic observatory.

[1] Extracts from a MS. report made by Assistant C. A. Schott to the Superintendent of the U. S. Coast & Geodetic Survey—to be printed as Appendix No. 1, C. & Geod. Report for 1896. Survey Office, March 18, 1897.

PENNSYLVANIA.

No.	Name of Station.	Lat.	Long.	Date.	D.	ΔD.	D_{1900}.	Observer.
		° ′	° ′		°	°	°	
1	Johnson Tavern........	40 00	79 48	1862.58	+1.23	+2.1	3.3W	C. A. Schott.
2	*Harrisburg*............	40 16	76 53	1895.72	+6.10	..	6.0	J. B. Baylor.
3	Warren Point..........	39 43	78 02	1893.55	+4.37	+0.5	4.9	A. S. Winger.
4	Pa. boundary, 5 miles due north of S.W. Cor.	39 48	80 31	1785.45	—2.05	+3.5	1.4	A. Ellicott.
5	Irwin Mill, near Mercersburg................	39 47	77 56	1840.65	+0.91	+4.2	5.1	A. D. Bache.
6	Gettysburg............	39 49	77 15	1866.6	+3.50	+2.6	6.1	County Surveyors
7	2 miles S. of Rock Lick.	39 52	80 31	1883.47	+0.60	+0.9	1.5	F. L. Hoge.
8	Pa. Bdry., ½ mile N. of S. W. corner.........	39 44	80 31	1883.48	+0.67	+0.9	1.6	F. L. Hoge.
9	Pa. Bdry., 12 miles north	39 54	80 31	1883.45	+0.60	+0.9	1.5	F. L. Hoge.
10	Uniontown	39 54	79 43	1884.28	+3.30	+0.8	4.1	A. J. Gilmore.
11	Waynesburg...........	39 54	80 12	1877.8	+2.17	+1.2	3.4	County Surveyors
12	McConnellsburg........	39 55	77 59	1893.22	+4.75	+0.5	5.2	A. S. Winger.
13	*Chambersburg*, n'r county meridian............	39 56	77 39	1893.30	+4.53	..	5.0	A. S. Winger.
14	Westchester...........	39 57	75 40	1878.3	+5.87	+1.7	7.6	County Surveyors
15	Pa. Bdry, about 16½ miles north..........	39 57	80 31	1785.49	—1.50	+3.5	2.0	A. Ellicott.
16	York	39 58	76 44	1876.9	+4.90	+1.4	6.3	County Surveyors
17	Pa. Boundary, 19 and 20 miles north..........	39 59	80 31	1785.50	—1.31	+3.5	2.2	A. Ellicott.
18	Bedford..............	40 01	78 30	1883.3	+3.57	+1.3	4.9	County Surveyors
19	Somerset.............	40 01	79 04	1883.3	+3.33	+1.0	4.3	" "
20	Upper Strasburg.......	40 03	77 41	1892.20	+4.38	+0.6	5.0	J. B. Kaufman.
21	Greenfield............	40 06	79 52	1874.62	+2.04	+1.4	3.4	F. E. Hilgard.
22	Hopewell.............	40 07	78 17	1876.62	+3.18	+1.8	5.0	County Surveyors
23	Carlisle	40 12	77 11	1883.77	+4.25	+1.0	5.2W	" "

DELAWARE.

No.	Name of Station.	Lat.	Long.	Date.	D.	ΔD.	D_{1900}	Observer.
1	Dagsboro..............	38 35	75 16	1856.66	+2.68	+3.1	5.8W	C. A. Schott.
2	*Cape Henlopen*..........	38 47	75 05	1885.58	4.99	..	6.2	J. B. Baylor.
3	Pilot Town............	38 47	75 10	1846.50	2.71	3.8	6.5	J. Locke.
4	Lewes Landing.........	38 49	75 12	1846.50	2.75	3.8	6.6	J. Locke.
5	Bombay Hook..........	39 22	75 31	1846.46	3.31	3.3	6.6	J. Locke.
6	Fort Delaware.........	39 35	75 34	1846.45	3.28	3.3	6.6	J. Locke.
7	Sawyer...............	39 42	75 34	1846.42	2.80	3.6	6.4	J. Locke.
8	Wilmington...........	39 47	75 32	1875.55	3.74	1.6	5.3	J. M. Poole.
9	Delaware City.........	39 35	75 36	1842.50	+3.50	+3.7	7.2W	Barnett.

WEST VIRGINIA.

No.	Name of Station.	Lat.	Long.	Date.	D.	ΔD.	D_{1900}.	Observer.
		° ′	° ′		°	°	°	
1	Clarksburg	39 17	80 20	1880.94	+1.76	+1.2	3.0W	J. B. Baylor.
2	Grafton	39 21	80 02	1864.03	+1.86	2.4	4.3	A. T. Mosman.
3	Cameron	39 50	80 34	1864.04	—0.40	2.2	1.8	" "
4	Wheeling	40 03	80 44	1881.40	+0.02	1.1	1.1	J. B. Baylor.
5	North Branch of Potomac	39 18	79 19	1824.0	—1.58	4.6	3.0	—— Boye.
6	Pruntytown, Taylor Co.	39 20	80 05	1883.3	+2.55	1.0	3.6	R. McPheeters.
7	Martinsburg	39 27	77 57	1873.52	+2.86	1.7	4.6	F. E. Hilgard.
8	Cumberland Gap	39 38	78 44	1824.0	—4.58 (?)	5.0	0.4(?)	—— Boye.
9	Observatory, 2 miles W. of S. W. corner of Pa.	39 43	80 33	1785.44	—2.25	3.5	1.2	A. Ellicott.
10	Echo Point Park, 2½ miles S. E. of Wheeling	40 03	80 42	1886.7	+0.20	+0.8	1.0W	F. L. Hoge.

VIRGINIA.[1]

No.	Name of Station.	Lat.	Long.	Date.	D.	ΔD.	D_{1900}.	Observer.
		° ′	° ′		°	°	°	
1	Cape Charles	37 07	75 58	1856.68	+1.59	+2.4	4.0W	C. A. Schott.
2	Wolf Trap	37 24	76 15	1871.36	2.82	1.7	4.5	A. T. Mosman.
3	Joynes	37 42	75 37	1856.68	2.06	2.7	4.8	C. A. Schott.
4	Tangier	37 48	75 59	1871.47	3.05	1.9	5.0	A. T. Mosman.
5	Snead	37 58	75 26	1856.67	2.31	2.7	5.0	C. A. Schott.
6	Fredericksburg	38 18	77 27	1856.71	1.04	2.6	3.6	C. A. Schott.
7	Bull Run	38 53	77 42	1871.79	4.36	1.5	5.9	C. O. Boutelle.
8	Peach Grove	38 55	77 14	1869.84	2.91	1.6	4.5	C. O. Boutelle.
9	Mobjack Bay	37 18	76 20	1824.0	+0.62	+2.8	4.4W	—— Boye.

Isogonic Chart for 1900.

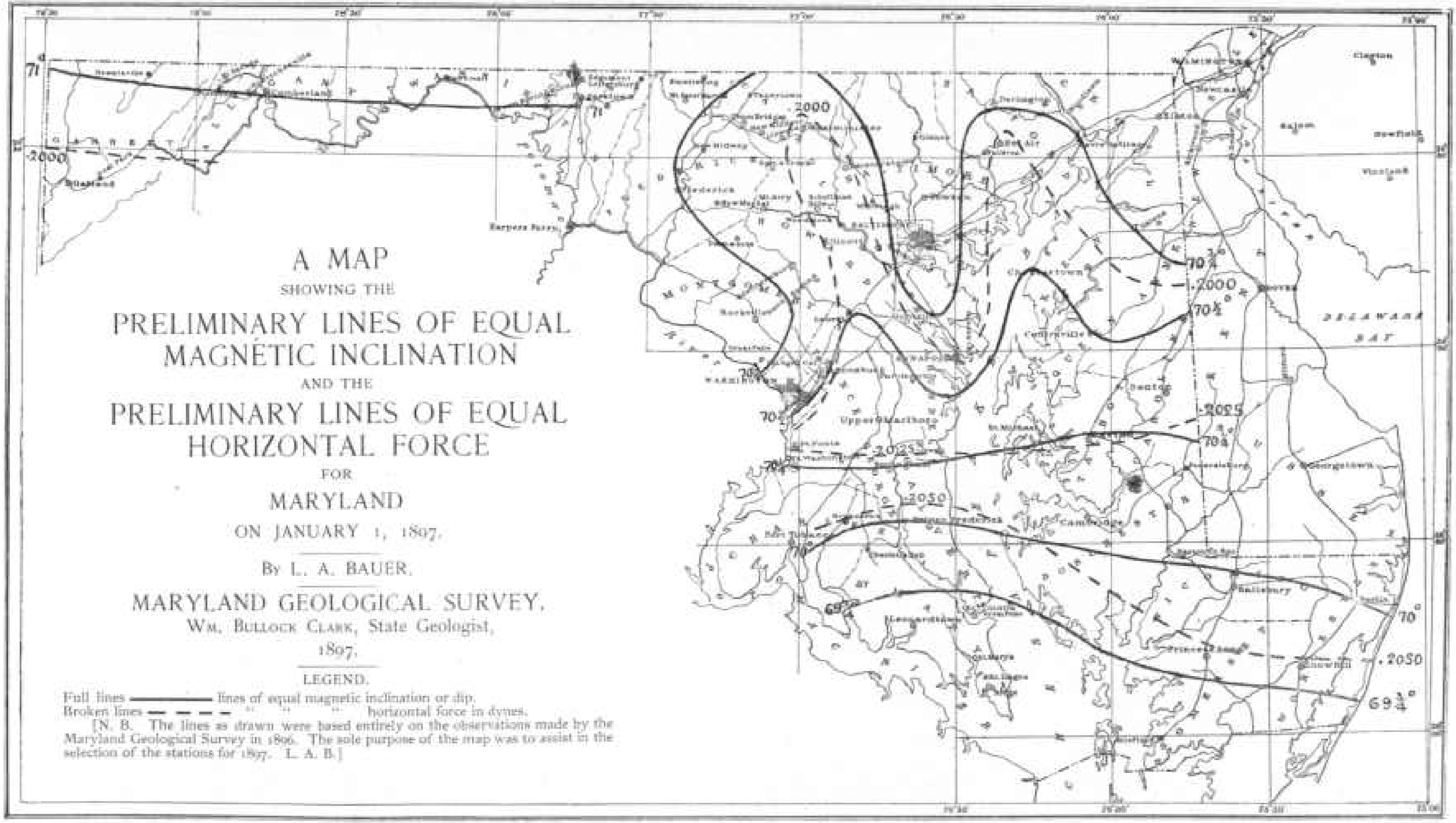
[Plate XIV.]

Doubtless no further explanation is necessary than that already given and likewise contained on the chart itself.[2] *It is seen that the*

[1] As the MS. is passing through the press I embrace the opportunity of adding an additional station. The observations were made by Mr. E. D. Preston, Assistant of the Coast and Geodetic Survey, and were courteously furnished to me. They were received too late to be used in the construction of the isogonic chart.

Station.	Latitude.	Longitude.	Date.	Mean declination.
	° ′	° ′	1897.	° ′
Cherrydale, Alexandria County, at Mr. Preston's residence.	38 53.8	77 06.7	June 11, 12, 13	5 16.2 W

[2] The curves were obtained by platting on a map, of twice the scale of the one herewith presented, the 1900 values of the magnetic declination given in tables XIII and XIV, and then drawn with a free hand, in general conformity with those values.


A MAP
SHOWING THE
PRELIMINARY LINES OF EQUAL
MAGNETIC INCLINATION
AND THE
PRELIMINARY LINES OF EQUAL
HORIZONTAL FORCE
FOR
MARYLAND
ON JANUARY 1, 1897.
By L. A. BAUER.
MARYLAND GEOLOGICAL SURVEY.
Wm. Bullock Clark, State Geologist,
1897.
LEGEND.
Full lines ——— lines of equal magnetic inclination or dip.
Broken lines — — — " " " horizontal force in dynes.
[N. B. The lines as drawn were based entirely on the observations made by the Maryland Geological Survey in 1896. The sole purpose of the map was to assist in the selection of the stations for 1897. L. A. B.]
DELAWARE BAY
Cumberland
Baltimore
Washington
Annapolis
Cambridge
Salisbury
Frederick
Chestertown
Centreville
Easton
Upper Marlboro
Georgetown
Salem
Clayton
2000
2025
2050
70°
71°
69¾°

P. 193 A

lines of equal magnetic declination (variation) run very irregularly over the region embraced by the Piedmont Plateau (central and north-eastern Maryland), while over the Coastal Plain (southern and south-eastern Maryland) they are fairly regular. The counties that are especially disturbed are Cecil, Harford, Baltimore, Carroll, Howard, Montgomery and Frederick. In the regions covered by these counties the density of the stations must be greatly increased before we can be sure of giving a true representation of the distribution of the earth's magnetism as manifested by the declination.[1] Additional observations made since the drawing of these lines, especially in Harford County, clearly demonstrate that little dependence can be put upon lines constructed from a small number of stations. The line 6° W. as at present sketched must be regarded as but a rough approximation to the truth. A more detailed investigation in this region will result in a number of closed areas, where the values will be smaller or larger than those obtained by direct interpolation. Thus east of line 6° W. there are a number of places where the declination drops down to 5½° and less, whereas the values should have been greater. For example, Elkton gives but 5°.4 for 1900. The line 6° W., as at present projected, is doubtless not far from the position which the line would have were it not for the marked disturbances referred to. Its general direction harmonizes with that as indicated by the distant observations in Pennsylvania.

The same marked anomalies in the distribution of the earth's magnetism have been revealed by the other preliminary magnetic map, viz., the map giving the lines of equal magnetic inclination and the (Plate XVI) *lines of equal horizontal magnetic force.* These preliminary maps have served a useful purpose in guiding me in the map-

[1] The results thus far obtained from the work of the present year clearly indicate that the curves presented in this report have not exaggerated the amount of disturbance in the distribution of the earth's magnetism over the counties enumerated. Thus, for example, the declinations observed at Linden and Rockville—both in Montgomery county and distant from each other seven miles—differ from each other by nearly two degrees. At Linden the declination for January 1st, 1900, will be 3°.6 and for Rockville 5°.5. It will be seen that the isogonic line (4½°)—drawn before the Rockville observations were made—would represent a *mean* of the two stations for this locality quite satisfactorily.

ping out of the work of the present year. It will be interesting to trace the further progress of the line of equal magnetic inclination 71°. Special stress is to be laid this year upon the investigation of the regional disturbances.

It will be noticed that at present the declination is westerly over the entire area of the state, ranging from a little over 6° west in the northeast to about 3½° in the extreme west. The distribution of the declination has, however, not always been thus.

Isogonic Charts for 1700 and for 1800.

[Plate XVII.]

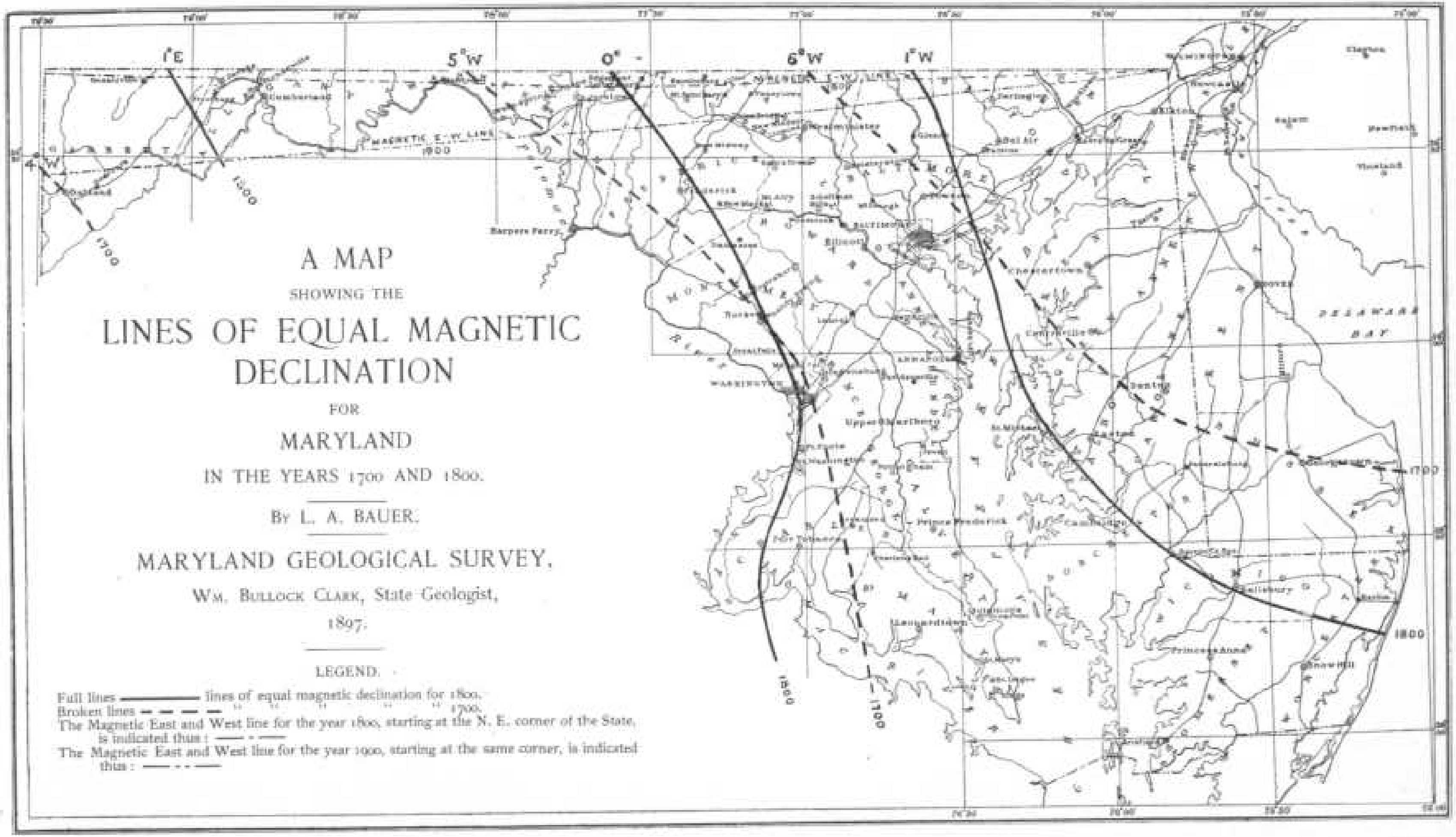
With the aid of the table, XII, giving the approximate values of the magnetic declination at the various county-seats from 1700 to 1900, and with the aid of the long series of observations in the adjoining states, I have been able to construct isogonic charts for 1700 and for 1800 with a fair degree of accuracy. *It will be seen that for 1700 the lines of equal magnetic declination are about the same as those for 1900.* In other words, in the first decade, approximately, of the eighteenth century the needle pointed in precisely the same direction as at present. But this did not occur simultaneously over the entire state; hence the isogonic chart, while closely approximating the 1900 chart, would not be exactly the same.

The lines for 1800, however, present a vastly different appearance. We now have a central line—the so-called *agonic line* (line of no declination)—along which the needle was "true to the pole." East of this line the needle bore by a small amount *west* of true north, while west of the line the needle pointed *east* of true north.

The Secular Motion of the Agonic Line over Maryland.

When did the line of no declination enter the state and when did it leave it? Was its position in 1800 the extreme easterly one? These are questions that we can again answer with the aid of the table XII. Turning back to it we obtain the following facts:

	Latitude.	Longitude.	Needle true to pole approximately in	
	°	°		
Oakland	39.4	79.4	1769 and	1850
Cumberland	39.6	78.8	1781	1836
Hagerstown	39.6	77.7	1792	1828
Frederick	39.4	77.4	1797	1820
Washington	38.9	77.0	1790	1810


A MAP
SHOWING THE
LINES OF EQUAL MAGNETIC DECLINATION
FOR
MARYLAND
IN THE YEARS 1700 AND 1800.
BY L. A. BAUER.
MARYLAND GEOLOGICAL SURVEY.
WM. BULLOCK CLARK, State Geologist,
1897.
LEGEND.
Full lines ——— lines of equal magnetic declination for 1800.
Broken lines — — — " " " " 1700.
The Magnetic East and West line for the year 1800, starting at the N. E. corner of the State, is indicated thus : —·—
The Magnetic East and West line for the year 1900, starting at the same corner, is indicated thus : —··—
1°E
5°W
0°
6°W
1°W
4°W
1700
1800
MAGNETIC E.-W. LINE 1800
Harpers Ferry
DELAWARE BAY
Chestertown
Dover
Salisbury
Snow Hill
Princess Anne
Cambridge
Washington
Annapolis
Baltimore

p. 174 B

We thus see that the line of no declination entered the state in about 1769 and thereupon marched eastward until it reached an extreme easterly position a few miles east of Washington in about 1805. It then began to recede, now marching westward until in about 1850, when it left the state. The average annual motion in longitude for the forward and the backward march was about the same—0°.7, or about 37 miles. The next map (Fig. 7) exhibits the motion of the agonic line over the eastern part of our country for various epochs, as drawn by Mr. Schott. It will be noticed that our deductions are in harmony with the facts set forth by this map.

It would appear, then, as though the needle did not point east of north between 1700 and the present date in the greater part of Maryland. It should be mentioned, however, that there may have been regions east of the extreme easterly position assumed by the agonic line where the needle in the early part of the eighteenth century was either "true to the pole" or bore by a small amount east. This occurred in the magnetically disturbed areas of Maryland and was due to the fact that in those regions the declination has a smaller value than it would have if the causes of the disturbances did not exist. Thus, for example, we find that at Elkton in about 1800 the direction of the needle practically coincided with the true meridian, whereas if the declination had been normal it would have been about 1½° west. It is this fact undoubtedly which makes the matter of re-locating old surveys of such especial difficulty in the northeast counties. There are disturbed and undisturbed areas in these counties. Over the former the needle may have pointed east at beginning of present century; over the latter, which may be within a very short distance of the former, the needle pointed west. Granted that over this region compass surveying should be prohibited in the future by the state, the difficulty will always remain in the proper re-location of the old surveys referred to compass bearings.

The Effect of the Secular Variation of the Magnetic Meridians.

If in the year 1800 the northern boundary of Maryland—the famous Mason and Dixon line—had been laid out with the compass so as to run magnetically east and west, beginning at the east end and supposing that the surveyor did not come across any areas of local

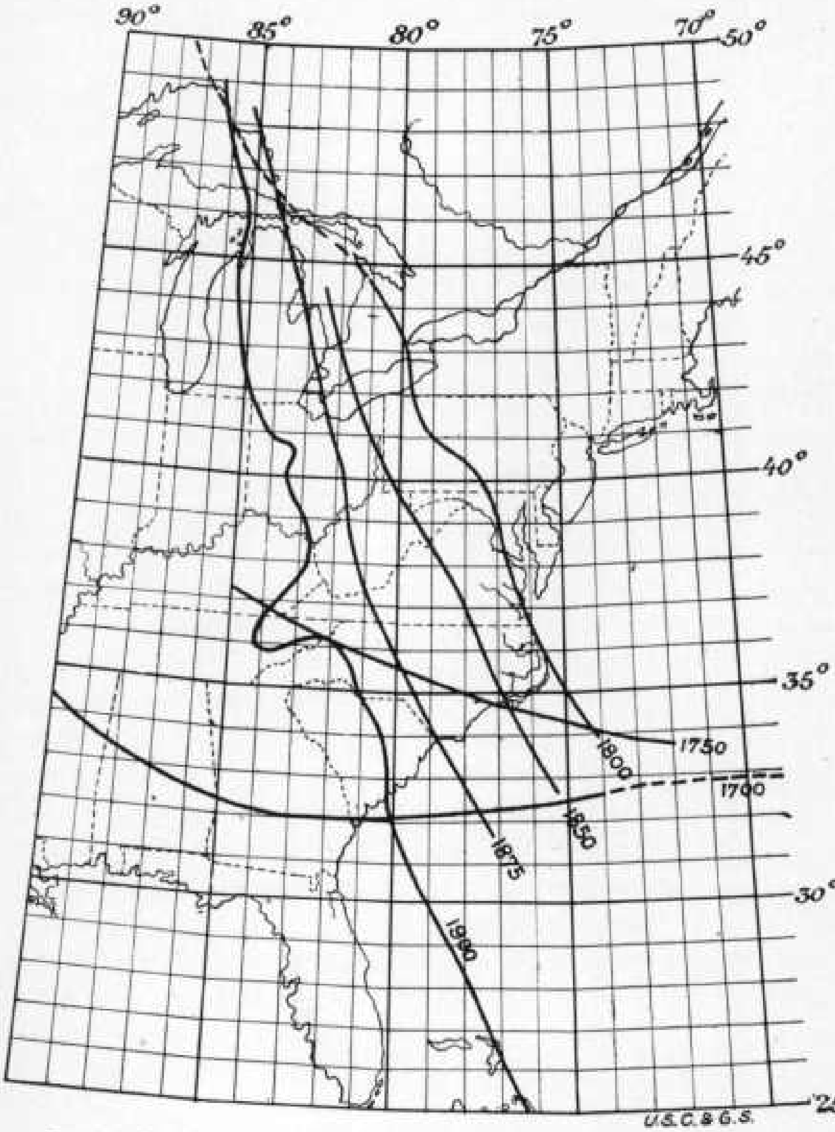


FIG. 7.—Secular variation in the position of the agonic curve of North America between A. D. 1700 and 1900, according to C. A. Schott.

attraction, the boundary as mapped out by the compass would be the line indicated on the map (Plate XVII). It will be seen that

Emmitsburg and Edgemont would be in Pennsylvania and Hancock on the boundary. The maximum deviation from Mason's and Dixon's line—about 2½ miles—would have occurred near Leitersburg and the west end of the line would be too far south by nearly a mile.

If now a magnetically east and west line were re-run at the present time, starting again from the east end, the line, as will be seen, would run considerably south of the true boundary. The rich coal regions of Allegany and Garrett counties would now lie almost entirely in Pennsylvania and the west end of the line would be just about at the middle point of the west boundary line, or in other words about 19 miles too far south!

This illustration brings the fact of the secular change of the *magnetic* meridians in the course of one century vividly before the mind. Fortunately, the Mason and Dixon line was run true east and west, and hence will be fixed forever.

Now let us suppose that a surveyor were called upon at the present time to re-run the magnetic east and west line of 1800. Then the question of proper allowance of secular variation would enter in and be the dominating factor in the accurate re-running of the line. Making the most favorable supposition possible, the *precise* position of the 1800 magnetic east and west line would never again be regained. Under favorable suppositions a skillful surveyor might approximate quite closely to the line, but assuming that conditions exist similar to those prevailing in the greater portion of the state, even the skillful surveyor might run a line which would be so far out as to make it doubtful whether certain towns belonged to this state or the adjoining ones. His line might be a fruitful cause of litigation for ownership of valuable districts, *e. g.*, the coal regions. This is precisely the condition of things in many parts of Maryland to-day, hence the practical importance of making our secular variation data as accurate as possible. During the present year special effort will be made to increase our knowledge of the secular change.

DESCRIPTIONS OF MAGNETIC STATIONS IN MARYLAND.

STATIONS OCCUPIED BY THE MARYLAND GEOLOGICAL SURVEY IN 1896.

The arrangement of the stations is alphabetical. The number indicates the general order in which the stations were occupied, and at the same time serves as a brief method of designating the various stations. When an additional station was obtained in the same town or locality a capital letter is attached to the number.

All the stations were temporarily marked at the time of observation by wooden stubs with brass nails or screws in their tops. These stubs were left in the ground. No money was available for marking the stations more permanently, nor was it particularly advisable, except in a few cases, to spend any great amount of time or money in this way. The descriptions below will, in general, suffice for future observations at the identical station.

30. ANNAPOLIS, ANNE ARUNDEL COUNTY.—On the Naval Academy grounds, in the open area near the Observatory; 45 paces west-northwest of Observatory and 62 paces northeast of Herndon Monument. Site was chosen by Professor Terry, in charge of the Physical Department of the Academy.

32. BALTIMORE, FORT MCHENRY.—The description furnished by the Coast and Geodetic Survey of their station occupied in 1895 by J. B. Baylor, Assistant, is as follows: New station selected is in the large open space in the extreme eastern part of the fort next to the outer sea-wall; 16½ yards from the outer sea-wall and 13 yards from a locust tree, and is marked by a substantial locust post with a copper tack in it, and sunk flush with ground. Site is quite free of artificial disturbing influences, such as pipes, ordnance materials, etc.

The Geological Survey station was placed as near as possible to above station. The locust post could not be found, but with the aid of the orderly who had assisted Mr. Baylor, it was possible to locate within a few feet of Mr. Baylor's station.

[The former C. and G. S. station of 1877 and 1885 in another part of the grounds had to be abandoned on account of proximity of electric cars. The commander of the Fort states that there is a bed of iron below the grounds of the Fort.]

29. BEL AIR, HARFORD COUNTY.—In the garden back of Rouse House, a hotel; 110 paces back of the house, 41 paces north of south barbed-wire

fence and 34 paces west of east fence at a point where stands a small willow tree. Site appears to be free from any artificial disturbing influence.

[The above hotel is now known as Eagle Hotel.]

33. BELCAMP, HARFORD COUNTY.—On the farm belonging to Mr. James Walsh and occupied at present by Mr. E. J. Cottle, about 400 feet back of railroad station, 34 paces west of first locust tree, 25 paces south of wild cherry tree and 29 paces west of hay crib blown down by storm.

13. BERLIN, WORCESTER COUNTY.—In the northwest corner of Buckingham High School grounds; 61.2 feet from the northwest corner of the frame building and 21.8 feet (at right angles) from the fence in the rear of grounds.

4. BRANDYWINE, PRINCE GEORGE COUNTY.—In the woods about 100 yards east of railroad station. Dip only observed. Soil, sandy.

37. CARDIFF, HARFORD COUNTY.—In the open lot about 100 yards southeast of railroad station; 32 paces from the white wooden fence and 8 paces from fence near road. [In 1897 additional stations were obtained in Cardiff and vicinity. Marked local disturbances were encountered.]

8. CENTREVILLE, QUEEN ANNE COUNTY.—In the grounds of the Centreville Academy for boys, about one eighth of a mile east of court house; 62 feet south of south corner of Academy and 44 feet west of young sycamore tree. Soil, sand and clay.

19. COCKEYSVILLE, BALTIMORE COUNTY.—On Mr. Cockey's property, a large, open lot on right of road near stone bridge. Station is about 500 feet west of road and 25 feet east of a clump of three willow trees.

43. CRISFIELD, SOMERSET COUNTY.—In the large, open lot west of the Academy on 12th and ——— Street; 60 paces from southwest corner of Academy (a frame building) in a line with rear side of Academy.

35. CRESWELL, HARFORD COUNTY.—About half-way between Creswell and Fountain Green on the road to Belair, about one-sixth of a mile from Winchester crossing, on a small triangular plat opposite Mr. W. H. Michael's place; about four miles from Belair.

23. CUMBERLAND, ALLEGANY COUNTY.—In the large, open area on Camp Hill, north of Rose Hill Cemetery and south of Willis Creek. To find station, go 75 paces along the north iron fence of cemetery, starting from northeast corner, then 75 paces at right angles towards Willis Creek. According to town map, this area is subdivided into lots and streets, but no sign of the latter on the ground at present. Station may have been between Sedgewick and Niagara Streets. According to the map it is about 4667 feet due west of middle point of Decatur Street, on which Mosman's astronomical and magnetic stations of 1864 were located. Station is also about 2744 feet west of court house and about 1280 feet north, and may possibly be over a cement mine. Site was selected in the absence of the County Surveyor by Thomas L. Patterson.

41. DAMASCUS, MONTGOMERY COUNTY.—On Dr. Lansdale's lot, 18 paces from west corner and 42 paces from small house at east corner.

26. DICKERSON, MONTGOMERY COUNTY.—On Mr. Dickerson's farm directly north of railroad depot, in the direction towards Sugarloaf Mountain, near a clump of locust trees about 500 feet from depot. Station is 27 paces west of locust trees and about 18 paces south of wooden fence.

7. EASTON, TALBOT COUNTY.—In the northeast corner of the garden on the east side of Avon Hotel. This station was but a temporary one. Soil, sand and loam. [Local attraction at this place due to iron standpipe; in 1897 the station was selected on the Fair Grounds.]

31. ELLICOTT CITY, HOWARD COUNTY.—In the grounds back of public school up on the hill near the court house and west of old Patapsco Institute; 40 paces back of frame school building near oak tree and 7 paces north of south wooden fence.

27. ELKTON, CECIL COUNTY.—In the south corner of grounds around new high school building just nearing completion; about 49 paces from the nearest edge of building, 13 paces from fence in the rear and 11 paces from fence on the side.

42. FOREST GLEN, MONTGOMERY COUNTY.—On the grass plat under maple tree east of road directly in front of Catholic cemetery.

38. FOREST HILL, HARFORD COUNTY.—In the large, open lot of E. Tucker & Co., west of railroad depot; 200 paces from fence corner nearest the depot and 46 paces east-northeast of cherry tree.

36. FOUNTAIN GREEN, HARFORD COUNTY.—In large open field on Mr. Grant's place; about 200 feet west of store at corner of road and about 25 feet from the middle of the road to Belair; about two miles east of Belair.

34. HARFORD FURNACE, HARFORD COUNTY.—About one-fifth of a mile from the village along the road to Belair; on Mr. A. H. Strausbaugh's farm, 15 paces from the road and opposite " hay bag " on Mrs. Mary D. Walsh's estate.

20. FREDERICK, FREDERICK COUNTY. *First Station.*—In the southeast part of the grounds back of the State Deaf and Dumb Asylum. Marked by two stakes, one 1¼x1¼x8 inches, and another four feet west ½x2x8 inches; the former marks the station and was driven flush with the ground; the station is 26 paces north of the south hedge fence and 34 paces from southeast corner of hedge fence.

20A. ———. *Second Station.*—North meridian stone, in the grounds on the side east of the court house.

[The first station is the preferable one.]

22. HAGERSTOWN, WASHINGTON COUNTY.—In the grounds on the east side of the Hagerstown Academy, down on the slope near the second maple tree on the right-hand side of path to railroad station. The tracks of Western Maryland Railroad are about 300 feet to the west and those of the Cumberland Railroad about 500 feet to the east. Site was chosen by the County Surveyor, Mr. Piper. Marked by an ash stave which broke off when driven. Limestone rocks crop out of the ground.

11. HURLOCK, DORCHESTER COUNTY.—Directly in front of frame school-house on the right-hand side of road to East Newmarket; near the road. Soil, sandy.

3. LA PLATA, CHARLES COUNTY.—In the northwest corner of new court house grounds, 40 feet southeast of northwest corner-stone of lot and 28 feet south of locust (?) tree and 49 paces northwest of northwest corner of new court house just nearing completion. Marked by an oak stub with a brass screw. There was no fence around the lot at this time and the station may possibly fall in that portion of the lot to be set aside as a road. Soil, sandy.

[In 1897 the wooden fence around the grounds was partly constructed and it was found that the old station fell in the line of the west fence. The new station is the south meridian monument.]

6. LEONARDTOWN, ST. MARY'S COUNTY.—In the southwest corner of the court house lot, 92 feet from southwest corner of court house and 23¼ feet from southwest corner post of wooden fence. Soil, sand and loam.

1. LINDEN, BASE STATION, MONTGOMERY COUNTY.—In the middle of Professor M. H. Doolittle's rear garden, 94.1 feet northwest of northeast corner of frame dwelling house and 84.1 feet northeast of northwest corner of same house. Station is marked by a brass screw in a 2″x4″x2½′ yellow pine stub projecting four inches above ground. The primary azimuth mark was the extreme tip of the Chevy Chase standpipe, three miles distant, azimuth 39° 15′.7 W. of S. The secondary azimuth mark was the extreme tip of tower on Major Lawrence's house about 200 yards distant, azimuth 66° 46′.8 W. of S. The station is to be marked by a granite post suitably lettered.

1A. LINDEN, MONTGOMERY COUNTY.—In large vacant lot back of base station; about 300 paces nearly due north of base station, 34 feet north of fence of Dr. Wright's Sanatarium and 44 feet southeast of the stile.

9. MASSEY, KENT COUNTY.—On the north side of road to Clayton near small school-house, about one mile from railroad station; 121 feet north-northwest of northwest corner of school-house.

MARLBORO.—See Upper Marlboro.

5. MECHANICSVILLE, ST. MARY'S COUNTY.—In the garden of Hotel Mattingly, 18 feet northeast of mulberry tree and 9½ feet west of wooden fence. Dip station 5½ feet north of mulberry tree. Soil, sand and loam.

14. OAKLAND, GARRETT COUNTY.—In the lot back of new public school, 60 paces north of school, 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.

12. OCEAN CITY, WORCESTER COUNTY.—Near Life Saving Station, 200 paces north and 200 paces west, in large, open, sandy area north of Bruce Cottage, northeast of school-house, between Baltimore and Philadelphia Avenues.

18. PARSONSBURG, WICOMICO COUNTY.—In open lot, 170 paces south of Baltimore, Chesapeake and Atlantic railroad station. Lot owned by proprietor of saw mill opposite station. Soil, black clay. Natural gas in vicinity.

15. POCOMOKE CITY, WORCESTER COUNTY.—In the northeast part of the grounds about the Academy; 36 paces west of Academy, 11 paces west of east hedge fence and 25 paces south of north hedge fence.

25. POINT OF ROCKS, FREDERICK COUNTY.—About one-sixth mile to the west-northwest of Junction Depot on the knoll on Mr. E. W. Mercer's property back of Mr. H. B. Carter's house to the west of depot. Site of former ore mines, ore being found 40-60 feet below ground. East of station is a sunken shaft of an abandoned ore mine; station is 15 paces west of bank of this shaft and 8 feet south of a projecting boulder.

16. PRINCESS ANNE, SOMERSET COUNTY.—In the southeast part of the spacious grounds around the new high school building; 62 paces southeast of entrance to school, 40 paces north of large oak tree in southeast corner of lot, 10 paces west of east fence. These grounds have been the site of a school-house for about 100 years.

28. PRINCE FREDERICK, CALVERT COUNTY.—In the grounds of the court house, between its southwest corner and small frame buildiug occupied at the time by a shoemaker; 15 paces north of latter building and 25 paces due east of wooden structure used as a jail. The roadbed of proposed Drum Point Railroad is about 200 feet to the west.

10. RIDGELY, CAROLINE COUNTY.—On the grounds in the rear of frame school-house, corner First Street and First Avenue west; 53 feet west of southwest corner of rear extension of school-house and 31½ feet east of young maple tree. Soil, sand, clay and gravel.

17. SALISBURY, WICOMICO COUNTY. *First Station.*—On the grounds in front of the court house; on the right-hand side of walk to entrance of court house, about 14 feet south of south edge of this walk and 20 feet east of east edge of pavement. Brick buildings rather close. The second station should be given preference.

17A. ———. *Second Station.*—On the grounds of Mr. Thomas Humphreys, attorney at law, about 175 yards southeast of the court house on the opposite side of "Lake" Humphreys. This is the site of the county merid-ian line established in 1896. Observations were made over the South monument and likewise 16 feet east of North monument, and is the preferable station. Site was chosen by Mr. Peter Shockley, County Surveyor.

39. STABLER, MONTGOMERY COUNTY.—On Warwick P. Miller's farm, near Spencerville, in the open field between Mr. Miller's dwelling house and that of Asa Stabler. This station was established in 1869 by C. O. Boutelle, Assistant of the Coast and Geodetic Survey, and is marked by a hole drilled in a large quartz bowlder projecting slightly above the ground. With the aid of Mr. Miller, who had assisted Mr. Boutelle, the identical spot was found in 1896. The trigonometrical station is 232 metres (761 feet) nearly due south of magnetic station, and is marked by five stone monuments projecting a few inches above the ground. The bearing of the central monument from the maguetic station was 4° 53′.3 west of south, according to Mr. Boutelle. In 1896 Mr. L. A. Bauer, from a single solar azimuth observation, found the same bearing to be 4° 53′.6.

14. SNOW HILL, WORCESTER COUNTY.—In the southwest corner of the court house lot; 61.8 feet from southwest corner of court house, $6\frac{1}{2}$ feet west of large sycamore tree. Soil, sandy. No fence around the lot, simply a stone curb. Station is 21.2 feet north of south curb and 15.2 feet east of west curb. Station too near to buildings.

40. UNITY, MONTGOMERY COUNTY.—In the lot back of stable adjacent to Mr. Waters' store, rented at present by Mr. Schwartz; 26 paces east of Mr. Schwartz's milk house and 50 paces southwest of Mr. Clay Brown's brick house.

2. UPPER MARLBORO, PRINCE GEORGE COUNTY.—In the southeast corner of the court house grounds, down in the hollow; 13.9 feet west of maple tree and 88 feet from southeast corner of court house, marked by a round $1\frac{1}{4}$ inch pine stub with a brass tack. Soil, sandy. Dip observed, 18 feet, magnetic north-northeast of main station.

21. WESTMINSTER, CARROLL COUNTY.—In the grounds back of court house about 22 paces west of back entrance near edge of pavement. Site not a good one.

STATIONS OCCUPIED BY THE COAST AND GEODETIC SURVEY BETWEEN THE YEARS 1845 AND 1896.[1]

15. BALTIMORE.—See description in previous list.

13. BODKIN LIGHT.—Captain T. J. Lee, U. S. Engineers, Acting Assistant U. S. C. and G. Survey, determined the elements of the earth's magnetism at this point in 1847.

The old Bodkin Light Tower is still (1897) standing. It is in Anne Arundel County on the point of land at the extreme southern entrance of Patapsco River into Chesapeake Bay.

From the best evidence at hand, Captain Lee's station was 50 feet south and 25 east of old Bodkin Light Tower.

3. CALVERT.—Calvert geodetic station is in Calvert County near Little Cove Point and north of the mouth of the Patuxent River. The geodetic station was on the land of Dr. James G. Ireland, and is about a mile back of the bay. It was marked by an earthen cone sunk 14 inches below the surface, with two stone pillars east of the geodetic station, one 19 feet 8 inches distant from it, and the other 24 feet $7\frac{1}{2}$ inches distant from the geodetic station. The station is just east of the garden of the old Ireland dwelling. The magnetic station was 262.2 feet south of the geodetic station.

22. CUMBERLAND.—See description in previous list.

2. DAVIS.—Davis geodetic station is in Worcester County about a mile and a quarter northwest of Ocean City. It is about one-quarter of a mile west of inner shore line of the southern arm of Isle of Wight Bay.

[1] These descriptions were courteously furnished by the Coast and Geodetic Survey.

The geodetic station was situated (1848) near the farm house of Mr. G. Davis and about 400 yards north of it in an open field, about 600 feet south by east of a point of woods, and on a ridge making out from this point of woods, with the ground slightly inclined towards the woods. The station was marked by a pole 2⅓ feet below the surface of the ground.

The magnetic station was 200 yards south of the geodetic station.

19. FINLAY.—Capt. T. J. Lee, U. S. Engineers, Acting Assistant U. S. C. and G. Survey, determined the elements at this point in 1845 and 1846.

Finlay geodetic station was located on Cub Hill in Baltimore County on the old Finlay farm. This farm is now (1897) the property of the Fastie heirs. The geodetic station is about nine miles from Baltimore and is about 300 feet east of the old Harford road and about three-quarters of a mile west of the Harford turnpike. The log school-house mentioned in the old description is still standing, and is now used as a blacksmith's shop by Mr. Fastie.

The geodetic station has been recently (1896) re-marked with a glazed drain tile (4 inches in diameter and 30 inches long) filled with cement and gravel and sunk in the ground so that the upper end was three feet below the surface. A small nail set in the center of this tile pipe marks the point. A chestnut post with a nail in it was placed on the under-ground mark as a surface mark.

The geodetic station bears S. 47° 06′ 33″ E. (true) from the N.E. corner of the log school-house and 253.71 feet distant. The east gable of the stone barn of the Fastie place bears N. 9° 27′ 27″ E. (true) from the station, and a large cherry tree bears S. 22° 46′ E. (true) from the station, distant 126.85 feet. From the best evidence at hand, Captain Lee's station was 38½ feet from the geodetic in the direction of Rosanne geodetic station in 1845, and in 1846 the station was 30 feet southwest of the geodetic station.

7. HILL.—Hill geodetic station was established in 1845. It is about 6 miles nearly due east from Washington City, and about 1½ miles southwest of Brightseat. The station is on a small plateau near the highest point and center of a hill known (in 1845) as "Hill's hill," as it was then the property of Wm. W. Hill of Prince George County, Maryland.

The geodetic station was marked by a stone pillar 2 feet 2 inches in length with an earthenware cone under it. Reference stone posts due east, north and south of the geodetic station, and distant 5 feet from it, were also sunk even with the ground.

In a line bearing S. 78° 14′ E. of the geodetic station and distaut 151.2 feet was a cedar stump, and in a line bearing S. 30° 16′ W. were two cedar stumps, distant 137.5 and 180.5 feet from the geodetic station.

The magnetic station was 331 feet east of the old geodetic station near a pine grove.

9. KENT ISLAND, *Station I.*—From the best evidence at hand, Kent Island Magnetic Station I was on Kent Island in Chesapeake Bay near the western shore of the Island, about 6198 metres north and 1949 metres east of the monument at the north end of the "Kent Island base." This monument has now (1897) been washed away, but its old approximate position is known to people living in the vicinity.

The magnetic station was marked with a cedar stake aud copper nail in it.

6. Kent Island, South Base.—Captain T. J. Lee, U. S. Engineers, Acting Assistant U. S. C. and G. Survey, determined the elements at this point in 1845.

South Base geodetic station was located near the western shore of Kent Island, almost east from Thomas' Point, Chesapeake Bay, and near the mouth of Price's Creek. From the best evidence at hand, Captain Lee's station was 64½ feet north of South Base geodetic station, in the line between South Base geodetic station and North Base geodetic station.

Both of the monuments marking North and South Base have been washed away since these observations were taken, but their old approximate positions are known to people living in the vicinity.

18. Maryland Heights.—Maryland Heights geodetic station is on Maryland Heights in Washington County opposite Harper's Ferry. It is near the southeast corner of the stone fort and 18.20 metres distant from it. It is also distant 9.88 metres and 15.15 metres from the two extreme southern corners of the stone bastion projecting from the southern edge of the fort.

The geodetic station was securely marked with a copper bolt placed in a large rock two feet below the ground with a stone post over it.

The magnetic station is in the fort 43.92 metres distant from the geodetic station. The azimuth of the magnetic station at the geodetic station is 134° 21'.4. The magnetic station was marked by a stub and copper nail.

5. Marriott.—Captain T. J. Lee, U. S. Engineers, Acting Assistant U. S. C. and G. Survey, determined the elements at this point in 1846 and 1849.

Marriott geodetic station is in Anne Arundel County about a mile and a half northeast of Owensville and about 6½ miles from South River. It is about 100 yards west of the road leading from Annapolis to St. Mary's.

This geodetic station was established in 1844. It was then on the property of B. Marriott, 99 feet from the main post of an old wind-mill and 34 feet 11 inches from a small hut on the side of a hill. Three stakes, each 30 feet distant, the first being in the direction of Taylor geodetic station and the other two at right angles to that line, were driven in the ground as reference marks.

From the best evidence at hand, Captain Lee's station of 1846 was 210 feet from the geodetic station in the direction of Taylor geodetic station. The station of 1849 was 114 feet southwest of the geodetic station on the south side of the hill. The hill is of gravel (drift with frequent nodules of ferruginous sandstone).

1. Mason's Landing.—This station was occupied by Assistant C. A. Schott in 1856, and is in Worcester County. According to Mr. Schott's description, it was on the south bank and near the mouth of Marshall's Creek, and 115 feet north of the store-house on the wharf at the landing. It was on the salt-water marsh, and the soil around the marsh consisted of white sand mixed with shells.

14. North Point.—From the best evidence at hand, Captain Lee's magnetic station was (in 1846) in close proximity to the Lower Light Station at North Point and between the Upper and Lower North Point Lights.

It is in Baltimore County near the northern entrance of Patapsco River into Chesapeake Bay.

20. OSBORNE'S RUIN.—Captain T. J. Lee, U. S. Engineers, Acting Assistant U. S. C. and G. Survey, determined the elements at this point in 1845.

Osborne's Ruin geodetic station is situated in the town of Abingdon, Harford County, on a hill formerly known as Dallam's Folly, about one-quarter of a mile northwest from the center of the village and a short distance north of the road leading from Abingdon to Bel Air. The land is owned by Mr. Ben Swartz, an old man living east of the hill on the road leading from Abingdon to Havre de Grace. The nearest railroad station is Sewell, on the B. & O. R. R., distant one mile.

The geodetic station has been recently (1896) re-marked. The earthenware cone sunk 21 inches below the surface of the ground was re-sunk so that its top is now a little more than three feet below the surface. A chestnut stub 2.5 feet long was placed over the cone as a temporary surface mark, the top projecting an inch or two with the nail in the center marking the point.

The following measurements were taken with a steel tape:

From geodetic station to a corner stone in fence, 61.65 feet.

From geodetic station to a nail in a blazed cherry tree, 50.9 feet.

From geodetic station to a nail in a blazed chestnut tree (the largest on the hill) 61.0 feet.

The following readings were taken with a 6-inch theodolite, reading from right to left:

Nail in chestnut tree	= 0° 00′ 00″ (N. 17° 30′ E. magnetic).
Nail in cherry tree	= 84° 42′ 50″.
Cross on Catholic church	= 105° 19′ 30″.
Corner-stone	= 129° 32′ 00″.
Belfry on school-house	= 268° 18′ 45″.

From the best evidence at hand, Captain Lee's station was 57½ feet east of the geodetic station.

4. OXFORD.—Oxford geodetic station is in Talbot County.

The station is near the beach, about three-quarters of a mile north of the dock of the Delaware and Chesapeake Railroad, and close to the end of the point of land just north of the town of Oxford.

From the best evidence at hand, the magnetic station was identical with the geodetic station. The soil consists of clay and marl, several feet in thickness, overlying sand mixed with marine shells.

16. POOL'S ISLAND.—Captain T. J. Lee, U. S. Engineers, Acting Assistant U. S. C. and G. Survey, determined the elements on this island in 1847.

Pool's Island is in Chesapeake Bay and is embraced in Harford County. It can be reached by steamer from Baltimore.

The geodetic station was established in 1844 on the property of P. Wethered. It was near the dwelling on the upper island, and was 429.5 feet from the center of the well and N.W. ½ W. from the center of the well.

This island is now (1897) the property of Mr. John Masheter and has been converted into a peach orchard. The old well is still to be found, but the position of the old geodetic station can only be approximately restored.

From the best evidence at hand, Captain Lee's station was identical with the old geodetic station.

17. ROSANNE.—Rosanne geodetic station stands on Prospect Hill, about five miles from Baltimore and one-quarter of a mile north of the old Frederick road.

The station is 18 feet from the northeast corner of the old Bogue house of 1845, 68 feet from a cedar at the southeast corner of this house, and 88.5 from a persimmon tree, midway between the lines to Finlay geodetic station and the Washington Monument.

From the best evidence at hand, the old geodetic station was marked with an earthenware cone sunk two feet below the surface of the ground with reference posts close to the old station. The magnetic station was 126 feet north of the geodetic station.

12. STABLER.—See description in previous list of stations.

11. SOPER.—Soper geodetic station is in Montgomery County about a mile east of the boundary line between Prince George County and Montgomery County and about 92 feet east of the old Columbia turnpike and about 1½ miles from Burtonville.

It is on what is known as Soper Hill, and was marked by an earthen cone sunk two feet below the surface of the ground with a granite post over it. Similar granite posts, as reference marks, were placed true north, east and south of the geodetic station and five feet distant from it.

Just north of the station, by the side of the road, were two red oak trees distant 110½ feet from the station. Each of these trees was notched and marked by a copper nail.

North 86° 05′ west from the geodetic station, and distant 92½ feet from it, a brass screw was inserted in a white oak tree.

The magnetic station was 352 feet north and 42 feet east of the geodetic station.

21. SUSQUEHANNA LIGHT.—The magnetic station was near the old "Susquehanna Light" in the suburbs of Havre de Grace.

From the best evidence at hand, the magnetic station was west of the old light-house in the prolongation of the line from the Susquehanna Light to Turkey Point Light, and quite close to the old light-house, which was in very close proximity to the present Havre de Grace Light House.

8. TAYLOR.—Captain T. J. Lee, U. S. Engineers, Acting Assistant U. S. C. and G. Survey, determined the elements at this point in 1845 and 1847.

Taylor is on Greenbury Point in Anne Arundel County, opposite Annapolis.

From the best evidence at hand, Captain Lee's station was 54 feet north of the geodetic station and 6½ feet west of the line from Taylor to Linstid geodetic station. Taylor geodetic station was, in 1844, on a farm which was then the property of Captain Samuel Taylor, located between Mill Creek and the Severn River. It was about one-quarter of a mile from Captain Taylor's house on the north side of the road leading to the Severn Ferry, and 226 feet from a chestnut tree in the direction of a cut in the woods to Marriott geodetic station. Three stakes, each 40 feet distant from the old geodetic station, were driven in the ground as reference marks.

10. WEBB.—G. W. Dean, U. S. C. and G. Survey, determined the elements at this point in 1850, and also C. O. Boutelle in 1868.

Webb geodetic station was established in 1850. It is in Anne Arundel County, about 2½ miles by road east from Odenton, the junction of the B. & P. R. R. and the Annapolis Branch of the B. & O. R. R. The land upon which it is now located (1897) is the property of Mr. James Woodward, President of the Hanover National Bank of New York City.

The geodetic station is on the side of a hill about one-quarter of a mile north of the old Webb house.

The station is marked by a granite post with an underground earthenware cone under it. There are also three reference stones so placed as to form an equilateral triangle; the base of the triangle being on a line due north and south, and the stones at the extremities of the base and the vertex of the triangle are distant five feet from the granite post marking the geodetic station in the middle of the base. A cross on the granite post marks the center.

Mr. Dean's magnetic station was 685 feet south and 25½ feet east of the geodetic station.

MISCELLANEOUS STATIONS.

26. ANNAPOLIS, ANNE ARUNDEL COUNTY.—Somewhere on the Naval Academy Grounds. No detailed description could be obtained.

27. ASHTON, MONTGOMERY COUNTY.—No description at hand.

25. CHELTENHAM, PRINCE GEORGE'S COUNTY.—On the grounds of the Reform School.

28. LONACONING, ALLEGANY COUNTY.—No description at hand.

24. VIENNA, DORCHESTER COUNTY.—No description at hand.

ESTABLISHMENT OF SURVEYORS' MERIDIAN LINES.

MERIDIAN LINES ESTABLISHED BY THE MARYLAND GEOLOGICAL SURVEY.

An act of Assembly passed at the session of 1870[1] and codified in 1882[2] authorizes the county commissioners to establish at their county-seats true meridian lines at the expense of the several counties.

[1] Laws of Maryland, 1870, Chapter 359.

[2] Maryland Code, 1888, Vol. I, Art. 25, Sections 77-82.

The purposes of such lines are:

(a) To enable the surveyor to readily determine himself at any time the declination or the "variation of the compass" at the county-seat and thus to provide the means for determining the amount of secular change.

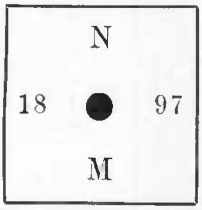
(b) To furnish a common line whose magnetic bearing as well as its true one has been accurately determined, on which surveyors can from time to time test and compare their compasses.

If such lines had been established long ago at the various county-seats the re-running of old lines would have been greatly simplified; for in addition to the secular change being now accurately determinable, the condition of the compass used in the early survey would have been known. The law provides, namely, that every surveyor shall duly file with the county clerk the "amount of variation" or magnetic bearing given by his instrument on the authoritatively established county meridian. It is well known that compasses may differ greatly from each other by reason of the fact that the proper care is not, in general, bestowed on them. A magnetic needle poised on a fine pivot point is a delicate instrument and must be carefully handled if it is to settle in the right place when it comes to rest.

Nine counties have thus far availed themselves of the privilege of having their meridian lines established in connection with the magnetic survey. These counties are: Baltimore, Dorchester, Charles, Frederick, Harford, Kent, Queen Anne's, Talbot and Wicomico.

The method used in the establishment of the lines was that of altazimuth observations on the sun before and after noon. When for some reason, which only occurred once, observations could not be made on both sides of noon, then special observations for a sufficiently accurate determination of the latitude were made. The accuracy aimed at was, that the established line should be correct within one minute of arc. The instruments employed were those used in the magnetic survey.

The line was permanently marked by two granite monuments about four feet long and seven by seven inches square. The monuments were generally imbedded in several courses of concrete and were allowed to project about 5 inches above the surface. In the centre of each was leaded, flush with the top, a brass dowel one inch in diameter and three inches long. The line was marked by crosses cut in the brass dowels. The tops of the monuments contained some suitable lettering, as for example:



North Monument or Meridian, 1897.

Owing to the lay and character of the grounds about the court-houses[1] it was not always possible to plant the monuments on a true north and south line. Of course any line whose true bearing is known will suffice for the surveyor's purpose. It was my endeavor, however, always to select as simple a line as possible. Thus at Frederick (Frederick), Salisbury (Wicomico), Towson (Baltimore) and La Plata (Charles) north and south lines were given; at Bel Air (Harford) and Chestertown (Kent), northeast and southwest lines; at Cambridge (Dorchester), a northwest and southeast line; at Centreville (Queen Anne's), an east-southeast and west-northwest line, and at Easton (Talbot), an east and west line.

After the line was established careful determinations of the magnetic declination, or variation of the compass, were made by me over the monuments with the Coast and Geodetic Survey magnetometer. The surveyor, hence, in addition to obtaining a line whose true bearing was known, also had the privilege of having determined for him the magnetic bearing with an instrument especially adapted for the purpose. This accurate magnetic bearing gave him the means of determining the reliability of his own instrument and of obtaining the correction to be applied.

When the conditions were such that it was not possible to get

[1] The law prescribes that the line shall be established on some public lot adjacent to the Court House.

entirely beyond the disturbing influence of some artificial cause near the place where by law the line had to be established, special magnetic observations were made at some point near the town where there was no reason to suspect a local disturbance and the result of these observations likewise furnished to the county commissioners.

The Frederick and Wicomico lines were established in the fall of 1896 and the remainder in the spring of the present year. More detailed reports of each line have been prepared and sent to the respective county commissioners and will, doubtless, be published in some other connection.

Numerous inquiries have been received by the Maryland Geological Survey with regard to simple methods for the determination of true meridian lines—such methods as could be employed with the average instrumental equipment of the surveyor.

In the hope that the furnishing of this information to the surveyor will be instrumental in inducing him to determine the magnetic declination or "variation of the compass" more frequently than is his custom, I take pleasure in complying with the requests for this information and have accordingly added the following article.

The method used in the magnetic survey—that of determining the true bearing of some distant mark by solar observations—while more expeditious for the work of the survey is not one that the surveyor in general can employ with success. I have therefore omitted an explanation of this method.

Simple Methods for determining a True Meridian Line.[1]

I.—To determine the true meridian by observation on Polaris at elongation with the engineer's or surveyor's transit.

1. Set a stone, or drive a wooden plug, firmly in the ground and upon the top thereof make a small distinct mark.

2. About thirty minutes before the time of the eastern or western

[1] The descriptions of the four methods given under this heading are borrowed almost entirely *verbatim* from the U. S. Land Office Manual of Surveying Instructions, Washington, 1896. I have made a few revisions and have referred the tables to the present year.—L. A. B.

elongation of Polaris, as given by the tables of elongation, No. XVI, set up the transit firmly, with its vertical axis exactly over the mark, and carefully level the instrument.

3. Illuminate the cross wires by the light from a bull's-eye lantern or other source, the rays being directed into the object end of the telescope by an assistant; while great care will be taken to see that the line of collimation describes a truly vertical plane.

4. Place the vertical wire upon the star, which, if it has not reached its elongation, will move to the right for eastern and to the left for western elongation.

5. While the star moves towards its point of elongation, by means of the tangent screw of the vernier plate it will be continually covered by the vertical wire, until a point is reached where it will appear to remain on the wire for some time, then leave it in a direction contrary to its former motion; thus indicating the point of elongation.

6. At the instant the star appears to thread the vertical wire, depress the telescope to a horizontal position; about 100 yards north of the place of observation set a stone or drive a wooden plug, upon which by a strongly illuminated pencil or other slender object, exactly coincident with the vertical wire, mark a point in the line of sight thus determined; then *quickly* revolve the vernier plate 180°, repeat the observation, and as before mark a point in the new direction; then the middle point between the two marks, with the point under the instrument, will define on the ground the trace of the vertical plane through Polaris at its eastern or western elongation, as the case may be.

7. By daylight lay off to the east or west, as the case may require, the proper azimuth taken from the table No. XVI; the instrument will then define the *true meridian*, which may be permanently marked by monuments for future reference.

TABLE XV.

Local mean (astronomical[1]) time of the culminations and elongations of Polaris in the year 1897.

[Adapted[2] for latitude 39° north and longitude 75° or 5 h. west of Greenwich.]

Date.		East Elongation.	Upper Culmination.	West Elongation.	Lower Culmination.
1887.		*h. m.*	*h. m.*	*h. m.*	*h. m.*
January	1....	0 38.9	6 33.9	12 28.7	18 32.0
	15....	23 39.7	5 38.6	11 33.4	17 36.7
February	1....	22 32.6	4 31.5	10 26.3	16 29.6
	15....	21 37.3	3 36.2	9 31.1	15 34.3
March	1....	20 42.1	2 41.0	8 35.8	14 39.1
	15....	19 47.1	1 46.0	7 40.7	13 44.0
April	1....	18 40.1	0 38.9	6 33.7	12 37.0
	15....	17 45.1	23 40.0	5 38.7	11 41.9
May	1....	16 42.2	22 37.1	4 35.9	10 39.0
	15....	15 47.3	21 42.2	3 41.0	9 44.1
June	1....	14 40.6	20 35.6	2 34.3	8 37.5
	15....	13 45.7	19 40.7	1 39.4	7 42.6
July	1....	12 43.1	18 38.1	0 36.8	6 40.0
	15....	11 48.2	17 43.2	23 38.0	5 45.1
August	1....	10 41.7	16 36.7	22 31.4	4 38.6
	15....	9 46.8	15 41.8	21 36.5	3 43.7
September	1....	8 40.2	14 35.2	20 29.9	2 37.1
	15....	7 45.3	13 40.3	19 35.0	1 42.2
October	1....	6 42.4	12 37.4	18 32.1	0 39.3
	15....	5 47.4	11 42.4	17 37.1	23 40.5
November	1....	4 40.6	10 35.6	16 30.3	22 33.7
	15....	3 45.4	9 40.4	15 35.2	21 38.5
December	1....	2 42.4	8 37.4	14 32.2	20 35.5
	15....	1 47.1	7 42.1	13 37.0	19 40.2

[1] The *astronomical* day begins 12 hours *after* the civil day, *i. e.* commences at noon on the civil day of same date. The hours are counted from noon, from 0 to 24.

[2] The table was obtained from the one given in Bulletin 14 of the Coast and Geodetic Survey or in App. 1, C. and G. S. Report for 1891 by applying the following corrections: + 2.7 m. to refer to the year 1897, this correction being furnished me by the Coast and Geodetic Survey; + 0.16 m. to make table apply to 75° west; + 0.13 m. and — 0.13 m. to times of west and east elongations respectively, to refer table to latitude 39°. Although the table, as stated on top, has been especially adapted for latitude 39° and longitude 75° west, it may be used over the entire state without committing a greater error on this account than 0.1 minute.—L. A. B.

A.—*To refer the above times to any year subsequent to the tabular year (1897)* ADD *to the tabular quantities.*[1]

	Minutes.		Minutes.
For year 1897	0.0	For year 1905	7.1
1898	1.5	1906	8.4
1899	3.0	1907	9.8
1900	4.3	1908	11.1 Up to March 1. / 7.2 On and after March 1.
1901	5.5		
1902	6.9	1909	8.6
1903	8.3	1910	9.9
1904	9.7 Up to March 1. / 5.8 On and after March 1.		

B.—*To refer to any calendar day other than the first and fifteenth of each month,* SUBTRACT *the quantities below from* PRECEDING DATE *or* ADD *when working from the* FOLLOWING DATE.

Day of month.	Minutes.	No. of days elapsed.
2 or 16,	3.9	1
3 17,	7.9	2
4 18,	11.8	3
5 19,	15.8	4
6 20,	19.7	5
7 21,	23.6	6
8 22,	27.6	7
9 23,	31.5	8
10 24,	35.5	9
11 25,	39.4	10
12 26,	43.3	11
13 27,	47.3	12
14 28,	51.2	13
29,	55.2	14
30,	59.1	15
31,	63.0	16

C.—*To refer the table to Eastern or Standard time and to the civil or common method of reckoning:*

(a) ADD to the tabular quantities a correction at the rate of four minutes for every degree longitude west of the 75th meridian, that is, apply a correction as obtained from the formula,

$$\text{correction (in minutes)} = 4(l - 75^\circ),$$

[1] The corrections up to 1905 were specially furnished by the Coast and Geodetic Survey. With the aid of these corrections I was able to extend the table to 1910.—L. A. B.

where l is the longitude west of Greenwich, expressed in degrees and decimals of a degree.

(b) If the tabular quantity thus corrected is greater than 12h., subtract 12h. from the tabular quantity and add one day to the date in the margin. If the tabular time is less than 12h. it will be *p. m.* time; if greater than 12h., *a. m.*

It will be noticed that for the tabular year two eastern elongations occur on January 10 and two western elongations on July 10; there are also two culminations on April 10 and on October 10. The lower culmination either follows or precedes the upper culmination by 11h. 58.1m.

TABLE XVI.[1]

Azimuth of Polaris when at elongation for any year between 1897 *and* 1910.

Lat.	1897.0	1898.0	1899.0	1900.0	1901.0	1902.0	1903.0	1904.0	1905.0	1906.0	1907.0	1908.0	1909.0	1910.0
	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
+37	1 33.3	1 32.9	1 32.5	1 32.1	1 31.7	1 31.3	1 30.9	1 30.5	1 30.1	1 29.7	1 29.3	1 29.0	1 28.6	1 28.2
38	1 34.5	1 34.1	1 33.7	1 33.3	1 33.0	1 32.6	1 32.2	1 31.8	1 31.4	1 31.0	1 30.6	1 30.2	1 29.8	1 29.4
39	1 35.9	1 35.5	1 35.1	1 34.7	1 34.3	1 33.9	1 33.5	1 33.1	1 32.7	1 32.3	1 31.8	1 31.4	1 31.0	1 30.6
40	1 37.3	1 36.8	1 36.4	1 36.0	1 35.6	1 35.2	1 34.8	1 34.4	1 34.0	1 33.6	1 33.2	1 32.8	1 32.4	1 32.0

Mr. Schott states that " the deduced tabular azimuth (counted from the north) may generally be depended upon with no greater error than $\pm 0'.2$. The table was computed with the mean declination of Polaris for each year; a closer result will be had by applying to the tabular values, the following correction, which depends on the difference of the mean and the apparent place of the star:

For Middle of	Correction.	For Middle of	Correction.
	′		′
January, . . .	—0.4	July, . . .	+0.3
February, . .	—0.3	August, . .	+0.1
March, ...	—0.2	September, .	—0.1
April, ...	0.0	October, . .	—0.3
May, ...	+0.2	November, .	—0.6
June, ...	+0.3	December, .	—0.8

[1] Extracted from C. and G. S. Report, 1891, App. 1, or Bull. No. 14.

II.—TO DETERMINE THE TRUE MERIDIAN BY OBSERVATION ON POLARIS AT ELONGATION WITH A PLUMB-LINE AND PEEP SIGHT.

1. Attach the plumb-line to a support situated as far above the ground as practicable, such as the limb of a tree, a piece of board nailed or otherwise fastened to a telegraph pole, a house, barn, or other building affording a clear view in a north and south direction.

The plumb-bob may consist of some weighty material, such as a brick, a piece of iron or stone, weighing four to five pounds, which will hold the plumb-line straight and vertical fully as well as one of turned and finished metal.

Strongly illuminate the plumb-line just below its support by a lamp or candle, care being taken to obscure the source of light from the view of the observer by an opaque screen.

For a peep sight, cut a slot about one-sixteenth of an inch wide in a thin piece of board, or nail two strips of tin, with straight edges, to a square block of wood, so arranged that they will stand vertical when the block is placed flat on its base upon a smooth horizontal rest, which will be placed at a convenient height south of the plumb-line and firmly secured in an east and west direction, in such a position that when viewed through the peep sight, Polaris will appear about a foot below the support of the plumb-line.

The position may be practically determined by trial the night preceding that set for the observation.

About thirty minutes before the time of elongation, as given in the tables of elongation, bring the peep sight into the same line of sight with the plumb-line and Polaris.

To reach elongation the star will move off the plumb-line, to the east for eastern elongation, or to the west for western elongation, therefore by moving the peep sight in the proper direction, east or west, as the case may be, keep the star on the plumb-line until it appears to remain stationary, thus indicating that it has reached its point of elongation.

The peep sight will now be secured in place by a clamp or weight, and all further operations will be deferred until the next morning.

4. By daylight place a slender rod at a distance of two or three

hundred feet from the peep sight and exactly in range with it and the plumb-line; carefully measure this distance.

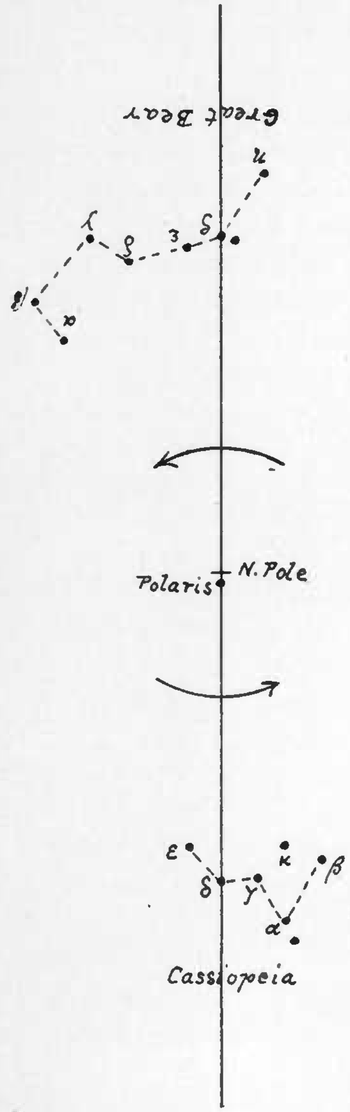
Take from the table XVI the azimuth of Polaris corresponding to the latitude of the station and year of observation; find the natural tangent of said azimuth and multiply it by the distance from the peep sight to the rod; the product will express the distance to be laid off from the rod *exactly at right angles* to the direction already determined (to the *west* for eastern elongation or to the *east* for western elongation) to a point which with the peep sight will define the direction of the *true meridian* with a fair degree of accuracy.

III.—TO DETERMINE THE TRUE MERIDIAN BY OBSERVING THE TRANSITS OF POLARIS AND ANOTHER STAR ACROSS THE SAME VERTICAL PLANE.

This simple method for tracing out on the ground a true north and south line, one demanding only a very slender instrumental outfit, was given in Lalande's Astronomy, published more than a century ago. It was used by Andrew Ellicott in 1785 in his boundary survey work of Pennsylvania and was again brought to notice in the present century by Dr. Charles Davies. It consists in watching for the time when Polaris and a given bright star come to the same vertical, and then after a short lapse of time, given in a table, Polaris will be found exactly on the meridian, and hence can be referred to the horizon and to any meridian mark placed there.

The verticality may be ascertained by a plumb-line or by the vertical thread of a transit instrument; the method demands neither a graduated circle, nor a chronometer, nor any *exact* knowledge of the local time, an ordinary watch being sufficient to measure the short tabular interval.

Early in the present century the star Alioth (ε Ursae Majoris) was favorably situated for the use of the method; however in 1850 the interval between times of verticality and of culmination already amounted to 17 minutes, which interval in 1893 had grown to 28.5m. for lower culmination and to 29.5m. for upper culmination, hence this star is no longer suitable. Zeta (ζ) Ursae Majoris or Delta (δ) Cassiopeiae should now be substituted for it, both these stars being



now in very favorable positions. Zeta (ζ) Ursae Majoris, or Mizar, as it was called by the ancient Arabians, is the middle one of the three stars in the tail of the Great Bear, the small star near it is Alcor. Delta (δ) Cassiopeiae is at the bottom of the less perfectly formed V of the letter *W*, as frequently imagined to unite roughly the five brightest stars of this constellation.

The diagram (Fig. 8), drawn to scale, exhibits the principal stars of the constellations Cassiopeiae and Great Bear, with Delta (δ) Cassiopeiae, Zeta (ζ) of the Great Bear, and *Polaris* on the meridian, represented by the straight line; Polaris being at *lower* culmination.

In employing this method the following instructions may be followed:

1. Select that one of the two stars, Delta or Zeta, which at the time of the year when the observation is made passes the meridian *below* Polaris. When the star passes the meridian above the pole it is too near the zenith to be of service. Delta (δ) Cassiopeiae is on the meridian below Polaris and the pole at midnight about April 10, and is, therefore, the proper star to use at that date and for

FIG. 8.—The diagram held perpendicular to the line of sight directed to the pole, with the right-hand side of the page uppermost, will represent the configuration of the constellations with Polaris near *eastern* elongation at midnight about July 11; *inverted*, it will show Zeta (ζ) of the Great Bear and Polaris on the meridian (the former *below* and the latter *above* the pole) at midnight about October 10; and held with left-hand side uppermost, the diagram will indicate the relative situations for midnight about January 8, with Polaris near *western* elongation. The arrows indicate the direction of apparent motion.

some two or three months before and after. Six months later the star Zeta (ζ) in the tail of the Great Bear will supply its place.

2. Using the apparatus just described under II, place the "peep sight" in the line with the plumb-line and Polaris, and move it to the *west* as Polaris moves *east*, until Polaris and Delta, for example, *appear upon the plumb-line together*, and carefully note the time by a clock or watch; then by moving the peep sight, preserve the alignment with *Polaris* and the *plumb-line* (paying no further attention to the other star); at the expiration of the small interval of time given below the *peep sight* and *plumb-line* will define the *true meridian*, which may be permanently marked for future use.

According to Mr. Schott the interval of time before Polaris will be exactly on the meridian is:

		Annual Increase.
For Zeta (ζ) Ursae Majoris in	1890 −0.9 minutes 1900 +2.6	0.35 m.
For Delta (δ) Cassiopeiae in	1890 +0.1 1900 +3.4	0.33 m.

The method given in this article for finding the true meridian cannot be used with advantage on account of the haziness of the atmosphere near the horizon, at places below about 38° north latitude.

The foregoing methods for the determination of the true meridian are excellent in themselves when available, as they answer the requirements of the surveyor and give results with all desirable precision. They do not require an accurate knowledge of the time, which is their principal advantage. The relative motion of the stars employed, when near the meridian and the unchangeable azimuth of Polaris at elongation (so far as the surveyor is concerned), indicate with sufficient exactness the moment when the observation should be made. Stormy weather, a hazy atmosphere, or the presence of clouds, may interfere or entirely prevent observation when the star is either at elongation or on the meridian, and both events sometimes occur in broad daylight or at an inconvenient hour of the night. Under such circumstances a simple method applicable at any time (Polaris being visible), may be acceptable, and can often be used by the surveyor when other methods fail.

IV.—DETERMINATION OF THE AZIMUTH OF POLARIS AND TRUE MERIDIAN AT ANY HOUR, THE STAR BEING VISIBLE AND THE CORRECT LOCAL MEAN TIME BEING KNOWN.

Many years ago a table was published giving azimuths of Polaris at stated times during one year, but as it was arranged for a kind of time with which surveyors are generally unacquainted, and was explained in unfamiliar astronomical terms, and required the use of tables and data not always accessible, it met with little favor and never came into general use.

In this article it is proposed to simplify the work, omit all technicalities requiring a knowledge of astronomy, and present the method with two new and compact tables adapted to common clock time, with such plain directions for use that any person of ordinary intelligence can understand and apply them.[1]

As the surveyor should have a perfectly clear idea of what is meant by *astronomical time* (used to simplify computations) and the *hour angle of Polaris,* these terms will now be explained.

The *Civil Day,* according to customs of society, commences at midnight and comprises twenty-four hours from one midnight to the next following. The hours are counted from 0 to 12 from midnight to noon, after which they are again reckoned from 0 to 12 from noon to midnight. Thus the day is divided into two portions of 12 hours each, the first of which is marked a. m., the last p. m.

The *Astronomical Day* commences at noon on the civil day of the same date. It also comprises twenty-four hours; but they are reckoned from 0 to 24, and from the noon of one day to that of the next following.

The *civil day begins twelve hours before the astronomical day;* therefore the first period of the civil day answers to the last part of the preceding astronomical day, and the last part of the civil day corresponds to the first part of the astronomical day. Thus, January 9, 2 o'clock p. m., civil time, is also January 9, 2h astronomical time; and January 9, 2 o'clock a. m., civil time, is January 8, 14h, astronomical time.

The rule, then, for the transformation of civil time into astronomical time is this: *If the civil time is marked p. m., take away the designation p. m., and the astronomical time is had without further change; if the civil time is marked a. m., take one from the day and add twelve to the hours, remove the initials a. m., and the result is the astronomical time wanted.*

[1] See foot-note, p. 511.

The substance of the above rule may be otherwise stated as follows: *The astronomical time is the hours and minutes elapsed since the* NOON LAST PAST, *the astronomical* DATE *being that of the civil day to which the noon belongs.* Thus, April 23, 4.15 p. m., civil time, is April 23, 4h. 15m., astronomical time, and April 23, 4.15 a. m., civil time, is April 22, 16h. 15m., astronomical time.

Hour Angle of Polaris.—In Fig. 9 the full vertical line represents a portion of the meridian passing through the zenith Z (the point directly overhead) and intersecting the northern horizon at the north point N, from which, for surveying purposes, the azimuths of Polaris are reckoned east or west. The meridian is pointed out by the plumb-line when it is in the same plane with the eye of the observer and Polaris on the meridian, and a visual representation is also seen in the vertical wire of the transit, when it bisects the star on the meridian.

When Polaris crosses the meridian it is said to culminate; above the pole (at S) the passage is called the *upper culmination*, in contradistinction to the lower culmination (at S').

In the diagram—which the surveyor may better understand by holding it up perpendicular to the line of sight when he looks toward the pole—Polaris is supposed to be on the meridian, where it will be about *noon* on April 10 of each year. The star appears to revolve around the pole, in the direction of the arrows, once in every 23h. 56.1m. (23 hours, 56 minutes, 4.09 seconds) of *mean solar time*; it consequently comes to and crosses the meridian, or *culminates*, nearly four minutes *earlier* each successive day. The apparent motion of the star being uniform, one quarter of the circle will (omitting fractions) be described in 5h. 59m., one-half in 11h. 58m., and three-quarters in 17h. 57m. For the positions s_1, s_2, s_3, etc., the angles SPs_1, SPs_2 SPs_3, etc., are called *Hour Angles of Polaris* for the instant the star is at s_1, s_2, or s_3, etc., and they are measured by the arcs Ss_1, Ss_2, Ss_3, etc., expressed (in these instructions) in *mean solar* (common clock) time, and are always counted from the *upper* meridian (at S) to the *west*, around the circle from 0h. 0m. to 23h. 56m.1, and may have any value between the limits named. The hour angles, measured by the arcs Ss_1, Ss_2, Ss_3, Ss_4, Ss_5 and Ss_6, are approximately 1h. 8m., 5h. 55m., 9h. 4m., 14h. 52m., 18h. 01m.,[1] and 22h.

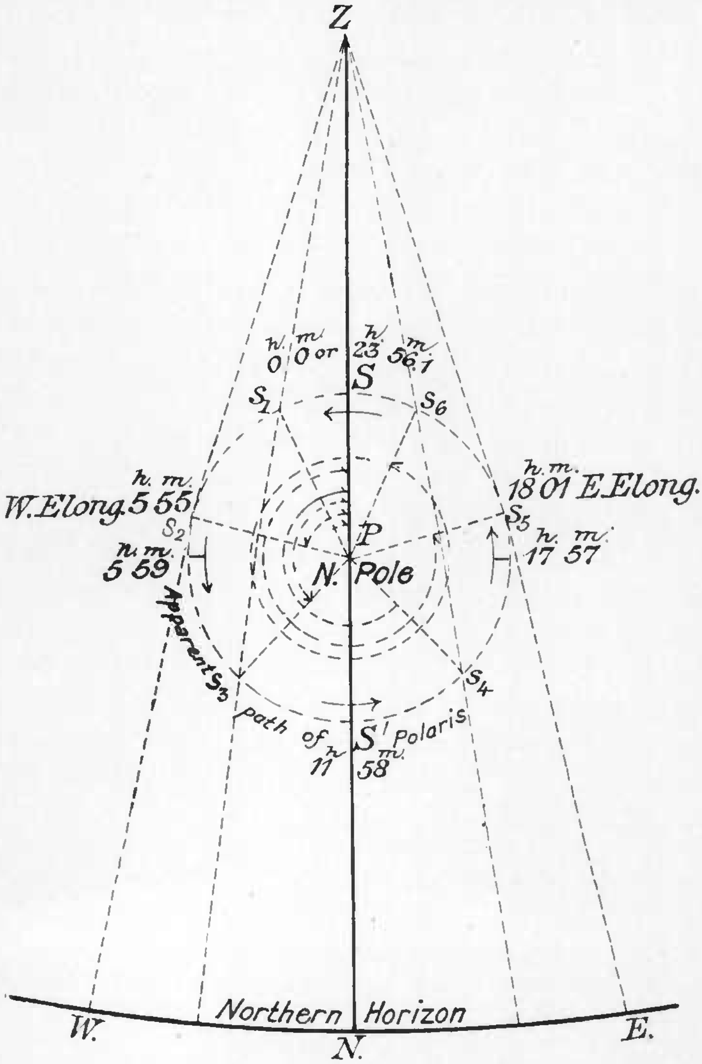


FIG. 9.

48m. respectively; their extent is also indicated in the diagram by broken fractional circles about the pole.

[1] The hour angles, 5 h. 55 m. and 18 h. 01 m., are those at west and east elongation respectively in latitude 40° N.

Hence, to obtain the hour angle of Polaris *subtract the time of upper culmination from the correct local mean time of observation; the remainder will be the hour angle of Polaris.*

The *observation* will be made as directed under Method I, modified as follows: there will be no waiting for the star to reach elongation; the observation may be made at any instant when Polaris is visible, the exact time being carefully noted.

Table XVII.

This table gives, for various hour angles, expressed in *mean solar time*, and for even degrees of latitude from 36 to 40 degrees, the *azimuths of Polaris* during the remainder of this century, computed for average values of the north polar distance of the star—the arguments (reference numbers), being the *hour angle* (or 23h. 56m.1, *minus* the hour angle, when the latter exceeds 11h. 58m.), which is termed the *Time Argument*;[1] and the *latitude* of the place of observation. The table is so extended that azimuths may be taken out by mere inspection and all interpolation avoided, except such as can be performed mentally.

The *hours* of the "time arguments" are placed in the columns headed "Hours," on the left. The *minutes* of the time arguments will be found in the columns marked "m.," under the years for which they are computed, and they are included between the same heavy zigzag lines which inclose the hours to which they belong.

[1] The vertical diameter SS', Fig. 9, divides the apparent path of Polaris into two equal parts, and for the star at any point s_6 on the *east* side, there is a corresponding point s on the *west* side of the meridian, for which the azimuth Nw is equal to the azimuth Ne. The arc $Ss_1S's_6$, taken from the entire circle (or 23 h. 56.1 m.), leaves the arc Ss_6, and its equal, Ss_1, expressed in time, may be used to find, from Table XVII, the azimuth Nw, which is equal to Ne.

The hour angles entered in Table XVII include only those of the *west half* of the circle ending at S', and when an hour angle *greater* than 11 h. 58 m. results from observation, it will be *subtracted* from 23 h. 56.1 m., and the *remainder* will be used as the "time argument" for the table. The surveyor should not confound these two quantities. The *hour angle itself* always decides the *direction* of the azimuth and defines the place of the star with reference to the pole and meridian, as noted at top of Table XVII. See examples at the end of this part.

The time arguments are given to the nearest half-minute; the occurrence of a period after the *minutes* of any of them indicates that its value is 0.5m. greater than printed, the table being so arranged to economize space.

The table will be used as follows: *Find the* HOURS *of the time argument in the column marked "Hours"; then, between the heavy lines which inclose the hours, find the* MINUTES *in the column marked at the top with the current year. On the same horizontal line with the* MINUTES *the azimuth will be found under the given latitude, which is marked at the top.* Thus, for 1897, *time argument,* 0h. 41m., latitude 38°, is the azimuth 0° 17′. For 1899, time argument 7h. 53m., latitude 36°, the azimuth is 1° 19′.

If the *exact* time argument is not found in the table the azimuth should be proportioned to the difference between the given and tabular values of said argument. Thus, if the time argument in the first of the above examples (for 1897) was 0h. 39m., instead of 0h. 41m., the azimuth would be the mean between 0° 15′ and 0° 17′ or 0° 16′. In a similar manner, if the *latitude* is nearer an *odd* than an *even* degree, the mean of the azimuths for the next greater and next less latitude will be used; thus in the above example for 1899, if the given latitude was 37°, the mean between 1° 19′ and 1° 21′, or 1° 20′, would be corresponding azimuth. The table has been arranged to give the azimuths, as exemplified above, by simple inspection. No written arithmetical work is required, all being performed mentally. It will generally be sufficient to take the nearest *whole* degree of latitude and use it as above directed; for a few values near the bottom of the table, for example, the latitude may be taken to the nearest *half* degree.

The attention of the surveyor is directed to the fact that he should always use *one day of twenty-four hours* as the unit when he subtracts the time of *culmination* from the time of *observation*. *In any case when the time of upper culmination taken from Table XV, for the given date, would be numerically greater than the astronomical time of observation, the former time will be taken out for a date one day earlier than the date of observation.* The surveyor will decide when such conditions exist by comparing the time given in the table with his astronomical time of observation. *The upper culmination to be used at any time will always be the* LAST *one that occurs before the observation.*

When an hour angle comes out within *one minute* of either 0h. 0m., or 23h. 56m.1, the observation may be regarded as having been taken with the star on the meridian, *above* the pole; if within one minute of 11h. 58m., Polaris may be considered on the meridian *below* the pole at the time of observation.

At *elongation* Polaris is nearly 5h. 55m. west (or east) of its position at upper culmination; consequently if the hour angle for *any* observation comes within *five minutes* of 5h. 55m., or 18h. 1m., the star may be assumed to be *at elongation, west* for the first and *east* for the second hour angle, and its azimuth may be taken from a preceding table (No. XVI), which gives its value at elongation from 1890 to 1910 inclusive.

Should the surveyor wish the time of *lower culmination*, for use with the plumb-line method (No. II), described on page 516, or for any other purpose, he will first determine the time of *upper* culmination for the date (Table XV) and then *subtract* 11h. 58m. for the *preceding* lower culmination, or *add* 11h. 58m. for the lower culmination *following* the derived time for upper culmination, attending to the addition or subtraction of 23h. 56.1m., as directed in an example (1) below.

The time to be used when making observations on Polaris off the meridian should be as accurate as can be obtained. Looking at Table XVII, near the top of the page, the surveyor will observe that for a difference of *four* minutes in the time argument there is a change of about *two* minutes in azimuth; consequently, to obtain the azimuth to the *nearest whole minute of arc*, the *local mean time*, upon which all depends, should be known *within two minutes*. When the surveyor uses a solar instrument, he can readily determine the time for himself during the afternoon *before* observing Polaris, or in the morning *after* observation, and, without moving the hands of his watch, apply the necessary correction to his *observed* watch time. When the surveyor uses *standard railroad time* he will correct the same for the difference of longitude between his station and the standard meridian for which the time is given, at the rate of *four minutes* of time *for each degree* of the difference in arc (see instructions, p. 514). Thus, if the difference of longitude for the station be $1^\circ\ 45' = 1^\circ.75$, the equivalent in time will be $4 \times 1.75 = 7$ minutes. Since table XV applies to longitude 75°, the correction will always be *subtracted* from the standard railroad time of observation to obtain *local* time. It is immaterial *where* the surveyor obtains the standard time, provided he gets it right; a result which will be determined in the most satisfactory manner by a direct comparison at a telegraph office.

Generally the surveyor will have only two or three simple additions or subtractions to make, and ten minutes will be ample time in which to make the observation and perform the little computation required.

TABLE XVII.

Azimuths of Polaris for the use of land surveyors.

POLARIS ABOVE THE POLE.								POLARIS BELOW THE POLE.							
	Time Argument.				Azimuth for latitude.				Time Argument.				Azimuth for latitude.		
Hours.	1897.	1898.	1899.	1900.	36°	38°	40°	Hours.	1897.	1898.	1899.	1900.	36°	38°	40°
h.	m.	m.	m.	m.	° ′	° ′	° ′	h.	m.	m.	m.	m.	° ′	° ′	° ′
0	04	04	04	04	0 02	0 02	0 02	11	54	54	54	54	0 02	0 02	0 02
0	08	08.	08.	08.	0 03	0 03	0 04	11	50	50	50	50	0 03	0 03	0 03
0	12	12.	12.	12.	0 05	0 05	0 05	11	45.	45.	46.	45.	0 05	0 05	0 05
0	16.	16.	16.	16.	0 07	0 07	0 07	11	41.	41.	41.	41.	0 06	0 07	0 07
0	20.	20.	21	21	0 08	0 09	0 09	11	37.	37.	37.	37.	0 08	0 08	0 08
0	24.	24.	25	25	0 10	0 10	0 11	11	33.	33.	33	33	0 10	0 10	0 10
0	28.	29	29	29	0 12	0 12	0 12	11	29.	29	29	29	0 11	0 12	0 12
0	33	33	33.	33.	0 13	0 14	0 14	11	25	25	25	25	0 13	0 13	0 14
0	37	37	37.	37.	0 15	0 15	0 16	11	21	21	21	21	0 15	0 15	0 15
0	41	41.	41.	41.	0 17	0 17	0 18	11	17	17	16.	16.	0 16	0 17	0 17
0	45.	45.	45.	46	0 18	0 19	0 19	11	13	12.	12.	12.	0 18	0 18	0 19
0	49.	49.	50	50	0 20	0 21	0 22	11	08.	08.	08.	08	0 19	0 20	0 20
0	53.	53.	54	54	0 22	0 22	0 23	11	04.	04.	04.	04	0 21	0 22	0 22
0	57.	58	58	58.	0 23	0 24	0 25	11	1	00.	00.	00	0 23	0 23	0 24
1	02	02	02.	02.	0 25	0 26	0 26	10	56.	56.	55.	55.	0 24	0 25	0 25
1	07	07	07.	07.	0 27	0 28	0 28	10	51	51	50.	50.	0 26	0 27	0 27
1	12	12.	13	13	0 29	0 30	0 31	10	46	46	45.	45	0 28	0 29	0 29
1	17.	17.	18	18	0 31	0 32	0 33	10	41	40.	40.	40	0 30	0 31	0 31
1	22.	22.	23	23	0 33	0 34	0 35	10	35.	35.	35	35	0 32	0 33	0 34
1	28	28.	28.	28.	0 35	0 36	0 37	10	30.	30.	30	29.	0 34	0 35	0 36
1	33	33.	34	34	0 37	0 38	0 39	10	25.	25	24.	24.	0 36	0 37	0 38
1	38	38	38.	39	0 39	0 40	0 41	10	20.	20	19.	19	0 37	0 39	0 40
1	43	43.	44	44.	0 41	0 42	0 43	10	15.	15	14.	14	0 39	0 40	0 41
1	48	48.	49	49.	0 42	0 44	0 45	10	10	09.	09	08.	0 41	0 42	0 43
1	53.	54	54.	55	0 44	0 46	0 47	10	05	04.	04	03.	0 43	0 44	0 45
1	58.	59	59.	00	0 46	0 47	0 49	9	59.	59	58.	58	0 45	0 46	0 47
2	03.	04.	05	05.	0 48	0 49	0 51	9	54.	54	53	53	0 47	0 48	0 49
2	09	09.	10	10.	0 50	0 51	0 53	9	49	49	48	47.	0 48	0 50	0 51
2	14	14.	15	16	0 51	0 53	0 54	9	44	43.	43	42	0 50	0 51	0 53
2	19	20	20.	21.	0 53	0 55	0 56	9	39	38.	37.	37	0 52	0 53	0 55
2	24.	25	26	26.	0 55	0 57	0 58	9	33.	33	32	31.	0 53	0 55	0 56
2	30	30.	31	32	0 57	0 58	1 00	9	28.	28	27	26.	0 55	0 57	0 58
2	35	35.	36.	37	0 58	1 00	1 02	9	23	22.	21.	21	0 57	0 58	1 00
2	40	41	41.	42.	1 00	1 02	1 03	9	18	17.	16.	15.	0 58	1 00	1 02
2	45.	46.	47	48	1 02	1 03	1 05	9	12.	12	11	10	1 00	1 02	1 03
2	50.	51.	53	53	1 03	1 05	1 07	9	07.	06.	05.	05	1 02	1 03	1 05
2	56	57	57	58.	1 05	1 07	1 08	9	02	01.	00.	59.	1 03	1 05	1 07
3	01	02	03	04	1 06	1 08	1 10	8	57	56	55	54	1 05	1 06	1 08
3	06.	07.	08.	09.	1 08	1 10	1 12	8	52	51	49.	49	1 06	1 08	1 10
3	13	14	15	16	1 10	1 12	1 13	8	45.	44.	43	42.	1 08	1 10	1 12
3	19.	20.	21.	23	1 11	1 13	1 15	8	39.	38	36.	35.	1 09	1 11	1 13
3	25.	27	28	29	1 13	1 15	1 17	8	32.	31.	30	29	1 11	1 13	1 15
3	32.	33.	35	36	1 14	1 16	1 19	8	27	25	23.	23.	1 13	1 15	1 17
3	39	40	41.	43	1 16	1 18	1 20	8	19.	17.	17	15.	1 14	1 16	1 18
3	46.	48	49.	51	1 17	1 20	1 22	8	12	10.	09	07.	1 16	1 18	1 20
3	54	55.	57.	59	1 19	1 21	1 24	8	04	02.	01	59.	1 18	1 20	1 22
4	02	03.	05	07	1 21	1 23	1 25	7	56.	55	53	51.	1 19	1 21	1 24
4	12	13.	15.	17.	1 23	1 25	1 27	7	46.	44.	42.	40.	1 21	1 24	1 26
4	23.	25.	28	30	1 24	1 27	1 29	7	35	33	30.	28.	1 23	1 26	1 28
4	35.	38	40.	43	1 26	1 29	1 31	7	23	20.	18	15.	1 25	1 27	1 30
4	48.	50.	54	57.	1 28	1 30	1 33	7	10.	07.	04.	01.	1 27	1 29	1 32
5	08.	12.	17.	23	1 30	1 33	1 35	6	50	45.	41	35.	1 29	1 32	1 34
5	37	50	..	..	1 32	1 34	1 37	6	22.	11	..	..	1 31	1 34	1 36

REMARKS.

1. The *hour angles* are expressed in *mean solar* time. The occurrence of a *period* after minutes of an hour angle indicates that its value is 0.5m. greater than printed.
2. "*Time argument*" is the star's hour angle (or 23h. 56.1m. *minus* the star's hour angle).
3. *The azimuth*, or bearing, is *W. of N.* when hour angle is *less* than 11h. 58m. and *E. of N.* when hour angle is greater than 11h. 58m.
4. *To determine the true meridian.*—The azimuth will be laid off to the *east* when the hour angle is *less* than 11h. 58m., and to the *west* when *greater* than 11h. 58m.

Examples of Application of foregoing Tables.

1. Required the *Hour Angle* and *Azimuth of Polaris*, at Linden, Montgomery County, on June 10, 1897, at 8h. 33m. 12s. p. m., according to pocket watch keeping *standard* time.

Geographical position of Linden: Lat. 39.0°, Long. 77.05° W.

	m. s.	h. m. s.	h. m.
Watch time of observation, 1897, June 10		8 33 12 p.	
Watch fast on standard time, 1 m.	—1 00		
Reduction of standard time to Linden local mean time = 4 (75–77.05) = 8.2 m.	— 8 12	— 9 12	
Linden local mean time of observation, 1897, June 10..		8 24 00 p.	
Astronomical time of " " " " ..			8 24.0
Astron. time, U. C. Polaris, June 1, 1897 (Table XV) ..		20 35.6	
Reduction to June 9[1] (p. 514)		—31.5	
		20 04.1	
Check: Astron. time U. C. Polaris, June 15, 1897.......		19 40.7	
Reduction to June 9 or 6 days		+23.6	
		20 04.3	
Hence astron. time U. C. Polaris, June 9, 1897		20 04.2, subtract[2]	20 04.2
Hour angle of Polaris, at observation			12 19.8
Subtract from........................			23 56.1
Time argument for Table XVII			11 36.3
Azimuth of Polaris, at observation			0° 08.5′ E.

To obtain the meridian lay off 0° 08.5′ to the *west*.

2. Required the *Hour Angle* and *Azimuth of Polaris*, for Easton, Talbot County, at 6h. 20.4m. a. m., standard time, November 20, 1900.

Geographical Position of Easton: Lat. 38°.8, Long. 76°.1 W.

	h. m.	h. m.
Standard time of observation, Nov. 20	6 20.4a	
Reduction of standard time to Easton local mean time = 4(75 — 76.1) = —4.4 m.	—4.4	
Easton local mean time of observation, Nov. 20	6 16.0a	
Astronomical time of observation 1900, Nov. 19		18 16.0
Astron. time U. C. Polaris, 1897, Nov. 15 (Table XV)	9 40.4	
Reduction to 1900, Nov. 15 ....+4.3 m.; Reduction to 1900, Nov. 19....—15.8 m.	—11.5	
Astronomical time U. C. Polaris, 1900, Nov. 19	9 28.9	9 28.9
Hour Angle of Polaris, at observation and Time Arg., for table XVII		8 47.1
Azimuth of Polaris, at observation (Table XVII)........................		1 09.5 W.

To obtain the meridian lay off 1° 09.5′ to the *east*.

[1] By reference to table XV, the surveyor will observe that the times between June 1 and 15 are greater than 8 h. 24 m.; consequently, the culmination for one day earlier, June 9, will be used; see directions p. 524 (bottom).

[2] To subtract, take one day from June 10 and add its equivalent, 24 h. to 8 h. 24 m., making June 9, 32 h. 24 m. (which is the time expressed by June 10, 8 h. 24 m.); then subtract in the usual manner.

The Determination of the Magnetic Declination by the Surveyor.

In conclusion, it may be remarked that when the surveyor determines the value of the magnetic declination himself it would be well for him to make the observations on several days, if possible. Probably the best time of day for making the observations would be towards evening, about 5 or 6 o'clock.[1] At this time the declination reaches, approximately, its mean value for the day (see Table II). The observations on any one day should extend at least over one-half of an hour, preferably an hour, and the readings should be taken every ten minutes. Before each reading of the needle it would be well to tap[2] the glass plate lightly with the finger or a pencil so as to slightly disturb the needle from the position of rest it may have assumed. The accurate time should be noted opposite each reading and a note entered in the record-book as to the date, the weather and the kind of time the observer's watch was keeping. A brief description of station and of method employed in determining the meridian line and declination should be added to the record. It is very essential that the surveyor should have some knowledge as to the *error*[3] of his compass. He can determine this by making observations at one of the magnetic survey stations. He should reduce his value to January 1st, 1900, by allowing an annual change of 3′ per annum, as explained elsewhere, and then compare his value with that obtained in the magnetic survey. This correction can best be determined at the county-seats where meridian lines have been established. It would not be amiss to determine the compass correction before and after the determination of the magnetic declination.

[1] Or the surveyor may make his observations in the morning and early in the afternoon, at about the times of minimum and maximum values of the magnetic declination. He may regard the mean of the two extreme values as corresponding closely to the mean value for the day (24 hours).

[2] Great care must be taken not to electrify the needle by rubbing the glass plate in any manner. Remarkable deflections of the needle can thus be produced.

[3] I have found surveyor's compasses to differ at times as much as 1° from the readings with the C. and G. S. magnetometer. The error may be due to a variety of causes, such as an imperfect pivot, non-coincidence of magnetic axis of needle with the geometric axis, and loss of magnetism of the needle.

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